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Agricultural Conference of Malaya

PROCEEDINGS

OF THE

FIRST AGRICULTURAL CONFERENCE, MALAYA,

HELD AT THE

CHAMBER OF COMMERCE, KUALA LUMPUR,

APRIL 25TH TO 28TH, 1917

Including the Papers Contributed to the Conference
and Reports of the Discussions

EDITED BY

L. LEWTON-BRAIN

AND

B. BUNTING.

KUALA LUMPUR:

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PREFACE.

THIS volume represents the official report of the *Proceedings* of the First Agricultural Conference of Malaya, and includes the papers contributed to the Conference, together with the discussions which followed the reading of the papers. The discussions in most cases were not so thorough as they might have been, but, now that we are assured that the planting community will support an Agricultural Conference, it is hoped to arrange programmes for future Conferences which will allow more time for discussion, and to appoint delegates in different parts of the Peninsula who will come prepared to discuss the papers submitted to these Conferences.

The Conference Committee wish to place on record their appreciation of the valuable service rendered by the gentlemen who took part in the Conference.

FIRST
AGRICULTURAL CONFERENCE, MALAYA,
HELD IN KUALA LUMPUR,

April, 1917.

PRESIDENT :

L. LEWTON-BRAIN,
(Director of Agriculture, F.M.S.).

VICE-PRESIDENTS :

R. C. M. KINDERSLEY,
(Chairman, Planters' Association of Malaya).
R. W. MUNRO,
F. G. HARVEY.

HONORARY SECRETARY :

B. BUNTING,
(Assistant Agriculturist, F.M.S.).

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AGRICULTURAL CONFERENCE, MALAYA, 1917.

THE first Agricultural Conference of Malaya was held at Kuala Lumpur on 25th to 28th April, 1917.

The following Committee was appointed to make all arrangements :

Chairman—Mr. L. Lewton-Brain, *Director of Agriculture* ;

Members—Mr. R. C. M. Kindersley ;

„ R. W. Munro ;

„ F. G. Harvey ;

„ L. Mooijaart ;

„ H. C. E. Zacharias, *Secretary, P.A.M.* :

Hon. Secretary—Mr. B. Bunting, *Assistant Agriculturist*.

The first session was held at the Chamber of Commerce, Kuala Lumpur, on 25th April at 2.30 p.m., there being about 75 visitors present.

The Director of Agriculture (*President of the Conference*) was in the Chair and in opening the Conference extended a hearty welcome to the visitors to the Conference and said that he expected that the papers to be read would prove of benefit to all. He hoped that a great part of their value would be in eliciting the opinions of all those attending. Every opportunity would be given for discussion and he hoped that everybody would avail themselves of it freely.

The Chairman then introduced Dr. S. H. R. Lucy who read his paper on "Health and Sanitation on Estates."

The next session consisted of a visit to the Offices of the Department of Agriculture on 26th April at 8.30 a.m. The visitors, of whom there were about 110, were first conducted round part of the Experimental Plantation and shown a number of economic products which were being grown on an experimental scale. At 9.30 a.m., a demonstration of the rubber vulcanizing and testing station, acetic acid plant, fibre and paper making machinery, etc., was given. Later, the visitors were shown the various laboratories and inspected specimens of various diseases and pests, besides various economic products grown at the Government Plantations.

The third and all subsequent sessions were held at the Chamber of Commerce, Kuala Lumpur.

At the third session Mr. R. W. Munro (*Vice-President*) took the Chair at 2.30 p.m., on the 26th April; the audience numbered about 120. The following papers were read and discussed: "Cultivation and Manuring" by Mr. A. P. N. Vesterdal, "Cultivation, Drainage and Manuring" by Mr. F. G. Spring, and "Rubber Seed Selection" by Mr. A. H. Malet: A further paper on "Seed Selection" by Mr. J. McNicol was taken as read.

The President again took the Chair at the fourth session (owing to the absence through illness of Mr. R. C. M. Kindersley, Chairman of the Planters' Association of Malaya) at 9 a.m. on the 27th April, the attendance numbered about 150. The following papers were read: "Leaf and Stem Diseases of Hevea" by Mr. R. M. Richards, and "Clean Clearing and Root Diseases" by Mr. W. N. C. Belgrave. Owing to the absence of the writer through illness a paper on "Clean Clearing Pest and Diseases" by Mr. W. R. Shelton-Agar was taken as read.

At 11.30 a.m., the Conference adjourned for half an hour. On resuming other papers were read as follow: "Pests and Diseases of Coconuts" by Mr. R. M. Richards, "Termites" by Mr. P. B. Richards, and "Application of the Agricultural Pests Enactment" by Mr. F. W. South.

Mr. F. G. Harvey (*Vice-President*) took the Chair at the fifth session, which started at 2.30 p.m. on the 27th April; the audience numbering about the same as at the morning session. The following papers were read: "Thinning Out" by Mr. T. J. Cumming, "Thinning Out" by Mr. E. W. King, "Factory Methods" by Mr. F. G. Souter, and "Preparation of Raw Rubber" by Mr. B. J. Eaton.

The final session was held at 9 a.m. on the 28th April with the President in the Chair. The attendance was somewhat disappointing, there being only about 50 present, which included several numbers of the Agricultural Department. The following papers were read and discussed: "Foodstuffs in Malaya" by Mr. F. G. Spring, "Cultivation of Liberian Coffee" by Mr. R. W. Munro, "Economic Products in Malaya" by Mr. F. G. Spring, and "Observations on Coconut Experiments" by Mr. W. S. Cookson and Mr. G. E. Coombs, while, in the absence of the writer, Mr. I. H. Burkill's paper on "Food Crops in Malaya" was taken as read.

In publishing the proceedings of the Conference the papers will be grouped under the following headings:

- (a) RUBBER CULTIVATION;
- (b) PESTS AND DISEASES;
- (c) RUBBER PREPARATION; COCONUTS;
HEALTH AND SANITATION;
- (d) MINOR ECONOMIC PRODUCTS,

RUBBER CULTIVATION.

CULTIVATION AND MANURING.

BY A. P. N. VESTERDAL,

(*General Manager, Mount Austin Estates, Johore.*)

MANY interesting articles on tillage of soil and various other matters in connection with this question have from time to time appeared in the *Agricultural Bulletin*, and what has been mentioned in those articles I shall only touch lightly upon.

The general principles of cultivation will apply to most crops, but of tropical agriculture I only know rubber, and what I have to say will, therefore, refer only to rubber trees, and mostly to those planted on poor undulating land. Trees planted on virgin land or alluvial soil will continue for many years to grow well and to yield well, and although I do not doubt that cultivation would increase the crops anywhere, it is, for the present, not required here to the same extent as it is on poor land.

All over the Peninsula large areas formerly cultivated with pine-apples, gambier and tapioca have been planted with rubber. The state of such land is well known, it is always up in lalang and blukar, and, generally speaking, it is exhausted; firstly, on account of the crops taken, and secondly, because of the frequent burnings of the lalang.

Through fires some valuable foodstuff is always wasted, not only what goes away in the air by the burning process itself, but also what is afterwards washed away with the ashes by heavy rains even on gently sloping hills.

Trees planted on this kind of land take a long time to reach maturity, and the result is often far below average. It will always be below average, if nothing is done to help the trees along.

The usual method of clean weeding is not so satisfactory here as it is on good flat land. It is certainly the cheapest, but in this particular case the cheapest, in my opinion, is not the best, as it will sooner or later lead to retarded growth of the trees. In some instances the retardation is shown when the trees are from two to three years old, and in other cases it is not noticeable until tapping has commenced.

It is always said that tapping does not hurt a tree, and it is true that it does not hurt those growing on first class soil, but it hurts weak trees. Whether the cause is removal of latex or removal of bark, I do not know, but the fact remains, that trees in tapping do not grow so quick as trees not in tapping. It is not unusual that

trees grow quite well up to the time tapping is started, and after that they almost cease putting on girth, even if they are only lightly tapped.

On such trees improvement is a necessity. They are simply starved, the bark-renewal is bad, and if they do not get some nourishment it is only a question of time when the flow of latex will cease, if not altogether, then anyhow to such an extent, that the profit per acre will be very much reduced, which, of course, is the wrong way to go.

There are thousands of acres with that sort of starved trees in the Peninsula. As far as I have seen the south is considerably worse than further up country, but there are some everywhere, and I think that something more could be done to resuscitate those trees than has hitherto been the case.

To start manuring on a large scale before it has been properly ascertained what the soil is lacking is not wise, and before going to such expense it would be the natural thing to try to improve matters by cultivation.

When a young hilly plantation on old *jalang* land has been kept perfectly clean for some years big quantities of the top-soil have been washed away, leaving the ground hard, and under such conditions the trees are unable to get the full benefit from the more or less scanty supply of plant food present.

The chief object of cultivation is to prepare the soil in such a way that absorbable plant food can be formed and held until used by the plants.

As a whole, the question of nutriment of plants is very extensive and complicated, and I shall, therefore, on this occasion, confine myself to the mentioning of a few facts.

It is common knowledge that all plants require, in order to live, the following ten elements: oxygen, hydrogen, carbon, nitrogen, sulphur, phosphorus, potassium, calcium, iron and magnesium, or what is easier to remember, four bases, potash, lime, magnesia and iron dioxide and four acids, carbonic acid, sulphuric acid, nitric acid and phosphoric acid.

The plants obtain their supply of carbon chiefly by assimilation of carbonic acid through the leaves, and the leguminous and a few other kinds of plants are able, aided by bacteria, to assimilate and utilize the free nitrogen from the atmosphere, but otherwise all plant food is taken from the ground, mostly dissolved in water, but in some instances dissolved by the acid exuded by the young rootlets.

A small amount of carbonic acid contained in the water is assimilated by the roots of plants, but besides this carbonic acid is of some use in the ground, mostly by bringing inorganic matter into solution.

As far as oxygen is concerned this element is of importance not only in the atmosphere, but also in the soil. Here it plays an important part in the formation and transformation of most nutritive compounds, and it is essential in the ground, because the roots of plants breathe in the same way as the stems and branches breathe. Oxygen is also required by many bacteria, which are important for transforming certain foodstuffs into absorbable compounds, for instance, transforming ammonia into nitric acid, in which form the plants take most of their supply of nitrogen, and also for transforming decaying matter into absorbable substances.

In a hard and compact soil the bacteria referred to do not thrive, and their well-being is only ensured by cultivation.

If the ground is not properly ventilated suitable solutions cannot be formed either for want of water or for want of air, and it is thus obvious that a well aerated and permeable soil is of the greatest importance to the plants.

On uncultivated land the water, which is the main factor in all plant life, cannot penetrate properly. After heavy showers it just runs off, and I believe that starvation of rubber trees is frequently due to an insufficient supply of water.

Cultivation helps to retain the water, and between old trees it also helps to retain fallen leaves, which are often washed away if the surface is too smooth.

Cultivation is mostly done by chankolling and amongst old trees this cannot very well be done otherwise, but young clearings can almost always be treated cheaper and better by the use of agricultural implements, ploughs and harrows.

In the course of time several different kinds of harrows have been tried on plantations, and at a certain period disc harrows were much in favour. On the estate with which I am connected we also tried some, but we did not find them satisfactory. In hard soil the discs could not work, and where they worked they only loosened a couple of inches of the soil, resulting in very bad wash.

About two and a half years ago we commenced ploughing, and on one of our sections 2,200 acres out of 2,800 have been treated.

The first ploughing was done by a small one-handled American plough, "Luzon," which did very good work, but since then a bigger type of a two-handled Danish plough, "Fräugde," has been introduced and is now used exclusively. It is quite an ordinary plough, but so strongly made, that it does not break when encountering the usual obstacles in the ground.

I know that some planters have tried ploughing and given it up on account of the difficulty of teaching the bullocks to drag the plough, but I may say that we have never experienced any trouble

in that respect. In a few days any pair of bullocks will learn to walk steadily if attended to by a good cooly. Bullocks walk better when dragging the plough in a pole fixed to the shoulder harness than when dragging by means of an ordinary rope.

When ploughing the first time with the small plough one pair of bullocks with two coolies were only able to treat three-fourths of an acre per day, but with the bigger plough at the second and subsequent ploughings they can do as much as one acre per day. It should be mentioned here that the soil is very light, consisting chiefly of a sandy loam.

The cost of ploughing with everything included, wages to coolies, bullock food and depreciation on bullocks, and machinery comes to about \$2.40 per acre. Harrowing is cheaper, as a team can treat four acres per day. The harrow we use is divided into three parts, each two feet wide, and this construction makes it possible to treat undulating ground better than with a harrow in one piece. The harrow is used partly for levelling the ground and partly for checking grass in young clearings. In old clearings they are not used.

Out of the 2,200 acres 12 teams usually plough about 300 acres per month, and the ground can thus be treated about twice a year.

The ploughs, going to a depth of about five inches, turn the soil so well that the ordinary small kinds of grasses are buried completely. On a well-cultivated soil such grasses do no harm, they help to prevent wash, and they increase the humus in the soil when ploughed down.

When the talk is about toxins, I presume that these are formed where the grass cover is kept more permanently. I said before that clean weeding is the cheapest, but the cost where ploughs are used does not come to much more. The land must be gone over once a month to remove obnoxious weeds and small bushes, but the expenses incurred by this work, added to the cost of ploughing and harrowing, average only about 80 cents per acre per month.

Where ploughing is commenced before the trees are three years old the soil can be treated to within one and a half feet of the rows of the trees. Later on it may not be safe to go quite so close, but I see no reason why ploughing, when started early, should not be continued also when the trees grow big, anyhow where thinning is carried out judiciously.

The plough furrows should as far as feasible run across the slopes on hills, as otherwise there is the danger that those left open when the ploughing is finished will be acting as drains.

At the first ploughing, and also occasionally at the second, it happens that fairly big roots are cut, but I have so far seen no bad effect from this.

The damaged roots are perhaps more liable to attacks by Fomes, but the danger is not great because the frequent turning and airing of the soil is sure to reduce the virulence of any *mycelium* in the ground.

All roots cut by the ploughs throw out whole bunches of new roots which, owing to the loose nature of the ground, have a tendency to go deeper down. This is quite contrary to their habit on uncultivated soil, where the roots always lie near the surface, and where the young rootlets sometimes even go above it. The young rootlets from rubber trees often form one mass, and when the ground is ploughed or chankolled these are all spoilt. But in a fortnight it will be found that new rootlets are taking their place, and this lively action of the roots can only be beneficial to the trees.

The cutting of the roots has been one of the points against cultivation, and another is, that the uneven surface of the ground causes too great a loss of moisture.

I do not think that the root-question need cause any alarm, and in a climate like this where rain is so plentiful the loss of moisture by evaporation from the ground cannot have serious consequences, at least not where something is done to keep the water.

A loose top-soil is of vital importance, and rubber trees respond very well to proper treatment in respect of cultivation, but it should not be overlooked that retarded trees cannot suddenly throw out sturdy shoots from weak branches, and the effect of cultivation is not to be expected until after a year's time. To judge the result by measurement of the girth of the trees only is not sufficient. The general appearance of the trees, the colour of the leaves and the thickness of the shoots have all to be taken into consideration, and if they are there is always a marked difference between trees on cultivated and uncultivated land.

With a view to gaining some knowledge concerning the effect of artificial manure on rubber trees many experiments have been carried out with rather varying results. It has been said once in a report that the good results of some experiments supposed to be due to the manure, was really the effect of turning over the soil when digging down the manure, and that view is probably correct.

It is in any case difficult to arrive at anything like exact figures as to the result of an experiment carried out on soil not cultivated before.

We have had two experiments running for some time, one on young trees and one on old trees, but as far as the latter is concerned the result is not very encouraging.

Previous experiments have proved that young trees respond very well to manure. We started our experiment on the three

years' old trees mostly with a view to trying the effect of lime together with artificial manure on light soil, and the various blocks received different quantities of kainit, basic slag, bone-meal and superphosphate with and without lime.

This experiment was started in April, 1915.

With the exception of the blocks receiving lime and kainit separately and also those receiving the two stuffs mixed, all the blocks have gained on the check-blocks.

Lime, as a whole, seems to have done more harm than good, as all the blocks to which manure only has been applied show better results than those receiving lime as well.

Kainit does not seem to have had any effect at all and the blocks manured with this stuff are losing on the check-blocks.

The best result is shown on the blocks receiving bone-meal at the rate of 400 lbs. per acre, but the effect of the same quantity of superphosphate is not far behind. The effect of basic slag and the smaller quantities of manures is less apparent, but it is quite satisfactory.

At the time the manure was applied the trees were very retarded in growth. The improvement from them until now is very marked, and some further effect from the slow-acting manures is still to be expected.

Altogether, 50 plots of two acres each were experimented with.

5	Plots were kept as check ;	
3	„ were manured with Lime, 1,200 lbs.	
3	„ „ Basic slag, 400 lbs.	
3	„ „ „ 800 lbs.	
3	„ „ Superphosphate, 400 lbs.	
3	„ „ „ 800 lbs.	
3	„ „ Bone-meal, 400 lbs.	
3	„ „ „ 800 lbs.	
3	„ „ Kainit, 1,000 lbs.	
3	„ „ Basic slag 400 and lime 1,200 lbs.	
3	„ „ „ 800 and „ 1,200 lbs.	
3	„ „ Superphosphate 400 lbs. and lime 1,200 lbs.	
3	„ „ „ 800 „ and lime 1,200 lbs.	
3	„ „ Bone-meal 400 lbs. and lime 1,200 lbs.	
3	„ „ „ 800 „ and „ 1,200 lbs.	
3	„ „ Kainit 1,000 lbs. and lime 1,200 lbs.	

The experiment on the old trees was carried out on decidedly over-tapped and backward trees. It was commenced in November, 1915, with the double object of improving the growth of trees and improving the yield.

Regarding the latter the result is so far disappointing. Out of four plots, Nos. 1 and 3 were manured, No. 2 was chankolled only, and No. 4 is kept as check.

A record was kept of the yield for seven months before the manure was applied. During the succeeding 12 months the yield of plots Nos. 1 and 3 rose by only 1 lb. and 6 lbs. per acre per annum, respectively, whereas the unmanured plots, Nos. 2 and 4, rose by 20 lbs. and 51 lbs., respectively.

During the last four months the yield of No. 1 has increased considerably, but as there has been a general increase all over the estate and as the check-block also shows an appreciable increase it is hardly fair to attribute the whole increase of No. 1 to the effect of the manure.

The check-block had the best trees, and we naturally reckoned that a heavy dressing of manure would improve Nos. 1-3 to such an extent that they would at least be just as good as the check-block, and I am unable to explain why it did not.

The following quantities of manure were applied per acre :

Field No. I—

- 500 lbs. basic slag and bone-meal, mixed ;
- 600 „ lime ;
- 100 „ superphosphate and muriate of potash, mixed.

Cost per acre, \$36.77.

Field No. III—

- 500 lbs. basic slag and bone-meal, mixed ;
- 600 „ lime ;
- 100 „ concentrated superphosphate.

Cost per acre, \$36.32.

The manured trees look much better than those not manured and this improvement is sure to tell upon the yield in future, but that more than a year should elapse without any noteworthy increase of the yield seems to indicate that the mixtures were not the most suitable for this particular soil.

Discussion.

The CHAIRMAN (Mr. R. W. Munro): rising, after the applause given to Mr. Vesterdal had subsided, said: The subject chosen by Mr. Vesterdal is a very wide one and all of us will agree as to the importance of cultivation and the manuring of soil. If this is the first, as we hope it is, of what will be a series of Agricultural Conferences, I think that we shall find that the question of the cultivation and manuring of soil is one that will have to receive a very large degree of attention at our Conferences. Mr. Vesterdal is in a position to tell us a great deal because he is in charge of

a very large area—some people might understand a large area to mean about 50,000 acres, but I think 10,000 acres is a very large area indeed. The experiments that Mr. Vesterdal has told us of have been carried out over a large area which Mr. Vesterdal controls, and I think, therefore, that we can rely on the information given to us as being of extraordinary value. But I do not think that Mr. Vesterdal, or anybody else for that matter, would like to lay down any hard and fast rule, because I think that you will all admit that cultivation of soil in this country is yet very much in its infancy. I think that you will agree in reading through the paper—which you will have an opportunity of doing, as all of these papers are to be printed in book form—that it contains a greater deal of information than you can possibly grasp in the course of half an hour as this Conference will not be able to take them up for discussion now. I had the opportunity of reading through Mr. Vesterdal's paper this morning before this meeting and I have no doubt that it is a very important one.

As to artificial manuring, it is a matter that varies a great deal with the soil, and we know that Mr. Vesterdal's experiments were made on poor soil which would necessarily show greater progress than on soils that it is not necessary to treat in that way. Now, we have not very much time to dwell on these questions long, but I must thank Mr. Vesterdal for coming from so far as Johore to read this paper to us, which I have no doubt will be extremely valuable to us. (Applause.) I will now call upon Mr. Spring to read his paper.

CULTIVATION, DRAINAGE AND MANURING.

By F. G. SPRING, N.D.A., F.L.S.

(*Agriculturist, F.M.S.*)

IN the past few years many changes and improvements have been made in rubber planting but this is only what would have been expected considering the size and importance of the industry. It cannot be claimed, however, that there has been any great advancement in knowledge of soil culture and artificial fertilizers as applied to rubber land. The varying conditions under which a rubber tree can be grown are partly responsible for the somewhat slow progress. Hilly and flat lands should not be treated in all respects alike and the same applies to heavy and light soils, deep and shallow.

The objects of tillage are to make the soil lighter, more porous and permeable to roots, to enable vegetable and mineral matter to decompose more rapidly, to promote oxidation and stimulate the activity of nitrifying bacteria, to loosen the particles of soil and mix them, to check the growth of weeds and reduce soil evaporation.

SOIL CULTIVATION AND DRAINAGE.

Tillage is of the utmost importance but it requires to be applied to suit conditions. Heavy yields of rubber are obtained, in many instances, on land which has never been tilled and which is comparatively poor in essential plant food constituents but in such cases it is generally found that the mechanical condition or mixture of the soil is excellent. Rich lands are sometimes very poor yielders and this may be owing to quite a variety of causes but a not uncommon one is mixture of soil. The mechanical condition of a soil is of the greatest importance in rubber growing, more so, perhaps, than its chemical. Improvements can be effected in this direction by tillage and the turning under of green manures, the latter opens up heavy soils and renders light soils heavier, or in other words tends to establish an equilibrium.

I will deal in the first place with hill cultivation and then refer to treatment of undulating and flat lands. It is common knowledge that tillage cannot be carried out on hill land without considerable loss by surface wash, but several methods may be adopted to enable one to cultivate a soil properly and yet reduce surface wash to a minimum. A cover-crop on the land is a reliable preventative, but, unfortunately, there is always a period of soil wash following tillage even with a plant which rapidly reproduces itself.

Terracing has much in its favour but can only be recommended provided it is done previous to planting. The terraces require to be

at the same elevation throughout otherwise the object aimed at is lost. Any wash from the slopes is retained on the flat terraces and this assists in the nourishment of the tree. Should the land be very steep it is advisable to plant some cover-crop such as *Centrosema plumieri* on the slopes and it may be desirable to establish a strong growing plant, for instance, citronella or lemon grass, along the edge of the terraces. The flat terraces are maintained clean weeded and tilled when required. I have seen remarkably good results from rubber grown under such conditions and have no hesitation in recommending it for hill land. One estate in Negri Sembilan has a good area planted in this way and the writer was much struck with the growth of rubber there as compared with that of similar age in adjacent fields. Terracing cannot be recommended for previously planted areas and in such cases circular plots may be gradually constructed around the trees, this is best commenced when the trees are quite young, the diameter of the circle being increased as the tree ages. Should these plots be kept well tilled it is surprising how rapid growth is and there is every prospect of an excellent root system being developed.

With regard to drainage of hill land I think it is generally agreed that contour drains are unsatisfactory while perpendicular ones are good examples of what not to do. I am doubtful if any type of open drain, on hill land, serves its purpose in an efficient manner and in the majority of cases it is better to dispense with drains altogether and adopt some such system as that referred to.

In the case of undulating land tillage can generally be effectively carried out without any material loss. On the flat and gently undulating country, cultivation is, I believe, more essential and beneficial than on the hill, the obvious reasons being that flat land is, as a rule, heavier in nature, and has not as good air circulation, consequently responds better to cultivation. There are various forms of implements of tillage, ploughs, cultivators and harrows which do excellent work and may be used to great advantage on the flat and gently sloping lands, provided the timber has been cleared and estate drains do not materially interfere with the work. Tillage should be commenced at as early an age as is possible in order to compel surface roots to grow at a greater depth in the soil and thus enable tillage to be done, in later years, with a minimum injury.

The changkoll and fork are the most common implements of tillage here, and I propose, therefore, to make a few remarks regarding their efficiency. When used in young clearings it is, I believe, a waste of labour to changkoll or fork all over the area. Should one commence this type of tillage in circles around each tree, increasing the diameter as the root area develops, it is probable that excellent returns will be obtained when costs are considered. Ultimately, the circles would meet and tillage would then be conducted all over the land, the greatest attention being given to culture in the middle of

the rows. As regards depth of tillage this will, of course, depend on the nature of the soil, but generally speaking, the heavier the soil the greater the depth required.

Cultivators and harrows are more economical but, unfortunately, they can only be used in certain cases. On Castleton Estate, Telok Anson, harrows have been in operation for some considerable time, where they have done good work at a small cost. The cost of tillage of the first one or two applications is comparatively high but decreases as the tilth improves.

With regard to drainage of flat land it is well known that this is of the utmost importance. Should a soil be water-logged, or the water level near the surface, it is impossible to have a good tap root developed, the absence of one being often evident by loss of trees during wind and rain storms. Cultivation and manures will not effect a remedy, in fact it is waste of money to adopt either until drainage conditions are first improved.

There is some difference of opinion as to when tillage should be done. Personally, I think the best results are likely to be obtained when done towards the end of the wet season in order to conserve the then abundant water for the dry period.

Soils which are more or less baked on the surface have lost, and continue to lose, a good deal of water by soil evaporation. In some instances the surface is like a brick and should this condition be present on a slope the majority of rain water merely runs off the land. It is obvious that to cultivate a soil during a dry season is expensive but in addition to this you effect a remedy after considerable damage has already been done in loss of soil water. To cultivate at the close of a wet period bears out the old saying: "Prevention is better than cure." Tillage to a depth of two or three inches will greatly assist in the conservation of water.

With regard to the cultivation of old clearings the soil of which has not been previously turned over to any depth, one must use a good deal of discretion. It could not be recommended to till this soil in such a way as to destroy surface roots, both large and small, in a drastic fashion. Light changkolling, in the first instance, should be carefully done and all large roots avoided. I do not think much harm is done in cutting numbers of small surface roots, as a better root system is, by cultivation, encouraged at a greater depth in the soil. The depth of tillage may be gradually increased as time goes on. There is little doubt that the best root system is developed when tillage is commenced while the trees are quite young, one must devote attention to soil cultivation, at some time or other, if maximum yields of rubber, good bark renewal and healthy trees are to be maintained.

Dynamite has been considered, for some time past, in connection with rubber growing and may possibly prove a valuable method of

soil culture particularly as a means of breaking up heavy sub-soils. Experiments were conducted at Kuala Lumpur Government Plantation with dynamite where good results were obtained as regards girth increase of young rubber. The greatest objection would appear to be that of cost.

MANURING.

The question of artificial fertilizers as applied to rubber is a rather delicate one and requires to be carefully considered. As long as good yields can be obtained by cultivation it is probably a mistake to resort to manuring. At Castleton Estate, Telok Anson, an extensive series of manuring tests are being conducted on good class land and the results obtained so far would not appear to justify their application, and many estates with rich soils would, in all probability, behave in a similar way. There are, however, many cases where it would appear that manuring is to be recommended and the man with long practical experience can generally discover those areas.

A test was conducted in the Kuala Lumpur Gardens with young rubber growing on poor laterite soils with the following results: In the first year, the trees in the manured plots, in every case, showed a good excess in girth measurements over the trees in the unmanured plots. In the second year, there was no manure applied, and the average girth increases for this period were about equal to that of the control plots, which goes to prove that the manures had good effect for one year only. At the commencement of the third year, a second application of similar manures was applied, and the results for this year were also satisfactory but the excess was not as large as that of the first year. In the fourth year, no fertilizers were applied, and it was found that the manured plots had not given as large an average girth increase as the control plots. In this particular soil, the manures appear to have had a stimulating effect, as regards growth, after each application, for about one year but afterwards there seemed to be a slight reaction. Over the four years, however, the total girth increases of the manured plots in every case considerably exceed that of the controls. At the close of the four years tapping was commenced and it was found that the control plots gave the poorest yields of rubber while the highest yields were obtained from those manured plots which gave the largest girth increases. This is the result for the first nine months of tapping and it will be interesting to see how long the high yields are obtained. In the ninth month of tapping the manured plots continue to give the proportionate excess of rubber over the unmanured plots, and there seems no evidence at present of a declining superiority; rather the contrary. I have not the slightest doubt that the fertilizers in this soil were beneficial, for we would appear to have recovered the costs of application in the first nine months of tapping. It should be remembered that increase of girth means a corresponding increase in length of tapping cut.

Good results from manuring might be expected from the following: poor, light, laterite soils, soils deficient in one or more essential plant food material, thinned out areas which are slow in recovering from the effects of close planting and areas which have been severely tapped in the past.

As regards the method of application this will depend on the age of the trees. With young rubber, I believe, the best value is obtained by spreading the manures around each tree, the area treated would naturally vary with small and large trees and increase as the rubber ages. The manures are best turned under to a depth of two or three inches, sufficient to prevent loss by surface wash. With older rubber the manures may be broadcast all over the land but more especially about the middle of the rows and then turned under. I do not favour the placing of manures in trenches around a tree as in this area the manures are too concentrated and for a time limited to a small root feeding area.

I do not propose to deal with quantities of manures to be applied, per acre, as this varies more or less with each fertilizer. Information, however, can be obtained on application to the Department of Agriculture.

With regard to the kinds of manures I might mention that a complete fertilizer consisting of sulphate of ammonia, double superphosphate, sulphate of potash with the addition of lime gave the best results in the Kuala Lumpur Gardens. Comparatively good returns have also been obtained from Perlis guano, bone-meal and basic slag.

LIME AND ITS APPLICATION.

One of the chief effects of lime on a soil is to accelerate nitrification and thus enable plants to draw upon the nitrogenous and potash stores in the ground. It has a neutralizing action on organic acids which helps to sweeten sour soils. Lime has a beneficial action on clay soils by breaking them up, while sandy or light soils are improved by binding the particles together. In order to obtain the full benefits of artificial fertilizers I think it is essential to apply a small dressing of lime beforehand, this should be done several months previous to the spreading of the fertilizers on the land. There are many soils in Malaya which would, I feel sure, respond well to lime treatment. Quick lime is the best form of application, the lumps being distributed throughout the field and allowed to slake naturally. One night's rain is sufficient for this decomposition to take place but in dry weather it may take several days. The result is a fine dry powder which is found easy to distribute equally over the land. Slaking lime in this country in a large heap and adding water does not appear to give such a fine dry powder as the natural process and the cost of distribution is higher.

Before closing this address I would like to refer briefly to costs.

COSTS OF TILLAGE AND FERTILIZERS.

Establishing Cover-crops.—I will give in some detail the cost of establishing *Centrosema plumieri* as this is one of the most promising cover plants for rubber clearings. The seed is dibbled in at distances of three feet apart each way at a cost of \$3 per acre, 3 pounds of seed being required. The price of seed, at present, is from 25 to 50 cents per pound, which is somewhat high on account of the limited areas planted. The cost of weeding until the plant is well established amounts to about \$3 per acre and if this sum is charged to ordinary estate weeding it will be seen that the total costs amount to from \$4.25 to \$5 per acre. The seed is sometimes broadcast at the rate of ten pounds of seed per acre on a well-prepared surface, but dibbling is preferable.

Canavalia ensiformis is best dibbled in three feet apart requiring 8 pounds of seed per acre or 15 pounds if broadcast. The cost of weeding until *Canavalia* is established is higher than in the case of *Centrosema*, owing to the habit of the plant.

It may generally be taken that large seeds such as those mentioned above give the best results when dibbled in, while small seeds such as horse gram require to be broadcast. When broadcasting is the method of sowing, the land is first changkolled or forked to a depth of about three inches, sufficient to provide a good seed bed, and this will cost from \$2 to \$3 per acre.

Horse gram (*Dolichos biflorus*) sown broadcast requires 12 pounds of seed per acre, which can be obtained in the local markets at six to seven cents per kati. The cost of broadcasting is 25 cents per acre. Sarawak bean (*Dolichos Hosei*) is best established from cuttings and this system of planting is slightly higher than dibbling on account of additional cost of procuring and planting cuttings.

Terracing.—A six-foot terrace made by three feet cutting and three feet filling in costs 25 to 30 cents per 50 feet length, which amounts to about \$10 to \$12 per acre allowing on an average 20 feet between the terraces. It might be mentioned that the cost of maintaining well-made terraces is small, considerably less than upkeep of drains.

Dynamite.—Sixteen cents per charge, inclusive of labour, is a reasonable figure, one charge per tree is generally what is allowed but with heavy clays more may be required.

Cultivation.—The following are the actual costs of various methods of cultivation, conducted at Castleton Estate on a heavy soil. Plot 1, three crops of horse gram were grown within a year, at a cost of \$17.45 per acre. In Plot 2, surface weeding was conducted monthly at a cost of \$10.71 per acre per annum. The treatment in Plot 3, was monthly weeding and changkolled twice per year to a depth of four inches which amounted to \$18.27 per acre per annum. Plot 4 was changkolled once every three

months to a depth of four inches for \$21.96 per acre per annum, while in plot 5 the land was forked once in three months to a depth of four inches at a cost of \$21.21 per acre per annum. In Plot 6, harrowing was conducted twice a month for \$7.26 per acre per annum. The harrows were first drawn by buffaloes but Indian bullocks were found to be very much cheaper. A couple of bullocks can harrow five acres per day of eight hours. The above figures are the results obtained in one year, but now the costs of changkolling, forking and harrowing are very much less, in some cases about half, while surface weeding remains more or less the same. It is usually found that as deep tillage is continued the costs become less, for a time, until a high class tilth is formed when charges remain about the same.

Artificial fertilizers.—The cost of spreading artificial manures varies somewhat according to the quantity applied. Two hundred and fifty lbs. of a mixture can be broadcast and slightly covered for \$1.80 per acre.

The cost of applying 1,000 lbs. of lime spread around young trees and turned under amounts to about \$9 per acre, inclusive of labour, while one ton broadcast all over the land, and turned under would cost, approximately, \$23 per acre. A complete mixture consisting of $\frac{1}{2}$ lb. per tree, sulphate of ammonia, $1\frac{1}{2}$ lbs. per tree, double superphosphate, 1 lb. per tree, sulphate of potash, and 1,000 lbs. lime per acre was applied at a total cost of \$28 per acre (November, 1911).

A dressing of four cwts. Perlis guano cost \$8.50 per acre, while three cwts. Bone-meal worked out at \$13 per acre (November, 1911).

Discussion.

The CHAIRMAN (Mr. R. W. Munro): Here again, gentlemen, we see what an extraordinary amount of instructive knowledge we can gain from these papers. I think you will all notice how very particularly the views of Mr. Spring agree with those of Mr. Vesterdal on this subject. Both have, I think, dealt with the subject quite independently of each other, and yet both of them agree on the main points. One of the greatest points of interest I wish to invite discussion on is the matter of drainage. We must thank Mr. Spring very much indeed for the valuable information he has given us. I invite you to discuss this subject for as long as we have time. I think Mr. Prior will give us his views on the matter.

Mr. PRIOR said that he wished only to mention what had been his experiment on Golden Hope Estate in manuring during the last 18 months, on what was known as "peat land," on a plantation that had been planted in 1907 and first tapped in 1912. Three portions of 10 acres each had been tried with basic slag, lime and forking, respectively. In 1913 the whole field was forked over and 12 pikuls of lime per acre applied. All plots were tapped during the

first period of six months with two cuts on $\frac{1}{3}$ tree, alternate days, and then on one cut on $\frac{1}{3}$ tree daily. The yields of No. 1 latex and scrap rubber were recorded and the figures given below are the weights of wet crepe, weighed 15 hours after machining.

Plot No. 1, 10 acres, 1,015 trees, 1 ton basic slag per acre and forked 22nd to 30th July, 1915, cost \$48.68 per acre. Crop for first six months, 860 lbs., second six months 985 lbs. (showing an increase of 125 lbs.); third period of six months 1,264 lbs., daily tapping as previous period, increase of 404 lbs. over first period.

Plot No. 2, 10 acres, 1,017 trees, one ton lime, 10 tons crushed limestone per acre, and forked, August, 1915, costing \$131.50 per acre: crop, first six months, 1,068 lbs.; second six months, 1,134 lbs.; third six months, 1,416 lbs.; increase over first period, 348 lbs.

No 3 plot, 10 acres, control plot, forked 1915, 1,460 trees: crop, first six months, 1,439 lbs.; second six months, 1,640 lbs.; third six months, 2,056 lbs.; increase over first period, 617 lbs.

Girth measurements of all the trees at three feet from the ground were taken in February, May and November, 1916. The average girth of the trees in each plot on the different dates was as follows:

	February, 1916.	May, 1916.	November, 1916.	Total increase, nine months.
	Inches.	Inches.	Inches.	Inches.
Plot No. 1	26.50	27.14	27.73	1.23
„ No. 2	26.63	27.20	28.32	1.69
„ No. 3	27.20	27.89	29.23	2.03

Mr. L. MOOIJART said that as to manuring he once sent a sample of soil to Ceylon and was advised to put down a large amount of a certain mixture, and up to date he had not got much more from that plot than from any other. (Laughter).

Mr. G. H. BENNETT: May I ask how much per acre was used? (Laughter).

Mr. MOOIJART: I am sorry I have not come prepared to tell you that.

The CHAIRMAN reminded the meeting that the time was short and that they might go on discussing just for the time available.

Mr. PRIOR said that he understood Mr. Spring to deprecate the idea of contour draining as against terracing. He wished to know what system of contour draining he had in mind. Was it the old Ceylon system?

Mr. SPRING: I meant hill land. I do not know the Ceylon system but the one I referred to is 1 in 25.

Mr. PRIOR: The old system in Ceylon draining was on the scale of 1 in 20, which carried a lot of water to the valley down below.

Mr. SPRING : And carrying lots of soil, too. (Laughter.)

Mr. PRIOR : The system I have tried is one of short, blind drains quite level. According to the contour of the hill it goes all round and catches all the water. The trees grow well and there is no wash. I have seen the old Ceylon system by which the whole hill is washed away and there are tearing torrents, so that the hill gets nothing of the water to be retained for the trees.

Mr. SPRING : I have not tried that system you have practised, but I think it is a very good system. It would have as much beneficial effect as in the terracing system.

Mr. A. H. MALET next gave his experience of manuring on a 30-acre block. That was the only block on the estate that had not a single case of pink disease that year. (Hear, hear.)

The CHAIRMAN : Have you got any analysis of the mixture you tried ?

Mr. MALET : Yes, I think so. A sample of the soil was sent to Mr. Kelway Bamber (Agricultural Chemist, Ceylon), to be analysed, and on the analysis of the soil the manure was made out.

Another planter said that in his experience he had found that rubber trees really fed their roots on the surface. It seemed strange, therefore, to find that both Mr. Vesterdal and Mr. Spring recommended that the soil should be dug down and that the trees should feed below. How could such an idea be reconciled with the views expressed ?

The CHAIRMAN : I think that you will take it from either gentleman that what they intended to imply was that as the roots get down to the more permanent manure you get better results.

Mr. SPRING : The principal ideals in the matter of cultivation are to get the roots to go down and stop too much evaporation of moisture. If you get that done, I think it would be found beneficial to get the roots down so that you can continue the cultivation.

THINNING OUT.

By T. J. CUMMING,

(*Manager, Seafield Estate, Selangor, F.M.S.*)

IN the early days of rubber planting few realized to what magnitude a tree 15 to 20 years old would attain, and most planters made the mistake of planting too closely—some more, some less—common distances being 10 ft. \times 10 ft., 10 ft. \times 15 ft., 12ft. \times 12 ft., 15 ft. \times 20 ft., and so on.

Though these distances have since been found to be too close there is a good deal of reason in the case of the early planter who planted closely, as no one at that time could foretell the future of the marketable product, and, while the price of rubber was booming at 10s. to 12s., there was a lot of profit to be made off an acre carrying from 150 to 300 trees, and in the case of the private owner, he naturally wanted the maximum yield in the minimum time.

Then, too, labour was cheaper, and the profits were sufficiently large to allow of little extravagances, or rather, what appear as extravagances to-day, to be glossed over.

NEED FOR THINNING.

The slump in the price of rubber caused planters to look around for ways and means of curtailing expenses, and a point that was quickly apparent was the fact that practically the same crop could be, and was, being got off an acre carrying 100 trees as off an acre with double the number of trees, and the cost of tapping in the latter case was naturally double the former.

There appeared also with the close planting the delay in bark renewal, and this, of course, meant loss of money, as the longer the period required for renewal the less the yield per acre over a period of years. To commence with, a two years' renewal was considered sufficient, and it appeared to be so until the next two years' renewal came to be operated on, when it was found the bark was not nearly ready for tapping, and wounding and reduced yields were the result.

It was noticed that trees on the outside of the fields or near roads where there was any extra space appeared to have a much better bark renewal than those inside, and this probably first led one to consider the necessity of light and air to procure good healthy bark renewal in a reasonable period.

The Agricultural Department were at the same time working on the subject of the rubber tree and it was pointed out in various lectures and bulletins that latex was formed in the leaves of the tree, and that without a good head of leaf the tree could yield but little latex. Well, as everyone knows, with close planting all the lateral branches get pushed or drawn up almost perpendicularly in order to

catch the little light there is at the top and instead of having a tree with fine wide-spreading foliage, there is something closely resembling a "swizzle stick."

If height was all that was wanted for tapping then close planting would be the correct thing, but, as girth of stem and lots of leaf are the main factors necessary to ensure profitable yields, close planting undoubtedly fails.

Fear of loss of crop through thinning should not deter any one from tackling a closely planted field as, if the thinning is done while the trees are fairly young, the remaining trees will quickly respond to the improved conditions and the crop will soon reach its normal figure and pass it, while the longer thinning is delayed, the more crop is to be lost.

Disease too is a factor which has had a lot to say in the necessity for thinning out. As has been already stated, light and air are absolutely necessary for the well-being of the tree and nothing is more conducive to the spread of disease than closeness and damp.

Another advantage in wide planting is that after rain the surface of widely planted trees dries much more quickly and allows tapping to go on early, while sometimes with close planting tapping is impossible for a few hours after a heavy shower.

There is also the saving in labour and utensils, and I need not go into details to show this, as previous papers on the subject have dealt very fully with this point. It is obvious that if an acre with say 100 trees yields the same amount as an acre with 200 trees, there is a considerable saving in labour and only half the number of cups, spouts, etc., are required, while the percentages of output are bound to be to the advantage of the wider planted area, as there is half the number of trees, spouts and cups to give "scrap."

METHODS OF THINNING OUT.

The difficult question for the planter to start with is whether to thin out by selection or remove every alternate tree if his original planting allows of this.

On one estate the original planting was 20 ft. \times 20 ft. and in order to get more trees to the acre this was interplanted with a quincunx, thus $\begin{matrix} \cdot & & \cdot & & \cdot \\ & \cdot & & \cdot & \\ \cdot & & \cdot & & \cdot \\ & \cdot & & \cdot & \\ \cdot & & \cdot & & \cdot \end{matrix}$ giving double the number of trees to the acre and if it were found necessary to thin out, the quincunx could be removed.

The necessity soon arose, and when it came to thinning out, the ravages of Fomes, white ants, wind storms, etc., had been left out of account and many quincunx trees had to be left in to make up blanks, and it got so confusing in places that the original 20 \times 20 line was frequently mistaken for the quincunx.

The theory is all right as a theory.

In ordinary square planting the best method in my opinion is by *frequent* selection. It takes much longer and seems to keep the

work of thinning out dragging on for a long time, but there is less crop lost this way, as each round the trees which are not paying their way are removed, giving the advantage to the adjacent trees, the yield per acre is not greatly reduced and the cost of tapping is automatically reduced.

With present day planting thinning out should not present any great difficulty as provision can be made for thinning out in the early stages. The time for thinning out is just as soon as growth is being hampered by branches interlocking, probably when the trees are about four years old. If a clearing is planted 20 ft. \times 20 ft. with a view to thinning out later to leave say 70 or 80 trees per acre, the trees to be removed could be marked after careful examination and comparison with adjacent trees, and any branches interfering with the development of the favoured trees could be removed periodically as the necessity occurred. The marked trees could in this way be tapped for a considerable time in the regular round, enabling a fair return of latex to be obtained before they are finally removed and leaving them with very few heavy branches to cause damage while they were being felled. Of course, the ideal system would be to allow each tree eventually the same space, but this, I fear, would be impossible in practice, as weak unhealthy trees are frequently found side by side and have to be removed, while good trees have to be left near each other to make up the number per acre.

There are various methods of removing the tree. Some recommend pollarding the first stage, tapping the stump so long as it gives latex, then removing it. This system I have found not at all profitable. It is much more difficult to remove the pollard than it is the whole tree, as in the latter case the head gives leverage when the side roots are cut away, while the pollard has to be lifted bodily from the ground. The pollards yield very little latex after the first few tappings, and tappers are inclined to be careless with the tapping of them, and this carelessness, like other diseases, soon spreads to the good trees. The roots of the pollards too are still feeding and the adjacent trees are not benefiting to the same extent as if the trees to be cut out had been removed wholesale.

Another system is to cut off the tree about a foot above the ground, but since the discovery of *Ustulina zonata* I fancy this system is not much in favour.

The most satisfactory way is to cut out the tree about two feet below the level of the ground, removing as many of the side roots as possible without interfering with the roots of the adjacent trees which are to remain. The cut out trees and branches should be burned, or otherwise removed as quickly as possible, to prevent an invasion of borers and the spread of disease.

I have to thank the General Rubber Co., Sumatra, for the privilege of seeing their report on thinning out and for permission to use their recommendations.

THINNING OUT.

BY E. W. KING,

(*Technical Manager, Société Financière des Caoutchoucs, Selangor.*)

I have been asked to read a paper on "Thinning Out," paying particular attention to points which are open to discussion. I think I may take it as granted that everyone agrees with the principle of thinning out and that the only points about which controversy is probable are: (1) the time at which it should be done; and (2) the extent to which it should be done. I have, therefore, divided this paper into two parts. The first part showing the reasons for it and the second part giving the main lines on which I consider it should be carried out.

PART I.

Everyone has seen the result of trees which have been left closely planted. In some cases old nurseries have been left for several years with the result that they have shot up into a number of long poles with a few leaves at the top, from this to the case of a tree planted in the open by itself you get the varying degrees of malformation due to insufficient sunlight. The importance of sunlight to the health of a plant cannot be too strongly insisted on. The two sources of supply of material for the formation of plant food are the root system and the leaf system or head. The root system supplies water from the soil and soluble inorganic salts, which are essential to the health of the tree. The leaves supply the bulk of the material forming the tissues of the tree. They absorb carbon dioxide from the air and by the aid of sunlight transform it into starch and other substances needed in the tree's economy.

As young trees grow they soon fill up with the leaf system all the space allotted them. At this period in their life history if more space is not given them many consequences follow, the chief of which is the reduction in the rate of the growth of the trunk and hence in bark renewal. For, since the amount of plant food manufactured by the tree is proportional to its leafage and root growth, one of the first consequences of a limited growing space is that the tree's food supply does not increase but remains at the same amount. It should, of course, gradually increase to correspond to the constant demands made by the increased activities of the tree as it ages.

No green plant deprived of light can produce the chemical changes on which its proper supply of nutrition depends. Many planters, for instance, will have noticed the better growth of clearings with an

eastern aspect. The first effect of close planting is noticeable in the exaggerated upward growth of the trees, which, finding that their branches if extended laterally meet with the branches of neighbouring trees, attempt to overtop their neighbours with the result that their branches are drawn upwards, giving the trees the appearance of bundles of birch twigs.

Food that could be utilized in the thickening and rounding out of the trunk is used to build up length of branches and trunk, because, in the struggle for sunlight, each tree tries to overtop its neighbour. In consequence, an activity of no profitable use to the planter is induced. By giving the tree more space it will grow outward as well as upward and in a normal, evenly distributed growth. Let it be emphasized that thinning out to be most beneficial should be done before the "drawing up" stage has set in. Very little lateral branching will be induced in an old tree whose early environment has been an overcrowded estate.

I do not think it necessary to say anything further regarding the effect of sunlight on the branch growth. The effect on the depth of bark is equally noticeable and although it does not follow that a thin bark will necessarily yield less latex than a thicker bark it is extremely probable that coolies in getting the latex will touch the cambium and cause wounds over which the renewed bark will be poorer still. We may, therefore, take it as granted that a tree which has room for normal development as regards branch growth will prove more healthy than that which is retarded and that as a corollary the yield from such a tree should be greater and the bark renewal better.

The second point is the great economy which is effected. The unit which is generally taken as a basis of all calculations is the yield per acre. If you can get a high yield per acre from a comparatively small number of highly yielding trees it is obviously more economical than if you got the same yield per acre from a closely planted estate. I think I may take a yield of 450 lbs. per acre as one likely to satisfy directors and shareholders, and to make every point quite clear we will take a suppositional case of two estates of 500 acres, one of which is planted with 80 trees to the acre and one with 160 trees to the acre—other factors being the same—a reasonable task being 400 trees per cooly. With a check-roll average of 40 cents the cost of collecting will be:

$$\begin{array}{l} \text{A. } \frac{100 \text{ coolies} \times 350 \text{ days} \times 40 \text{ cents}}{225,000} = \text{say, } 6.2 \text{ cents per lb.} \\ \hspace{15em} \text{Labour only} \\ \text{B. } \frac{200 \text{ coolies} \times 350 \text{ days} \times 40 \text{ cents}}{225,000} = \text{Twice the above} \end{array}$$

It has often been argued that in a widely planted clearing coolies would not be able to do the same task. In practise this is not the case, the work of tapping and collecting takes up the time, not the distance

to walk between the trees. In addition to the cost of labour there are the following items: fewer cups, spouts, wire, etc., are required, and a smaller labour force with its attendant expenses in line accommodation, recruiting expenses and hospital charges. This applies mainly to estates employing Indian labour. In the case of estates which employ Chinese labour it will generally be found that the coolies work at a given rate per lb., this rate is governed by the amount of rubber a cooly can reasonably be expected to collect. To illustrate this we will suppose that a Chinese cooly expects to get 70 cents per diem; most planters have found that the number of trees a cooly can tap well has its limitations, and though, of course, every estate has its "star" tappers the capacity of the average Chinese cooly is, say, 450 trees. If then the trees are yielding at the rate of 6 lbs. dry per annum, a cooly tapping 450 trees can get a daily average of 8 lbs. which at 9 cents per lb. will give him the required wage; if, however, the trees are yielding at the rate of 3 lbs. he would have either to do twice the task or the rate would have to be increased.

Both these cases are possibly exaggerated, but if allowance is made for a slightly higher task in the case of closely planted trees and also a slightly higher yield per tree it is still very obvious that a closely planted estate is less economical to work.

EFFECT OF THINNING OUT ON DISEASE.

Another point which most certainly should not be lost sight of is the effect of thinning out on plant sanitation. This is so closely connected with disease and pest work that I intend merely to call your attention to it.

Diseases which are giving the most trouble at the present time can be divided into three heads, the worst being (1) branch disease, *Corticium salmonicolor*, (2) stem disease, bark canker, and (3) root disease, *Poria hypolateritia*, *Ustilina zonata*. It is obvious that the stronger the plant the better its chances of recovery if attacked, in cases of branch and stem diseases if given proper treatment the effect of sunlight will greatly accelerate the cure. To prevent root disease the destruction of all butts and roots of rubber trees thinned out is essential and cannot be too strongly insisted upon. With proper precautions the mortality in old clearings should not be great, records from an estate with rubber about 12 years old show a loss of .8 per cent. during the past two years. We now come to the debatable question of how it should be done.

PART II.

YOUNG CLEARINGS.

The days of 10 ft. by 10 ft. planting have passed and most estates are now planted 20 ft. by 20 ft., or avenue planting 14 ft. by 28 ft. or 15 ft. by 30 ft. Let us take a normal

clearing planted 20 ft. by 20 ft. or 108 trees per acre. This will, as a rule, come into tapping at $4\frac{1}{2}$ years with an average number of 60 to 70 trees per acre, during the next year the number per acre will be increased to, say, 90, leaving about 10 trees per acre, which are still too small. I have made allowance for the loss of eight trees from disease, wind or other causes. The spread of a normal five-year-old tree on an up-country estate is, say, 18 to 20 ft., if then all trees are of a uniform size and shape there is a superficial area to allow for growth.

The remaining 10 trees have probably been stunted in growth for one of the following reasons: (1) poor soil, (2) deformed roots, (3) poor jât of tree. These trees will naturally grow at a slower rate than their neighbours and if retained might possibly be tapped in their sixth or seventh year, the yield from them will probably be poorer, and I consider that, as a general rule, as soon as 90 per cent. of the trees in a clearing planted 20 ft. by 20 ft. are tappable the balance might be dispensed with right away. It is both easier and cheaper to cut them out while still small. After this it should be the policy of the estate to take out trees by selection each year. The following are the measurements showing the spread of trees taken from clearings of normal growth at various ages:

6-year old	...	...	...	22 ft.
8	„	...	...	27/29 ft.
10	„	...	...	28/30 ft.

The number to be taken out yearly will depend on the average growth of the estate and no rule can be laid down other than this—*viz.*, that as soon as the natural development of the trees shows signs of being checked the number of trees per acre should be reduced. The first and most obvious signs are a large number of lower branches dying off and an upward tendency on the branches in their attempts to get sunlight.

The case of young clearings is comparatively simple and its practical application clearly shown by the following records:

A 1 CLEARING.

Year.	Area tapped.	No. of trees per acre.	Yield per tree.	Yield per acre.
7th year	... 120	... 121	... 2.93	... 355
8th „	... 120	... 86	... 4.64	... 401
9th „	... 120	... 77	... 6.69	... 533

It should be clearly understood that in the case of young clearings thinned out or widely planted originally, the yield per acre will not be as large as that on a closely planted estate. The effect will probably not be felt before the third or fourth year of tapping but it will endanger the health and yield of the estate in subsequent years when the estate should normally be increasing in value.

Mr. E. B. Skinner mentions the following case :

“On an area planted 10 ft. by 10 ft. when tapping was started there were about 300 trees to the acre, these were first reduced to 100 and afterwards gradually thinned out until the number was about 60 to the acre. It is interesting to note that at its best this area yielded as much as over 900 lbs. per acre, but after reaching this point, the area rapidly showed the result of close planting and before thinning out began the yield had dropped to below 400 lbs. per acre.”

I might mention at this point that some of the enthusiastic advocates of thinning out point to the immediate results as shown in the increase of the average yield per tree. To some extent this is misleading, as if the work has been done in an intelligent manner the poor yielding trees will have been removed, which automatically increases the average yield of these remaining.

OLD CLEARINGS.

The case of old clearings is far more difficult and depends very largely on the age of trees. In the case of very closely planted clearings of 12 to 14 years I should recommend the acquisition of new land and planting at a reasonable distance. The trees can undoubtedly be improved, but it will of necessity be a long time before the increased yield of the individual trees balances the loss in yield per acre caused by the loss in numbers.

CLEARINGS FROM SEVEN TO TWELVE YEARS OF AGE.

As a general rule, it will probably be found best to reduce the number of trees per acre to one hundred during the first selection. In this original selection it will probably be possible to pick trees and at the same time pay attention to spacing. Deformed trees, trees with forked stems, burrs, damaged heads, etc., will, of course, be chosen, but at the same time it will be necessary to take out a large number of trees which are perfectly healthy. After this the trees should be taken by selection and it would be well to mark the trees and keep them under observation for some time before cutting them out. The following year they could probably be reduced by twenty trees per acre and in the next year by ten.

Experience has shown that 60-67 trees per acre is sufficient in the case of 11 to 12-year old rubber.

METHOD OF THINNING OUT.

Formerly it was customary to pollard trees which it was intended to thin out at height of six to seven feet and tap them till the trees ceased to yield. Experience has shown that the rubber so obtained scarcely paid for the cost of tapping in addition to the danger of introducing a careless system of tapping. It is better, therefore, to take the tree right out. The tap root and any large

laterals should be dug out and burnt as old rubber butts have proved one of the most fruitful sources of *Ustilina zonata* and other fungus growths.

My suggestions are based on the supposition that directors have in view an average yield of say 450 lbs. dry per acre. Possibly they may hope for 500 lbs., but it must be remembered that with, say, 50 trees per acre this would mean an average yield of 10 lbs. per tree. The highest yield which I have records of for a section of over 100 acres is 8.33 lbs. per tree for a section of 110 acres of 13 to 14-year old rubber. This is still some way from the legend ascribed to a well-known planter of a single tree per acre connected with the factory by a pipe.

RUBBER SEED SELECTION.

By A. H. MALET,

(*Manager, Trong Estate, Perak, F.M.S.*)

ONE of, if not *the* most important of the problems that faces the rubber industry at the present moment is that of seed selection. It is a grave reflection on those who are technically responsible for the safe-guarding of millions of British capital that so far not the slightest effort has yet been made to guard the industry from the inevitable results of neglecting to provide for a supply of seeds from wholesome vigorous stock.

It is, moreover, as far as the writer is aware, the only tropical agricultural industry which is liable to this reproach. No sane planter thinks of buying any but tested seed when opening up an estate in tea, sugar, tobacco or cinchona, but hitherto almost any seed has been considered good enough for rubber. Individual efforts are made to secure seed from old trees, and certain well-known estates have in the past made considerable sums from advertising "seeds from well-known old trees," etc., but the claims of these estates to have more virtue in their seeds as prolific milkers and disease resisters than seed from other less known properties rest on a very shadowy foundation.

The question is not by any means an easy one to dispose of—further, it is almost an impossible one for the practical planter to undertake to solve. There are two main points at issue: they are the propagation of good caoutchouc-producing trees and the re-vitalizing of the trees themselves; of the two, the latter is certainly the more important.

The question then naturally arises, what is the relation between the vitality or disease-resisting power of a tree and latex production? Does it always follow that a strong healthy tree is a good milker and vice versa? As far as the latex production of individual trees is concerned the whole industry, at present, is on an equal footing—but this cannot be said of the disease-resisting qualities of all planted areas and in the humble opinion of the writer what is mostly to be feared is inter-breeding and consequent degeneration.

The flowers of the *Hevea* being uni-sexual, inter-breeding is impossible to stop, and thus one of the most important laws of Nature—namely, that vigorous growth and healthy life can only be secured when cross-fertilization takes place, is counteracted by our system of cultivation. In the jungles of the Amazon the law of natural selection is allowed full play and only the fittest survive, but

in Malaya every kind of germinated seed that is planted out receives a fostering care that is tending towards a state of things which *may* lead to an outbreak of disease resulting in the extinction of the industry much in the same way that *Hemileia vastatrix* disposed of coffee in Ceylon.

Leaving theory on one side, is there any evidence to show that degeneration is taking place? Possibly some may be found in the large number of trees, especially on the newer planted estates, whose bark consists largely of "stone" cells, so difficult to tap. A railway journey, say from Penang to Kuala Lumpur, reveals numbers of trees whose bark is covered with an unhealthy looking green fungoid growth. Neither of these conditions are natural, and although unsuitable soil, bad drainage, etc., play their part in producing them, there can be little doubt but that unhealthy stock in many cases is a contributory cause. Again it must not be forgotten that these degenerated specimens of *Hevea* produce flowers, the pollen from which may be carried some distance and cross-fertilize with some quite healthy tree, the seed from which may be being reserved for stocking nurseries; and so the game goes on.

Turning now to the question from a latex-producing point of view, the writer has been experimenting for some time with a view to obtaining reliable figures from which some conclusions may be drawn. Fortunately, the complete history of the trees experimented with is known, and is stated below.

Block A (trees now 17 years old) was planted with seeds taken from five years old trees which in their turn were planted from seed of the old trees originally brought to Perak by, I believe, Sir H. Low, so that they represented the third generation of the seed brought over from the Amazon by Wickham. The block was originally planted very closely and has been thinned down to an average of 90 trees per acre. For nearly two years 85 trees have been under constant observation, good, bad and indifferent milkers been duly noted. All diseased trees had been cut out and those that remain appear quite healthy. The latex from these 85 trees has been coagulated in the cups on various occasions, and the dry rubber from each carefully weighed on a medical balance and duly noted.

The result is that the average yield per tree was 155 grains per day from all the various tappings, only 33 trees gave results above the average, their average yield being 281 units per tree per day, while the average yield from the 52 trees below the general average is only 75 units.

Block B was planted up from seed taken from the trees on Block A when they were five years old and the trees here are consequently 12 years old. Fifty trees have been experimented on (one was found to be suffering from white ants and was cut out).

The results of the tappings here show a much more marked variation than those on Block A. The average of five days continuous tappings with suitable intervals gave the following :

1st	five days average from 49 trees,	146 units.
2nd	„ „ „	164 „
3rd	„ „ „	120 „

During the third experiment the trees were in the middle of wintering.

The average yield of the first two experiments gives 155 units as in Block A, the average over 10 days of the best yielder was 771 units, and of the worst yielder only 31 units. Twenty-three trees gave yields above the average and 26 below the average. The daily yields of the best milker were as follows: 501, 858, 810, 901, 849, 754, 669, 830, 905 and 634. Daily yields of the lowest yielder were: 11, 26, 25, 7, 17, 10, 30, 52, 36, 89.

It will be seen from these figures that the yields from both best and worst milkers are fairly steady. Such variations as are shown being easily accounted for by climatic conditions. In no instance has it yet been found that a tree yields heavily one day and poorly on another. Assuming that the seed had been properly selected from the best milkers in Block A and that each tree gave a yield equal to the average yield of the best 23 trees—*i.e.*, 252 units per tree, the output per acre would be increased by over 60 per cent.

Even allowing that trees vary in their yields very considerably during the course of a year, it is difficult to suppose that the variation is as great as the differences between the best and worst milkers.

It will be noticed that the averages in Block A of the best and worst milkers are 281 and 75, respectively, against 252 and 73 of those on Block B, or a slight reduction in the following generation.

While I am well aware that the figures quoted cannot by any means be called conclusive, as the experiments have only been carried on during a short period of time, I do think they are convincing enough to call for a thorough investigation under strict scientific control. I may also add that I am going to continue to take records of these trees for at least twelve months, when I hope to be able to publish the results.

If a case can be made out to support the suggested degeneration of our stock what is to be done in the matter? Two alternatives seem to suggest themselves. Firstly, seed can be taken from trees that have been proved good milkers through a sufficiently long period of testing, and planted out in a clearing completely isolated from any chance of cross-fertilization from outside trees. When these trees are tappable, careful records of their milking capacity, resistance to disease, etc., should be kept over another sufficiently

long time to enable all unsuitable trees being eliminated, and the process again repeated until the whole stock could be guaranteed. Instead of seeds, cuttings could be used to start with, or as an alternative, but in either case the whole process of selection or re-selection would take at least 20 years before a final result could be attained. This, therefore, does not seem a very suitable procedure.

The other alternative is to introduce new stock from the Amazon. The whole matter should be under Government control, and seed in such quantities imported that a sufficient supply for the needs of the whole Peninsula could be assured. I would also suggest that a Mycologist be sent with the expedition to study any disease that might attack trees in their wild state. Experiments in variation of yield might also be made on the spot.

The future of the rubber industry demands immediate action. Such an expedition as suggested would naturally entail considerable expenditure, but even £50,000 or £100,000 would not be too much to pay for the protection of the immense interests at stake.

The example of the Dutch Netherlands Indies Government in taking control of all tobacco, sugar and cinchona seed distribution should be a sufficient indication to our own Government of the necessity of controlling an industry which is now rapidly becoming, if it has not already become, their chief source of revenue.

Discussion.

The CHAIRMAN (Mr. R. W. Munro): We have heard something extraordinarily interesting just now. We expected to have another paper to-day on this subject, but I think we can take it as read, as it will be duly published. But this from Mr. Malet is quite one of the most interesting we have ever had. Any planter in any country knows the position and knows it from the start. But the whole question covers so much ground that it is rather difficult to see how we are going to start this very excellent proposition. In importing seeds and trees there are difficulties, but the seed which you wish to have imported is the chief thing after all. The principle laid down by Mr. Malet is, of course, sound. In giving my own opinion on the matter I should certainly say that all of us planters entirely agree with everything that Mr. Malet says. We are, I am sure, much obliged to him for his very interesting paper.

RUBBER SEED SELECTION.

By J. McNICOL,

(*Manager, Kuala Pertang Estate, Kelantan.*)

THE Rubber Industry has now reached a stage when it behoves planters and others directly interested to consider the welfare of their plantations.

There is no gainsaying the fact that luck has followed in the footsteps of rubber planting, and no great credit for its success can be claimed by any one in particular up to the present. Even to-day, you can scarcely find two planters—or would-be experts—to agree on the fundamental principles of the industry. The reason for this divergence of opinion would seem to be, that individual planters have not had the time, nor inclination, to make the necessary study of the why and wherefore; consequently, the industry from the point of view of scientific cultivation is still in its infancy.

The majority of estates are now producing, and handsome profits on their production are still obtainable. Therefore, the time seems opportune for giving a little more consideration and study to matters which may have an important bearing on the future welfare of the industry, and may ensure it being established on a sound business footing.

There are many points which require elucidation, but the writer proposes to touch upon one only—*viz.*, Seed Selection, which, in his mind, is the paramount essential, requiring our most careful study. The quality of the trees is best decided by direct experiment in the field, and having in view ways and means of procuring trees capable of giving the greatest latex yields combined with longevity, it may be of interest to record here what is taking place on the writer's estate with regard to this vital problem of seed selection, in the hope that it may encourage others to take up the all important subject on a much larger scale.

The original trees from which seeds were selected had been grown from seeds procured from some of the oldest estates in the Federated Malay States. Careful note has been kept of the respective latex yields daily, over a period of not less than a year—and still continue—from selected trees throughout the estate. Notes are regularly made as to general growth and appearance, and during the recognized seeding season, seeds from those trees which have shown the best results were gathered by an European personally, and not left to the discretion of ordinary coolies or mandors, whose work is never so thorough or reliable. This matter of gathering by a perfectly trustworthy person is all important,

because unless the data is absolutely correct, in records of experiment, the whole is useless. I may here remark that as the seed-pods burst, the seeds are scattered broadcast, and there would appear to be some difficulty, in fact, an apparent impossibility, in selecting the particular seeds of any one tree from the host of others lying intermixed on the ground. With a little care and close observation as to shape, colour and size, the task becomes simple. Further, it may be pointed out that no two trees have exactly the same seed formation. There is always some little peculiarity in the seeds of each tree, and the original pods which contained the seeds vary. Should doubt still exist pull a pod from the tree in question, open it and place a supposed seed in one of the sections. The observer will at once see whether it fits or otherwise, the outline of all seeds from the same tree being more or less alike. Again, one known seed of any one tree is always kept for comparison and from quite a large collection of mixed seeds we found no difficulty in separating those known from the unknown.

Having now detailed the first course of procedure, the next operation is to plant out the selected seeds as quickly as possible after collection, otherwise they soon lose their vitality, in a specially prepared nursery, each lot of seeds being kept entirely by itself: thus providing a safe-guard against any chance of the lots being inadvertently mixed when the seedlings are pulled for planting out.

While the seeds were germinating, an area of 15 acres of virgin jungle, slightly undulating and naturally drained, had been cleared, holed and made ready for planting out the young seedlings in the month of November. That month is selected because it comes at a time of year when the wet-season is with us, and every other day is dull or cloudy: thus ensuring a much better chance of successful life to the young plants.

Each respective lot of seedlings was carefully drawn from the nursery and planted out in the prepared holes in the formation of squares, fifty to a hundred seedlings in each square, 20' x 20' distance apart. Every square is numbered, and on the original plan-sheet all particulars of the parent tree are recorded; also where situate on the estate, so that when the young seedlings reach the age of maturity comparison can be made.

Up to date, we can observe a great similarity to the parent tree in so far as growth and general appearance goes, and we have every reason to feel justified in thinking that the experiment well warrants the time and trouble taken.

It is not our intention to tap those trees at an age when girth might warrant it, as is usually done in the ordinary course. They will be given every justice, with the sole idea of keeping them purely for seed-selection in the future, should the experiment bear out our anticipations.

Flaws may be found in the experiment, but nothing can be accomplished without expenditure of labour and thought, and should the only result be the gratification of one's own curiosity or hobby, it is surely a step in the right direction.

With reference to the question of seed selection the following interesting note indicates what work is being done at the Botanic Gardens, Singapore, with a view to obtaining high-yielding strains of rubber trees by careful selection of seed. (Ed.)

In a letter to the Director of Agriculture, Federated Malay States, Mr. Burkill observes :

“When a block is tapped the good trees and the bad trees are marked with crosses of red or green ; and out of them further selecting will be done. The indifferent trees are not marked. But three trees have been particularly selected on account of their well-established yield, and put out of tapping that they may furnish the best possible seed. The first choice is tree No. 27 and not only has it been put out of tapping but its neighbours have been cut back that it may have more light. Seeds of it will be distributed to you and others as soon as available.”

PESTS AND DISEASES.

VISIT TO LABORATORIES.

ON the occasion of the visit to the Offices of the Department of Agriculture on the 26th April, an inspection was made of the laboratories, a description of which is given below:

MYCOLOGICAL LABORATORY.

A number of specimens of diseases had been prepared and arranged by Mr. W. N. C. Belgrave (Acting Mycologist) and Mr. F. de la Mare Norris (Assistant Agricultural Inspector) the exhibits, in addition to specimens of parasitic fungi, included several of the common saprophytes, *e.g.*, several *Xylaria* sp., often found on decaying timber.

Among the parasitic fungi, there were specimens of pink disease in all its stages, die-back (*Diplodia*), thread-blight, *Ustilina zonata*, including all the different forms of fructification, *Poria*, *Fomes*, including a very fine resupinate fructification, brown root disease, *Sphaerostilbe repens*, and black stripe canker. Particularly interesting was a specimen of an old tree attacked by "black stripe" into which the disease had penetrated to a depth of six inches.

Visitors were also shown pure cultures of most of the above fungi, and the method of making them.

ENTOMOLOGICAL LABORATORY.

Exhibits prepared by Mr. P. B. Richards (Acting Entomologist) and Mr. C. B. Holman-Hunt (Systematic Entomologist) illustrated the common pests of cultivated plants in Malaya, the different stages in the life histories of the more important insects being displayed. The classification of the white ants was illustrated by a series of microscope preparations, while the structure of the nest, the social organization and the habits of the white ant of rubber, *Termes gestroi*, were demonstrated in some detail.

From the general insect collection cases were prepared to illustrate the classification of the Insecta, and considerable interest was shown in an exhibit of curious and rare insects.

CLEAN CLEARING, PESTS AND DISEASES.

By W. R. SHELTON-AGAR,

(*Manager, Kamuning Estate, Perak, F.M.S.*)

If I were asked to classify the various diseases and pests according to their relative activity in regard to rubber plant life, I should put disease into two classes—

- (1) "Those that are fatal";
- (2) "Those that are amenable to treatment";

and pests into both, *viz.* :

<p>Fatal class (I).</p> <p>All root diseases—such as <i>Fomes</i>, <i>Hymenochæte</i>, <i>Ustulina</i> and <i>Poria</i>.</p>		<p>Amenable class (II).</p> <p>Stem and bark diseases—such as pink disease, <i>Diplodia</i>, thread blight and cankers.</p>
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Pests—*Termes gestroi* and borers.

I do not include vermin, as most wild animals, so far as rubber is concerned, could be classed as such and measures to deal with them, as a rule, are easily attended to.

As it will be impossible in a paper of this kind to deal individually with them all, I shall merely offer, for discussion categorically, four salient points:

<p>Prevention ;</p> <p>Treatment ;</p>		<p>Incidence and</p> <p>Control.</p>
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PREVENTION OF DISEASE.

So long as there is "no cure" for any fatal disease, obviously the next best thing is prevention.

Now prevention in this case means eliminating causability, or, in other words, having reference to all the fatal diseases and pests of class one.

The argument in favour of "clean clearing" is not mere theory, it has a practical side as well. Take those rubber estates that have been developed out of old tobacco, tapioca and lalang lands, they rarely give evidence of any appreciable trouble, and though we have these practical illustrations, timber clearing has never yet gained the whole-hearted support it merits. In some cases it is undoubtedly a matter of £ *s. d.*, but in others it is not so. Some planters hold that "by clearing timber much valuable humus matter is lost," and also that "no immunity exists from pests and disease so long as the roots and stumps of trees are allowed to remain in the ground."

These are admittedly weighty views, and the arguments are correct up to a point.

On the first point there is no doubt at all. One has only to turn over any old log, to see the countless feeding rubber rootlets that are gormandizing on the available collection of vegetable humus matter. Also memory still lives in regard to other agriculture, such as tea, coffee, etc., in which the best fields were always those that were most heavily timbered.

In rubber, however, we have to remember that decomposing or rotten timber is not only a hot-bed of infection but a nursery as well for the spread of fungoid diseases. *Poria* and *Ustilina*, for instance, are among the principal agencies that cause decay. Further, by leaving undestroyed timber and stumps of the "meranti," "merbau," and "kompas" type, we are only offering homes for the development of *gestroi* and borers.

What is the best way, then, of getting rid of one's timber?

I think, when opening up new land, we should adopt a "double-felling" method, after the style of old Ceylon coffee planters, *i.e.*, allow the clearing to grow up again for a year after the first felling. Then re-fell and burn off. The result of this operation ensures a thoroughly clean burn and, in view of our present-day knowledge, it seems to me that, in the case of rubber, this is essentially what is required.

As regards the second contention, mere up-rooting of small stumps does not present serious difficulty. Nor is it highly expensive. But to pull out and root the boles of large trees is costly and might run almost into any figure. In fact, to tackle really big stuff is financially prohibitive.

What, then, is one to do? In such cases, to my mind, there is only one practical course of action, *viz.*, isolate the bole by trenching (a distance of three feet is good enough) and if possible "run" any big lateral.

As a rule, two years after the original burn will see most of the soft woods in a state when they can be "fired," and in another two to three years only the very hardest will remain. If then "firing" operations are taken in hand at the times mentioned and steadily kept up, no great initial expense should be incurred to secure satisfactory destruction.

Now in regard to cost. Up to what point is one justified in incurring expenditure? There is only one way to answer this, and that is to apply the "will-it-pay" test. Let us take the two principal items of estate costs, *i.e.*, weeding and tapping. In my experience, there are few heavily-timbered fields that have cost less than \$1.05 per acre per month (average) to weed during the first five years. Had they been free of timber, I should have put their cost at an average of 80 cents or less. This represents a saving of \$15 per acre.

Then as regards tapping. The increase any tapper can do is at least a $\frac{1}{10}$ th larger task on clean-cleared land. Put this into figures over the first five years of tapping and another saving of \$18 per acre will be realized. That is, a total of \$33 per acre on *two items* only; in the first five years of each period.

The following example should explain what is meant:

		WEEDING.		
		(A)	(B)	
		Cost per acre per month.	Cost per acre per month.	
1st year average	...	\$1.50	...	\$1.25
2nd	„	1.25	...	1.00
3rd	„	1.00	...	.75
4th	„	.75	...	.50
5th	„	.75	...	.50
Totals		...	...	\$4.00
Average		...	...	\$ .80
Gross cost, five years		...	...	48.00
Saving per acre in five years		...	...	15.00

NOTE.—(A)—Uncleared of timber.

(B)—Free of timber.

TAPPING.

Task per cooly, 364 trees + $\frac{1}{10}$ th = 400 trees.

At 100 trees per acre labour required $1 \frac{1}{10}$ cooly = (4 acres) = one cooly.

Cost.

At 40 cents wages (say 30 days)	...	...	\$ 13.20 p.m.	...	\$ 12 p.m.
Gross cost, five years...	$\frac{792}{4}$	...	$\frac{720}{4}$	...	$\frac{720}{4}$
Actual cost per acre	...	198	...	180	
Saving per acre in five years	...	...	...	...	18

The above are obviously “arbitrary” figures, but are reasonably arbitrary. They are not exaggerated instances.

This matter of saving could be still further carried down, *i.e.*, saving in cooly labour, housing, medical, etc., but enough, I think, has been said to show that from the financial stand point, a considerable sum of money can be outlaid profitably—profitably not only in the sense of benefit to our production cost, but to the ultimate benefit of the estate, by improved plant sanitation.

TREATMENT OF DISEASE.

To be effective, treatment ought not to be merely a combative measure. It should also be curative. On this principle I have based my classification.

So far as the subject has reference to those diseases and pests that I have classed as "amenable to treatment" I only intend to touch on a few of the more important, *i.e.*,

- (1) *Phytophthora*, because, to my thinking, canker is about the nastiest thing we have to contend with ;
- (2) Pink disease, because of the application of different methods ;
- (3) *Gestroi*, in regard to the use of pumps.

(1). *Phytophthora*. The ordinary planter knows it under three headings :

- (a) Black line or black thread canker ;
- (b) Bark rot (claret canker) ;
- (c) Leaf and pod disease.

Whether these three are all one and the same matters little. The fact remains, they are so closely allied, that curative and preventive operations (to be successful) should be worked conjunctively and as part of the same scheme.

In regard to black thread canker: estates in Burma have furnished us with most experience, and from my knowledge of them and from what I have seen there it is my opinion, that this disease can be effectively dealt with, by adopting a combination of rules as follows :

- (1) No tapping on any very damp day ;
- (2) Decrease frequency of tapping on any field so attacked, as progress of disease is checked on cessation of tapping or by dry weather.

The more constant the opening of a wound the more susceptible and receptive it becomes, as black thread canker is a wound parasite and it attacks the delicate tissue exposed by tapping.

- (3) The immediate painting of all diseased parts or wounds with Jodelite, which gives a sort of protective covering by systematic painting on a monthly round ;
- (4) Sanitation firing, *i.e.*, systematically burning all leaves and droppings ; and
- (5) Above all things avoid cambium wounding, which means no deep tapping.

Chiselling the disease out of a tree is not looked upon with any favour in Burma, and I personally share this view, also shared by H. C. Pratt. This does not refer to burr and nodule removal and if the painting mentioned elsewhere is put in—Jodelite—any of them will penetrate this and destroy it. If the disease is so bad as to

require the adoption of this method, the tree had better come out altogether, for, in the majority of cases, a healthy tree will throw off a slight attack.

This criticism I would also apply to bark rot or claret canker, which, in nine cases out of ten, escapes notice until too far gone.

When leaf, pod or branch canker occurs cutting out or lopping off and burning affected parts, followed by sanitation firing and changkolling, offers to my mind the soundest treatment.

Another alternative is to lime and bury the fallen deposit.

In Ceylon, again, research work lays great stress on the value of cultivation. And another recommendation, also from Ceylon, is to make a thorough inspection and clean out all dead branches and parts, etc., just after wintering is over. This, in my opinion, is very sound.

(2) *Pink disease*.—In the treatment of this disease, Federated Malay States planters follow two schools of thought. We have the “painters” and the “surgeons” and each “grinds an axe” of plausible argument.

Which method is correct? Personally I lean to the surgical operation and opine that the knife should be used in all but exceptional cases. My observations are that where painting is the vogue, such estates never seem to get free of the disease, whereas, where the knife has been liberally used, conditions are nearly always reversed even on estates in the same district.

(3) *Gestroi*.—Though machines for pumping and distributing arsenical fumes for the destruction of *gestroi* are most useful and efficacious, alone they do not constitute a cure—that is a cure in the sense of ridding an estate of this pest. Termitariums have to be searched out and destroyed, and as these are invariably located in logs or stumps and a *sine qua non* to successful operation is the removal of timber, etc. Where the pump is most useful is in dealing with the rubber tree itself.

Any attacked tree that is “pitted” and shows “tears of latex,” means *gestroi* inside and also borers, but there is always a difference which is easily ascertained. The latter’s droppings are always visible. Therefore, use an “augur” on it. Bore a hole first and then pump. Afterwards plug the hole with a bit of hard wood dipped in Jodelite, cut off flush with the tree, and tar.

There is nothing difficult in the actual use of the machine, but it is important to see:

- (1) That the correct mixture is used;
- (2) That a “red” fire is in the brazier;
- (3) That each tree or log gets a thorough drenching, giving five minutes pumping to each dose of mixture put in the brazier, and not less than five to six doses per tree;
- (4) Always carry an augur and don’t be afraid to use it.

On peaty lands or soils that crack, pumps are useless. In such cases there is no alternative but to apply Towgood's system of search for termitariums, *vide* H. C. Pratt's "Observations on *Termes Gestroi*."

The external application of sundry poisons or forking insecticides into the ground at best only affords temporary relief.

In the matter of wound protection, my experience is that borers have no regard for tar at all; while on the other hand "jodelited" wounds are nearly always immune from attack. The most successful covering I have used is a combination of the two, *i.e.*, Jodelite as a first coat and tar as the next.

INCIDENCE OF DISEASE.

If we could forecast accurately the incidence of development and if we knew exactly when to expect the appearance of certain types of disease, this would go a long way towards solving many planting difficulties. For instance, we should know, the approximate period of time available wherein to complete preventive measures and also up to what point initiating a process of treatment would be valuable. With greater knowledge on this point, each estate would have a better chance of working out its own salvation. At present, unfortunately, we have little to guide us other than individual observation, which, of course, is unsatisfactory to base any working-rule on. As a beginning I record below my own ideas on their sequence and incidence.

(1) *Hymenochate*—

Generally occurs during 1st year. Occasionally also in 3rd year, but not often.

(2) *Fomes and Diplodia*—

Commence end of 2nd year and seldom seen after 4th year (if treated). Greatest activity immediately after rainy season. *Fomes* development is rapid.

(3) *Pink disease*—

Appears early 3rd year. There is a pink and black variety. Both are inimical and are always constant. Activity is most noticeable during rains immediately following dry weather.

(4) *Ustulina and Poria*—

Rubber fatalities do not often occur under eight to ten years old and, as a rule, trees are older. Both diseases are slow in development. Attacked rubber yields well for several years until the trees "snuff out."

(5) *Black line canker or black thread disease*—

May be looked for in the first year of tapping and is more serious when tapping on renewed bark. Most active in damp weather.

(6) *Claret canker*—

As a rule, found on trees 10 to 15 years old. (See No. 5 remarks.)

(7) *Leaf and pod disease*—

Attacks rubber of any age and is most active after a spell of rain. Irregular defoliation of young rubber, such as "double-wintering," etc., is suggestive and should always be carefully examined.

CONTROL OF DISEASE.

This is where, I think, our planting system fails. Most planters have a "nodding" acquaintance with the history and treatment of the various disease and pests common to the country, but, is this sufficient? Take the generality of estates out here. They rely almost entirely on the planting manager. He does his best "according to the book," but, is it satisfactory in reality? Consider too, that each manager in turn relies on a working-cooly gang very briefly supervised. Is it not possible that something really essential has been missed or left undone? Is a system controlling scientific work based on such lines correct? It is true, our losses from all causes of pest and disease would probably never total what we have had to thin out, but is that adequate insurance against the future?

"We planters are not 'rubber doctors.'" I have even heard it said that we are only "crude agriculturists," which is probably true, because the economic equation to our training is the "almighty cost per lb." or "cost per acre" as the case may be. Therefore, if we are to keep up with a science that daily claims a larger share in the ethics of present-day planting methods, and if we are successfully to apply these teachings, ought there not to be on every estate a co-ordinate staff of some kind trained for field operations if not in actual control?

We have already group hospitals and group doctors. Why not mycologists?

This is the most effective means of getting into close contact. A man who is on the spot can devote his attention to things. A visiting mycologist only touches the surface. This could be further elaborated by kranis, overseers, and conductors, being taught a certain amount of practical work in technical schools. In India, I believe, a great deal has been done and they turn out some very good men. What we want are such men who would take up a position in the working staff, correlative with doctors, dressers, attendants, etc., in the medical line. This slap-dash, easy-going method of ours is all wrong, and I believe the industry must waken up sooner or later to this.

DISEASES OF THE LEAVES AND STEM OF HEVEA BRASILIENSIS IN THE MALAY PENINSULA.

BY R. M. RICHARDS, A.R.C.SC.

(*Mycologist, M.P.A. Association.*)

HITHERTO the tree from which plantation rubber is obtained has not suffered from any serious epidemic disease. Only a purely parasitic fungus which would favour Hevea as a host is likely to cause an epidemic disease and it is those parts of the tree above ground which would be subject to infection. Root diseases have been and are serious enough on some estates but it is a fact that the various fungi, which cause diseases of the root system of Hevea in this country are preventable—that is to say, by certain means, whether they be considered impracticable or otherwise, it is possible to create conditions which exclude the chance of infection.

It is quite another matter, however, to prevent air-borne spores of a parasitic fungus from affecting parts of the tree above ground. I do not wish to infer that it is not possible to prevent serious loss from attacks of air-borne diseases for no unsurmountable difficulty has been encountered in dealing with the diseases of the leaves and stem known to us up to the present time.

The Para rubber tree in this country has so far shown itself to be a particularly healthy plant, but let it be realized that only by the treatment of diseases as they appear can we hope to keep up to this standard. The planting of enormous tracts of contiguous areas with the one kind of plant renders conditions ideal in this country for the rapid propagation of disease and only by careful vigilance in the treatment of disease and by the immediate adoption of remedial measures can the rubber plantation industry keep its position of security.

Where planted areas have suffered severe loss through disease up to the present time, in the majority of cases this loss has been due to carelessness or indifference, to the adoption of unsound methods of plant sanitation owing, possibly, to false ideas of economy, to the want of expert assistance at the time when the trouble arose or to begrudging money for treating disease.

In Ceylon a species of *Phytophthora* causes an abnormal leaf-fall during the wet weather from July to September. The fungus is said to spread from diseased fruit pods to the leaf stalk. The attacks on the leaf stalk appear to cause the production of an abscission layer at the base of the leaf stalk and so cause the fall of the leaf. In wintering seasons the abscission layer is normally

produced to effect defoliation. So far this abnormal leaf-fall has not been recorded, or at any rate I have not seen any cases of it, in this country.

The leaves of nursery plants are attacked by several fungi but none of them are serious and I do not consider it necessary to describe them in detail here.

Two fungi are commonly found on leaves which turn brown or yellow at the edges, *Gleosporium albo-rubrum* and *Phyllosticta ramicola*. These will be referred to later in considering stem diseases. They do not cause serious diseases of the leaves.

Cephaleuros sp.

This alga which is found commonly on the under sides of leaves where it produces small brown spots has no economic importance. The "red rust" of tea, a serious disease in India, is caused by a similar *Cephaleuros*. It is worth noticing in passing that such an alga has been found penetrating the leaf tissue of *Hevea* as most diseases associated with the tea plant are also common to *Hevea*.

No leaf diseases have any economic importance. Fortunately, no fungus belonging to the family *Uredinæ* has been found on *Hevea* leaves. It is to this family that *Hemileia vastatrix*, the cause of the well-known coffee leaf disease which ruined the cultivation of coffee in Ceylon, belongs. It is quite possible that a member of this family might adapt itself to the leaf of the rubber tree and might even have equally devastating effects as *Hemileia* in Ceylon but at the present time that does not seem probable.

The consideration of leaf diseases need not keep us any longer. Owing to the particular nature of the leaf it is, perhaps, naturally not particularly suitable as the host for parasitic fungi.

DISEASES OF THE STEM.

Of the stem diseases now recorded in this country the most serious are those caused by *Corticium salmonicolor* (pink disease), *Phytophthora faberi* (bark canker), *Phytophthora* species (causing decay of the tapped surface) and *Botryodiplodia theobromæ* (die-back).

Other fungi causing disease are *Phyllosticta ramicola*, *Gleosporium albo-rubrum* (forerunners of die-back), *Cyphella heveæ* (thread blight) and the abnormal condition of the stem, which I must include here, caused by burrs.

PINK DISEASE (*Corticium salmonicolor*).

In Java and in this country this disease is exceedingly common. The disease was very fully investigated in Java by Zimmerman Zehnter and Rant, and in this country by Brooks and Sharples. The literature obtainable on this subject is considerable and in compiling a summary for purposes of discussion I must point out that this literature gives a very complete account of the disease.

South, the Agricultural Inspector, Federated Malay States, in December, 1915, published a paper on the "Distribution and Field Treatment of Pink Disease" in the *Agricultural Bulletin*. In this paper we are told that the disease was then known to exist on 154 estates (of over 100 acres in extent) in Perak, Negri Sembilan, Selangor, Pahang and Johore. I can add that the disease is not unknown in Province Wellesley and Kedah. It is true that there are certain limited areas where the disease is much more common than in other parts of the country but since 1913 it has become much more widely spread.

It is sometimes observed that when the main stem or large branches are attacked the fungus apparently dies during a spell of dry weather and the affected bark cracks and dries up and a lip or callus forms on the healthy bark at the margin of the wound. In some cases the disease is thrown off in this way but more often it begins to develop again as more suitable conditions, rainy weather, arise. The disease first appears sporadically, that is, isolated affected trees are found here and there in the planted areas but unless checked it soon begins to spread.

Various methods of treatment have been tried and among these I have found only one which I consider successful. Spraying with fungicides need not be discussed at all as it is quite impracticable as a method of treatment of affected trees. If it were considered that the disease might cause a serious epidemic then spraying might have to be undertaken as a preventive measure.

Brooks and Sharples considered that the best method of treatment was the application of tar to the affected parts of the bark. South in an article to which I have already referred (published December, 1915) stated "The year's additional experience has, however, shown all the officers of the Agricultural Department connected with this work that the treatment originally recommended by the Mycologists is not sufficiently vigorous and drastic. More cutting and less tarring is generally advisable, while the pest gang should be large enough to make one complete round each fortnight or at the very longest every three weeks." Mr. South may have changed his opinion since then but the conclusions which he arrived at at this date do not appeal to me at all. I think the better treatment is the covering of affected parts of branches with a mixture of tar and crude oil (80 per cent. tar to 20 per cent. oil).

The whole circumference of the bark well above and well below the area affected should be covered with this mixture. If the disease is found in its early stages the application of the mixture checks its progress and actually in practice no further treatment is necessary in a very large percentage of cases. Should the treatment not be successful the branch may be cut off but only after treatment.

The very drastic method of cutting away affected branches which more often than not means cutting off the top of the tree or a well developed branch affected by a spore-producing fungus tends to accelerate the dissemination of the spores. If any cutting away has to be employed the tar and oil mixture should be applied first.

The oil is mixed with the tar to prevent drying and not because this mixture has any more penetrative power than tar only. After using this method of treatment for nearly two years I am quite satisfied, and I am sure many planters who have adopted the method will agree with me, that it is the only method of treatment which is at all satisfactory.

I agree with Brooks and Sharples in their statement in Bulletin No. 21 of the Department of Agriculture that "where a considerable amount of 'pink' disease is present one can scarcely expect to eradicate it completely" but it is possible by treatment not only to check the spread of the disease but also to effect a cure without the loss of branches which are essential for the production of good yields of rubber.

Individual estates can check the spread of the disease from within but frequently there are neighbouring estates and kampongs where the disease is not treated equally well and it is impossible to check the disease to the extent one could wish.

I am of the opinion that the treatment of the disease in native holdings and kampongs needs revision. Pink disease has increased very considerably during the past three years and I think this is mainly due to the fact that it is not under control in districts where it is rife and I am one, among many, no doubt, who attribute renewed outbreaks to fresh infections from outside sources, chiefly from native holdings.

It is absolutely essential to employ a pest gang constantly on all plantations where pink disease has been discovered if any real results in checking the disease in the country are to be obtained.

DIE-BACK (*Botryodiplodia theobromæ*).

The fungus which after pink disease has up to the present caused the greatest amount of injury to the parts of the tree above ground is the disease which, because of the way in which it travels down the tree killing the branches and main stem in its progress, has been called and is known as die-back.

Botryodiplodia theobromæ may make its attack in a variety of ways; the commonest method, as far as my experience goes, is to enter young shoots killed by two parasitic fungi, *Phyllosticta ramicola* and *Gleosporium albo-rubrum*, or by one of these; but it may enter a wound of any kind. The fungus appears to be

essentially a wound parasite whether the wound which affords the place of entry is associated with the attack of another fungus such as those just mentioned or *Corticium* or whether the wound be caused by a dead twig or broken branch. However the entry is effected the hyphæ begin to spread downwards in the tissue in the young wood or young bark, that is near the position of the cambium, killing the tree in a characteristic manner. It has generally been my experience to find groups of trees affected together, usually small groups.

On one estate I recall an occasion on which 150 trees of seven years old were found affected in one group. A few of these trees, not more than six, were killed but many of the others had to be cut back below the fork. Usually one tree is found killed and a group of trees in the immediate vicinity more or less seriously affected.

The only method of treatment is to cut down all trees killed by the disease and to remove all affected branches of trees which have not suffered so severely. However slight the attack the affected parts must be removed. All attacked parts of trees should be destroyed by fire immediately. It is necessary to act immediately when dealing with this disease as it develops and spreads down the tree with great rapidity. Dead rubber trees and branches should not be allowed to remain lying about in plantations. Any part of a dead rubber tree affords a most suitable place for the development of the fungus and indeed it can almost invariably be found on dead rubber branches or stems.

During the time I have worked in Malaya I have not been able to find the stage described by Bancroft as the ascus stage in the life history of the fungus which he considered to be the higher stage of *Botryodiplodia* and for this reason re-named the fungus *Thyridaria tarda*. There is no confirmation of the existence of such a form and until Bancroft's work is confirmed *Botryodiplodia theobromæ* as a name has the prior claim.

Phyllosticta ramicola and *Glæosporium albo-rubrum*.

For the purposes of this paper these two fungi may be dealt with together as they are frequently intimately mixed on the same affected branch or twig. The two fungi are parasitic and usually affect the uppermost twigs which still have a green epidermis or skin—that is, where cork has not yet been formed.

Phyllosticta generally makes its attack at a point 6 to 18 inches below the apex of the shoot. When first noticed a brown patch may be observed which later spreads upwards and downwards killing the twig. Usually the fungus spreads no further down than two to three feet below the apex. *Glæosporium* has a similar mode of attack. It is usually immediately after wintering when the leaves are just

unfolding that the attacks of these fungi occur most commonly. I have seen several thousand trees affected on one estate within a few weeks. *Glæosporium* is frequently the cause of the fall of the young leaves before they are fully developed—an effect of not uncommon occurrence.

As far as these two fungi are alone concerned the attacks are not dangerous. Dead twigs killed by the fungi are often found but the disease spreads no further. The real danger lies in the fact that their attacks afford opportunity for the entrance of *Botryodiplodia* and for this reason affected branches should be removed and all diseased portions burned.

More often than not, especially in flat lands, *Botryodiplodia* makes its entrance after the attacks of these fungi and therefore it is necessary that the utmost precautions should be taken to prevent a serious local epidemic of die-back.

THREAD-BLIGHT.

The mycelial strands of this fungus appear like white threads running along the small branches and twigs of affected trees collecting and binding together leaves in bunches. Leaves are frequently killed and sometimes small branches. The bunches of dead leaves and leaf stalks found bound together by the threads render the fungus conspicuous.

Dead leaves or collections of leaves may be broken off and carried by wind or some other agency to other healthy trees where the fungus may start developing again and so spread the disease. Leaves of two trees may, so to speak, be sewn together by the threads and this is another way of spreading the infection.

Fortunately, the disease is easily treated by cutting away affected parts and as generally only small branches are attacked the loss occasioned is insignificant.

On one plantation I found this fungus in fructification and sent it to Kew for identification where Masee named it *Cyphella heveæ*, but this is a matter which required further evidence or confirmation before we can be satisfied that the fungus belongs to this particular genus.

Phytophthora species.

Here I come to the most important part of my paper. In Ceylon, South India, Burma, Java and Sumatra a disease known as canker and proved to be caused by *Phytophthora Faberi* has been known for several years. The disease was found in Ceylon in 1903. In January last I heard that on a certain estate a disease had appeared on the tapped surface. Through the courtesy of the manager I was permitted to look round the estate and it was obvious at once that the disease was extremely serious for in 500 acres of well-matured rubber tapping had ceased. I was not able to

obtain any material to work on for all the affected trees had been subjected to treatment. In February again, through the kind permission of the manager, I was able to visit another estate 200 miles away from the first where apparently a disease of a similar nature had occurred. Sharples, the Government Mycologist, was visiting this estate and he isolated the fungus *Phytophthora* from the diseased bark. Within a day or two I visited an estate which it is my privilege to visit regularly and there found a considerable number of trees with this same disease. I have now isolated the fungus from material collected. From evidence collected it appears that the fungus is not *Phytophthora Faberi* but another species of the same genus.

The disease is undoubtedly the same as that known as "bark rot" in Ceylon, "black thread disease of Hevea" in Burma, and one form of canker (vertical black line) in Java. Infection only takes place on the most recently tapped surface and, therefore, the fungus appears to be a wound parasite. Essentially the disease is a decay of the tapped surface. The most recently tapped bark immediately above the tapping cut shows vertical black lines varying in length up to one inch or more, and these on removal of the bark are shown to continue into the wood. This "bark rot" may spread and several "lines" of decay may coalesce to form small blackened or sometimes greyish, roughly rectangular areas of dead bark. Further, as the fungus develops several areas may coalesce, producing a decayed area of bark just above the tapping cut and right across the tapped area. Superficially the lines often appear as slits or vertical depressions some little distance above the tapping cut, but frequently, at an early stage, the lines may only be discovered by removing the thin outer-layer. As Dastur has pointed out the depressions may be due to the collapse of the cell walls of the outer tissues. Rutgers in Java, Dastur in Burma, and Macrae in India have proved that the decay of the tapped surface or "bark rot" is due to an infection of *Phytophthora*. That a species of this fungus is the actual cause of the decay is beyond all doubt since these three independent workers obtained positive results by infection experiments. That work has also been done in this country by Messrs. Belgrave and Norris in the Agricultural Department.

In Ceylon, Petch has shown that there are four different diseases caused by *Phytophthora Faberi*—namely, stem canker, "bark rot" of the tapping surface, abnormal leaf fall and pod disease, but recent evidence goes to show that more than one species of *Phytophthora* is responsible for these diseases.

Until January last I had not seen any sign of a disease caused by *Phytophthora* on any of the estates I visit regularly but I am inclined to think that the "bark rot" of the tapping surface is now extremely common in the country.

Bark canker.—The fungus causing this disease appears to be *Phytophthora Faberi*; there being then two distinct forms of disease apparently caused by different species of the same genus. The fungus was known to cause a canker on Hevea as long ago as 1903 in Ceylon. In this country, however, as far as I am aware the disease has only recently been found.

Certainly on estates-I visit I had not been able to attribute any pathological condition to the fungus *Phytophthora* until March of this year. The disease starts in patches usually on or near the tapped bark but they may appear at a higher level. It is possible that the first indication may be that the tree ceases to yield latex. If undiscovered at an early stage the decaying tissue will attract borers and the appearance of boring beetles may be the first visible sign. In all cases when latex ceases to flow the bark should be lightly scraped; if a green layer is found the tree is healthy. Sometimes, in the case of trees with a very scaly outer bark, the green layer is not very obvious. If the tree is attacked by the fungus *Phytophthora Faberi* a black layer is found on lightly scraping and the cortex beneath is variously coloured, greyish, brown or dirty red or purple red according to the stage in the attack, *i.e.*, it may be greyish in the early stage or may be very dirty red which changes to purple red on exposure in advanced cases.

The diseased patch usually has a well-defined dark border. No latex will flow from patches of cankered bark but surrounding bark may yield extraordinary quantities. It must be understood that the colour of the bark only applies to the internal layers of bark and that it can only be detected by scraping away outer layers. Usually there is no external indication of the disease. The disease is capable of spreading and may kill the whole bark from the point of attack to the position of origin of first branches or higher or all the bark of the main stem. Boring beetles are attracted by a peculiar smell, which appears to be characteristic of the cankered bark, and they may possibly cause more injury than the canker itself.

Treatment.—The red canker patches of bark canker must be excised or scraped if patches can be found where the disease has not affected the inner tissue to the cambium and the wounds so caused painted with a 20 per cent. solution of brunolinum in water and soft soap and later covered with coal tar. It is useless trying to apply any form of treatment in the case of badly affected trees where boring beetles have made their entry into the wood. These trees should be cut out and burnt.

As regards the treatment of "black thread disease" or the "bark rot" of the tapping surface I will here indicate methods advised by other economic mycologists in various countries.

Rutgers and Arens in Java suggest that "tapping be stopped and the cuts treated every five days with a 20 per cent. solution of

carbolineum or some other disinfectant. After a few weeks tapping can be started again; in some cases it is not necessary to stop tapping." As preventive measures they point out that free access of air and light should be given to the trees in the plantation by thinning out, that there should be a thorough system of drainage and the use of water in tapping should be avoided.

Dastur, who did the work on the disease in Burma, suggests cessation of tapping at the first appearance of the disease and the collection and destruction of all diseased fruits.

In South India an effective method is said to be the cessation of tapping on affected trees and a mixture of tar and tallow smeared over the diseased area of bark.

Petch says "When the tapped surface shows signs of decay it should be brushed over twice a week for three weeks with a solution (20 per cent.) of brunolinum (brunolinum one gallon, water four gallons, soft soap one lb.) The canker patches must be cut out and the diseased tissue burnt."

I have not as yet been able to draw any very definite conclusions from the experimental treatment adopted on the various estates affected but hereunder I make suggestions which may be acted upon at once should the disease be found on your estate.

Prior to making suggestions it is necessary to understand the conditions which favour the growth and spread of the fungus. All species of *Phytophthora*, the potato disease of Ireland caused by *Phytophthora infestans* is one example, need excessive humidity for their development. Any particular cause which has the effect of preventing the drying up of moisture on the tapping or tapped surface should be eliminated if such elimination is possible. One cannot prevent rainfall but it is possible by one or more of several means to increase the rate at which the moisture on the bark will evaporate.

It does not follow that because a method of treatment is successful in one country it is necessarily a success in another country or another part of the same country because conditions, particularly atmospheric conditions, vary so considerably.

In Burma, for example, there is a distinct wet season and it is during this season that the disease is prevalent. In this country again it seems to me that the fungus, for some unexplained reason, penetrates more deeply into the tissues of the plant, to a considerable depth in the wood, than, from the information obtainable, in other parts of the East, where Hevea is planted. It would appear then that what may be an unavoidably drastic measure in one place could be extremely unnecessary in others even in the same country.

In all probability the disease is worst on closely planted estates, where, necessarily, the bark renewal of tapped surfaces is poor since the increase in girth is slow.

On estates where the spacing of the trees is adequate to allow for good growth and rapid renewal it is possible that the trees are able to throw off the disease.

If the rainfall is unusually excessive the spacing factor would obviously not have the same significance.

Although pruning is not recommended at all in the ordinary course of events as I consider it necessary to provide all possible leaf area and not to deprive the tree of any branch if it can be avoided, it may be necessary to prune in order to increase the distance between soil and foliage to allow for access of light and air where there are serious outbreaks of the fungus.

Water lying about on the surface soil would increase the moisture content of the atmosphere about the level of the tapping surface, preventing rapid drying and increasing the chances of infection. Should such a condition exist remedial measures should be adopted without delay.

It is not easy to give any definite reliable information on the treatment of the disease at the present time for the reason, as I have stated above, that sufficient time has not passed to allow one to draw any sound conclusions.

When trees are badly affected it would seem that superficial treatment with disinfectants would not check the disease as it could readily spread in the wood behind the cortex and bark could be re-infected at a lower or higher level. It would, therefore, be necessary to cut out the affected bark and possibly the superficial layers of wood—in any case all dead bark should be removed.

The tapped surface of slightly affected trees may be painted with a 50 per cent. solution of Jodelite (half Jodelite, half water) or even a stronger solution or a 20 per cent. solution of brunolinum twice a week for three weeks.

It may be necessary later on to cut out the diseased bark but such drastic measures should not be taken unless the other method fails, as the resulting wound is a serious matter.

In all cases tapping should cease on affected trees. I have not seen any evidence to prove that the disease is carried by the tapping knife but it is quite possible that that may happen. To be on the safe side it may perhaps be advisable to sterilize the tapping knives and for this purpose to use a 5 per cent. solution of formalin which should be carried by the tappers in receptacles of some kind large enough to hold the knife. After each tree is tapped the knife should be placed in the formalin solution.

Where the disease is serious it will be found necessary to apply a disinfectant to the tapped surfaces of every tree in the area. The infection takes place on the cut. That is on the thin bark most recently tapped. It is at this position then that the disinfectant must be applied. The most important questions are the frequency of application, the best disinfectant to use and the method most practicable in estate practice. From an article in the most recent *Agricultural Bulletin* I gather that in Sumatra it is found that the best results are obtained if the disinfectant is applied every day. From figures given in the article, by H. C. Pratt, to which I refer, it appears that this is the only satisfactory method. The disinfectant may be 20 per cent. carbolineum as used in Sumatra or its substitute 20 per cent. brunolinum, 10 per cent. Izal or a solution of sodium bisulphite and formalin. The last question—the most practicable method—may well be left for the planter to decide.

BURRS.

These structures are too well-known to need any description. Rutgers and Arens considered that they are produced as a result of attacks of *Phytophthora Faberi* but there is no indication of the presence of a fungus of any kind within the tissue of a burr or nodule.

Burrs are formed round a portion of a latex vessel as a result of alteration of the contents of a latex vessel. Whether that alteration be disintegration, decomposition or coagulation, cortical cells surrounding the latex vessel are stimulated to divide and form a cambium which cuts off wood cells on its inner side forming a core of wood tissue and bark cells on its outer side. The remains of the latex vessel are easily discovered when sections are examined microscopically. Similar nodules are produced as a result of latex oozing out of a tube or occupying spaces between the cells (intercellular spaces) or, occupying lesions in the cortex. Bryce divides these into three types, he distinguishes yet another type which I have not seen—namely, nodules which are formed round areas of cortex from which latex may be entirely absent.

I have not been able to find any evidence whatever that this pathological condition has any connection, directly or indirectly, with the attack of any fungus disease or insect pest.

Bryce suggests that "the tendency to suffer alteration in the latex vessel content appears to be confined to certain individual trees which have a predisposition to develop this condition."

I think myself that in a very large proportion of the number of burred trees the original central point (round which the burr develops) the factor which is the cause of the burr, is merely accidental, due to local coagulation or alteration of the latex within the tube or to the bursting of a tube allowing latex to occupy spaces where it is foreign.

ROOT DISEASES OF HEVEA AND CLEAN CLEARING.

BY W. N. C. BELGRAVE, B.A.

(Acting Mycologist, F.M.S.)

THE interest taken in root diseases, which had waned with the control of *Fomes*, has been revived in the last three years by the discovery of *Ustulina* and *Poria* as common and destructive parasites of Hevea; and in some quarters something approaching a panic was experienced.

Still more recently, root diseases have been again overshadowed by bark cankers. Without minimizing the seriousness of the latter, it is to be urged that root diseases be not neglected—especially now that the policy of drastic thinning out has been widely adopted.

The fungus root diseases known to attack Hevea in Malaya are:

Fomes lignosus (*semitostus*).

Sphærostilbe repens.

Ustulina zonata.

Poria hypolateritia.

Brown root disease.—*Hymenochaete noxia*.

Of these, *Fomes lignosus* is the only one which regularly attacks young rubber. Although described since 1854, it was not till 1904 that its parasitic nature was recognized—by Ridley. Bancroft fully described the fungus and its mode of attack on Hevea in 1912. Like all root diseases an attack of *Fomes* is generally too far advanced when discovered, for the tree to be saved. The only signs of *Fomes* attack which show above ground are drying up of latex, and withering of leaves. The chief characteristic of *Fomes* is the production of external mycelial strands on the diseased roots. When young these are white, and much branched, becoming later cord-like and brown yellow, or reddish; and attaining a thickness of as much as $\frac{1}{4}$ inch. The mycelium under favourable conditions is capable of growing for short distances though the soil independently of roots. The most favourable conditions are moisture and acidity, hence in heavy clay or peaty lands, much more unattached mycelium will be found, than in looser drier soils. If the source from which the mycelium has started be removed, the hyphæ soon die, and no mycelium can be found after a lapse of a few days. It follows that once all the diseased wood has been removed from an infected area, there need be no fear of the "free" mycelium carrying on the disease.

The fructifications of *Fomes* are most frequently found on wet low-lying land. They take the form of brackets which may be

single or fused, and are, when fresh, of a brittle woody nature. On breaking across, the bracket is seen to consist of two layers, the upper of which is white and composed of fibres which run parallel to the surface, the lower bright orange coloured, and composed of tubes vertically arranged. The upper surface is zoned with alternate brown and pale yellow brown zones running parallel to the margin, while narrow wavy lines or striæ run at right angles to the zones. The margin, especially in young fruits is yellow, and the under surface is bright orange, studded with very small pores—the openings of the tubes mentioned above. The spores are borne on the sides of the tubes, and are shed from the pores. It must be mentioned, however, that the majority of the *Fomes* fructifications examined in this country are found to be sterile, *i.e.*, bear no spores, and cannot assist in the spread of the fungus.

The fructification may be found in another form—as a plate spread on the wood—the exposed surface being orange coloured. This form is known as “resupinate” and is not common.

The great majority of infections of *Fomes* arise from contact, of mycelial strands, or pieces of diseased wood, with healthy roots. Artificial inoculations carried out by Bancroft to prove this point were very successful, giving positive results in 10 out of 14 cases.

In the opinion of Bancroft, in Malaya the fungus occurs on all kinds of jungle timber, hard and soft, white and red; so the selective clearing favoured in Ceylon is unsafe here.

Attacks by *Fomes* are usually first detected at 12-18 months, and if properly treated, begin to diminish some time after the fourth year, owing to the decay of the jungle hosts of fungus.

Sphærostilbe repens.

This fungus was first recorded as a parasite on *Hevea* in 1907, in Ceylon; when it was found to have killed three 25-year old trees. Richards first recorded it in Malaya, and Brooks described it in the *Agricultural Bulletin* of November, 1914. In Malaya the disease has so far occurred on low-lying lands—Petch, however, states that in Ceylon it is not confined to low country.

Attacked roots are characterized by a blueish-purple colour and an extremely unpleasant odour. There is no external mycelium, but between the wood and bark run rhizomorphs—flat mycelial strands, red when young, turning black as they grow older. The disease sometimes travels up into the stem, after which borers often enter.

The fructifications of this fungus are very minute and easily overlooked. The form most frequently found is the conidial—*Stilbium* stage—consisting of white or pink blobs about the size of a pin's head, borne on stalks about $\frac{1}{4}$ th inch long, and hairy when young—spores are formed at the ends of the blobs.

Brooks obtained pure cultures of the fungus, and carried out inoculation experiments on the roots of healthy trees. These were entirely unsuccessful and suggest that some condition adverse to *Hevea* must exist before the fungus can enter living roots. This condition may well be bad soil ventilation. Infection may be either by spore infection on wounds (on exposed roots) or contact with diseased jungle roots and precautions must be taken accordingly.

Ustulina zonata.

A disease first detected in Malaya in 1914 by Brooks—followed by Sharples—the latter author attaches more importance to the manifestations of the fungus as a collar-rot than as a root disease; but root attacks and spread by contact should not be neglected. Petch attributes the prevalence of the disease in Ceylon on tea to lateral root contact from stumps of *Grevillea* which had been left in the ground. The characteristics of an *Ustulina* attack are—a dry rot of the attacked wood, and the production of coarse interlacing black lines in the wood. There is no external mycelium and the wood must be cut into before the disease can be found. The fructifications are of somewhat varied form—the most common being a plate-like mass, adpressed to the collar of the tree—the colour of which changes from yellowish-white, through grey—white and greenish-grey to black. In the later stages, when splashed by mud, the fruits easily escape observation. More rarely other forms of fruit body are found, e.g., a solitary stalked form; stalked forms aggregated to a plate; and other lichen-like forms. All, except the last, produce spores in abundance, which falling or being carried to wounds or cuts propagate the fungus. It follows that the fruit bodies of this fungus, like those of *Sphaerostilbe*, should be destroyed as soon as found.

BROWN ROOT DISEASE (*Hymenochæte noxia*).

So far this disease has not been recorded to any great extent in Malaya although Petch states that it is the commonest root disease of *Hevea* in Ceylon. Characteristic of this fungus is the production of hard, brittle, brown or black incrustation around infected roots—composed of soil bound to the roots by the fungus mycelium. Within the decayed roots are often found brown lines or plates of fungus tissue. Diseased wood, at any rate in Malaya, remains hard, but may become honeycombed. Fructifications are of very rare occurrence and are of no practical importance.

So far as I know, no artificial inoculations have been attempted with the fungus, but the disease can often be traced to a jungle stump. Brown root disease has usually been considered as not dangerous owing to its slow spread—the idea being that the attacked tree dies, and is taken out before the roots of the surrounding trees can be infected. This may be so, but it is better to be on the safe side, and to treat the disease like all other contact root diseases.

Poria hypolateritia.

This fungus, causing a wet-rot of *Hevea* was the subject of an article in the August *Agricultural Bulletin* for 1916. It appears since, that the specific name *hypolateritia* there given was not correct, and the fungus is nearer to one recently described by Petch in Ceylon as *Poria hypobrunnea*. The matter has been referred to Kew, and the final name will be settled by the authorities there. Whatever the systematic name, there is no doubt of the presence of the fungus, and of its characteristics, the chief of which is the wet rotting of attacked roots. This may vary from a slight dampness of recently attacked roots only discoverable on splitting, to the complete disintegration of the root to a jelly-like mass.

A very delicate snow-white mycelium is sometimes produced on the exterior, but no strands travelling through the soil have ever been found. The exterior of the root is sometimes covered by a very dark reddish skin of mycelium and bark tissues mixed; this skin is tough, and when freshly taken up can readily be detached from the wood—serving to distinguish an attack of this fungus from that of brown root disease; in the latter case the external crust is brittle and cannot be separated from the wood.

Brown lines or plates of hardened fungus tissue are often found. They differ from those produced by *Ustulina* in colour and texture, being much finer and less branched. Broad brown bands also occur, formed by the deposition of a substance akin to wound-gum. Attacks of *Poria* sometimes cause honeycombing of *Hevea* wood, but the phenomenon is more common when hard jungle woods are attacked. Like *Fomes* the fungus has been found both on hard and soft woods, including many of the largest stumps such as are very often left in otherwise cleared plantations.

Perfectly developed fructifications are very rare; more commonly on the under-side of exposed roots, small patches of an imperfect fructification develop. The fungus belongs to the same group as *Fomes*—and the fructifications have the same form as the resupinate form of *Fomes*, *i.e.*, a plate perforated with many fine holes. The colour is white when young, later becoming red-brown to black. These fructifications are sterile, *i.e.*, bear no spores, and cannot spread the disease.

It was first thought that the disease might be confined to special areas, particularly flat wet lands—but it has since been found to be distributed through the Peninsula.

The mode of infection is by contact of lateral roots with jungle stumps, or with other laterals; and the peculiar danger of the disease lies in its very slow rate of growth in living tissue, which makes it possible for neighbouring trees to be infected—through laterals—before the first infected tree is seen to be diseased. This insidious method of attack is further aided by the partiality of the fungus to

heart wood, which has ceased to function, and to the fact that it very seldom "rings" a tree but goes up to the collar on one side only.

In one field of rubber, 30 per cent. of the trees were affected by the disease before its presence was even suspected. The disease is usually discovered earlier on wet lands as owing to the poor development of the root system, attacked trees blow over sooner.

So far only one estate has had its young rubber badly attacked by *Poria*; this is not because young trees are immune to attack, but because the laterals take time to establish contact. Isolated cases can often be found on young rubber, and without doubt, many deaths formerly attributed to *Fomes* or brown root disease, were due to the then undescribed *Poria*.

TREATMENT.

With few exceptions treatment of individual trees is impracticable, as the diseases are never discovered till too late.

Attention must therefore be turned to prevention.

Prevention.—Is of two kinds: (a) Total prevention of attacks; (b) Prevention of spread from attacked areas.

It has been shown that all the root parasites of *Hevea* also live on dead wood, *i.e.*, can be saprophytes; and that it is from dead wood that infections arise. The obvious remedy is to remove all dead timber and stumps both of jungle and *Hevea* trees, *i.e.*, to adopt clean clearing: if this be done, it is not too much to say that immunity will be ensured from Brown root disease and *Poria*, while infections of *Fomes*, *Sphaerostilbe*, and *Ustulina* will be reduced to those from spores blown or brought from neighbouring jungle or plantations.

It is usual to find that saprophytic fungi, which become parasites, can only do so by gaining an entry through a "wound," and the results of inoculation experiments support this as applied to *Hevea* root diseases. It might be argued that if wounds could be avoided, *i.e.*, by covering all laterals, the roots would be immune from attacks. Unfortunately a "wound" in the technical sense, includes any break in the protective covering of the plant. Such breaks may arise in many ways, of which the deaths of very small rootlets is one of the commonest. It follows that although exposed wounds of animal origin should be avoided as far as possible, because of the danger of spore infection, the root fungi cannot altogether be prevented from entering by such precautions.

Before work was carried out on *Poria* and *Ustulina*, it was thought that clean clearing was not essential, the idea being, that trees attacked by *Fomes* died in a relatively short time, so the presence of the disease would be discovered, and the source removed before neighbouring trees had time to establish contact. Also in the

early stages, losses could be made good by supplying, or out of the excess number of trees planted. Bancroft states that this treatment gave very satisfactory results, on areas badly attacked by *Fomes*. Unfortunately, *Poria* and *Ustulina* may go on for very many years, sometimes twelve, without being discovered, and the only safe rule is to treat all timber as a possible source of infection. The possibility of healthy looking trees being in reality diseased is especially serious for existing plantations in view of the very extensive thinning-out now in favour. When it is intended to reduce the number of trees to the acre to less than 80 on plantations which were not clean cleared early, it will be found advantageous to examine the collar and roots of each tree—the expense should not be great. It is often pointed out that the various root parasites cannot be widely distributed in the jungle as this would soon die; it must be remembered, however, that although all these fungi are of comparatively slow growth as parasites on healthy wood, they are capable of very rapid growth on decaying wood, and will spread rapidly once the trees are felled, both under the ground (*Fomes*, *Poria*) and above it (*Ustulina*).

The ideal time for clean clearing is before planting up—but the removal of large jungle stumps in an undecayed condition entails prohibitive expense. It is, therefore, recommended that the smaller stumps and roots be taken up, while the large stumps be trenched, say with a trench of six feet radius and of a depth sufficient to sever all laterals. Parts of that laterals outside the trenches should be taken up and no *Hevea* should be planted inside the trenches. As long as the stumps remain the trenches must be kept open. When somewhat decayed, *e.g.*, at the time of thinning out, the stumps may be removed at much less cost.

Care must be taken as long as the stumps remain to examine them for fungus fructifications which should be destroyed as soon as they appear. In a field thus cleared no rubber wood must be allowed to remain. Although the certainty of immunity given by clean clearing cannot be attained later, clearing of timber and stumps will always be found beneficial, except in old plantations already badly diseased (say more than 30 per cent. of trees) there the expenditure could not be justified.

Prevention of spread.—Trenching is recommended for attacks by all root diseases, except perhaps *Ustulina*, for which, according to Sharples, spores from fructifications produced on the surface timber are the chief source of infection. Trenches must be deep enough to sever all lateral roots, and wide enough to include all affected roots; to be on the safe side, another trench should be dug around the neighbouring trees. The diseased trees are best cut out and burnt, the area within the inner trench being dug over to get out all diseased wood. Lime is of beneficial effect if supplying is undertaken.

A careful watch should be kept both on timber and rubber trees and stumps for the fructifications of the fungi mentioned, the most dangerous being those of *Ustulina*, those should be destroyed as soon as they appear. Rubber stumps left after thinning out often bear a plentiful crop of *Ustulina* fruits—the practice of felling trees by severing the laterals has much to recommend it, the roots left behind soon decay, and there is no chance of harmful fungi being harboured.

Admittedly the measures proposed above, involve an increase in expenditure. When considering the benefits conferred by immunity to disease, it should be borne in mind that, given time, contact diseases spread at what may be called “compound interest,” *i.e.*, the number of possible infections grows rapidly as the disease spreads out from the centre of the infection.

No figures have been given for costs of clearing, etc., as conditions vary too widely to make comparison reliable; it is, however, the emphatic opinion of the mycologists of the Department that the measures outlined above will be found in every case to be abundantly justified.

Discussion.

The CHAIRMAN (Mr. Lewton-Brain) invited discussion of the papers read, and a series of questions was asked, these being subsequently replied to by each lecturer in turn.

Mr. ELLIS, of Taiping, next gave his experience of diseases. He was of opinion that if they were going to treat disease at all they should do it thoroughly by cleaning the whole place out and doing away with the whole disease. It was of no use going only half way. Some managers on seeing pink disease appear on their estates naturally said it must have come from the kampongs, but it was just as likely that the kampongs got it from the estates. (Laughter.) Besides that there was the jungle that was a source of infection. When trees were seven or eight years old they were less liable to infection than when they were younger. It was a great mistake to take off a pest gang when the disease was less virulent, and the gang should be kept on always. He referred to bark canker and other diseases that came within his experience, and gave the results of treatment he had applied. He thought the black patch disease was carried by the tapping knife and advised the disinfection of the knife with a solution of 5 per cent. of formalin. The painting with 20 per cent. solution of Izal in black stripe disease was good in some cases, but the point was to let in air and light, good drainage, reasonable thinning out, and then painting with some disinfecting substance.

Mr. JARVIS said that Mr. Belgrave had advised clean clearing before planting but had not made it clear whether he advised timber to be cleared from old estates.

Mr. BELGRAVE said he would certainly advise such if the disease in the place did not exist badly.

Mr. JARVIS then enquired whether burning of the timber did not do more harm than good.

Mr. BELGRAVE suggested that burning of the timber in pits be adopted as it had proved very successful on some estates.

Another question asked was did the cutting of roots when clearing timber damage the trees.

Mr. BELGRAVE was of the opinion that the cutting of a few laterals was not of great importance especially if tar was applied.

Mr. PINCHING commenting on the carbolinium solution of 20 per cent. thought it did some damage and recommended not more than 10 per cent. In regard to Mr. Ellis's remark that pink disease should be caught up early enough, he said that that was the trouble, as the disease was not seen until it was too late, and the bark was dead by then. He had heard from the Mycologist in Ceylon that black line canker was not known there, and he thought some explanation was, therefore, necessary in regard to the allusion to that disease being found in Ceylon.

Mr. PINCHING also asked Mr. Belgrave as to what depth he considered stumping should be carried out when thinning out.

Mr. BELGRAVE said that two feet should be sufficient.

Mr. HARRISON asked whether timber in peat was liable to carry infection.

Mr. BELGRAVE replied that one estate on peaty land had suffered badly from root diseases.

Mr. COOMBS called attention to flat land and hilly land in their relation to disease. Leaf pruning in America and other countries was not very much advocated.

Another member said that he had noticed trees of seven or eight years old suffer from pink disease. On one occasion Mr. Sharples (the mycologist) and he had examined a large plantation of three- and four-year old trees and found no cases of the disease, but three or four years later he found the disease amongst the then young trees, which seemed to show that the old trees got the disease first, there having been no kampong within a mile of the place. If they said that old rubber was less liable to attack it might make planters neglect their old trees, and that would do more harm than good.

Mr. RICHARDS, referring to Mr. Belgrave's remarks regarding *Fomes*, said it was possible to cure a very large number of cases by looking for the disease by clearing the soil from roots in the case of trees one to five years old and painting with copper sulphate and lime wash.

Mr. PINCHING asked Mr. Richards to express his opinion as to whether he does or does not consider that deep tapping encourages infection by *Phytophthora*—"black thread."

Mr. RICHARDS replied that he had not sufficient experience of the disease to offer an expression of opinion but that he thought deeply tapped trees would not suffer any more severely than those lightly tapped. He added that he hoped no planter present would seriously consider it policy to commence shallow tapping because the question had been raised.

Mr. ELLIS advocated deeper tapping as liable to show disease more easily, besides being more beneficial for latex.

Mr. PINCHING said that Messrs. Harrisons and Crosfield had a solution that was said to be exactly the same as used in Sumatra, but what puzzled him was that they did not get the same results.

Mr. RICHARDS said he had not tried it, and so could not say.

THE DISEASES AND PESTS OF THE COCONUT PALM.

BY R. M. RICHARDS, A.R.C.SC.

(*Mycologist, M. P. A. Association*).

IT is only in recent years that any real knowledge of this subject has been attained. As recently as 1906 Prudhomme stated that "the important enemies and parasites are animals," but there is little doubt that diseases caused by fungi and bacteria did exist years before that date.

It is known that "bud-rot" existed in the West Indies long before the disease attracted any general attention.

The coconut palm in various parts in the tropical world like other plants producing economic products, but unlike the rubber tree up to the present time, has been subject to diseases of an epidemic nature. Climatic conditions in the tropics are so eminently suitable for the rapid development and spread of a disease that at any time any single cultivated plant grown in contiguous tracts of land is susceptible to epidemics, and it is only by exercising the utmost care in guarding against disease that the coconut industry can be maintained.

Warnings such as this have been issued and published by so many workers, in fact they appear in any work dealing with the cultivation in general or with the diseases of any particular economic and widely cultivated plant.

However, such warnings cannot be repeated too frequently and are not to be treated lightly or with contempt; they are not emanations from pessimistic or alarmist minds.

In 1906 a severe epidemic of "bud-rot" occurred in the delta of the Godaveri river, India, affecting palmyra, coconut and areca (betel nut) palms; in the province of La Laguna in Luzar, an epidemic of the same disease affecting coconut palms was reported as having occurred in 1907; and serious attacks have been recorded in the West Indies. *Pestalozzia palmarum* caused an epidemic disease in Kempit in the Banjorwangi Presidency in Java in 1905-6. Either these or some other disease may possibly become epidemic in the Malay Peninsula.

DISEASES.

Theilaviopsis ethacetica.—Petch described this fungus as the cause of the "Bleeding disease of the coconut stem in Ceylon." The following is the description of the disease as given by the Ceylon Government Mycologist.

“A brown liquid oozes out through the cracks in the cortex and forms a rusty patch which usually turns brown afterwards. On cutting into this patch, the internal tissues are found to be discoloured and decaying; they are brownish and finally turn black. If the diseased area is cut in wet weather, the liquids sometimes squirts out; in fact, it may in some stages be collected in a glass by simply pressing on the diseased patch. After some time the black patches appear on the trunk, usually on the same side. When this happens, it will generally be found that this is not a new infection, but the disease has worked up or down inside the stem, and the liquid has found a new outlet. . . . It is important to note that there is no sign of the disease until the liquid oozes out, and when this occurs the internal tissue is already decayed to some extent.”

On one estate in Perak I have made observations on palms affected by the similar rusty and finally black patches from which a brown liquid oozes. In every way the external and internal appearances correspond with Petch's description but I have never been able to isolate the fungus *Theilaviopsis ethacetica* from the affected tissues.

It is quite possible that this effect is produced by the same cause as in Ceylon but of course no definite statement as regards the disease can be made until the fungus is isolated from diseased tissue and infections are made from the cultures.

By cutting away the decayed or diseased parts of the stem and covering the wound with a very liberal coating of tar it is possible to prevent the patch from enlarging or spreading up or down the tree to other parts. Petch recommended that after cutting out the diseased tissue the wound should be burnt with a torch and then covered with hot coal tar. All diseased parts cut away are burnt, and should it not be possible to apply this local treatment in advanced cases the whole palm should be cut down and burnt.

Pestalozzia palmarum.—This fungus is the cause of a leaf disease in this country as apparently in most parts of the tropics.

Bernard found this fungus to be the cause of a destructive epidemic in the Banjorwangi Presidency, Java, in 1905-6.

In this country as far as my experience goes the disease is only found among young plants either in nurseries or in plantations after planting out. The fungus is extremely common as a saprophyte on dead leaves and the withering lower leaves of healthy palms.

In the first stages little whitish transparent spots appear on the leaves. The spots increase in size and coalesce, forming irregular areas of dead tissue on the leaves. A brown ring surrounds each area immediately outside which the tissue has a pale green or yellowish colour indicating where the fungus is growing into the healthy part of the leaf. The tips of leaflets and edges become

white or greyish in colour. When the effect of the disease is serious the whole leaf becomes yellow and all leaves are affected, and eventually the yellow colour changes to a greyish white and the leaves wither. Sometimes only the latest formed leaf, not yet fully opened, may be seen green and unaffected but this eventually dies and with it comes the decay of the growing point or heart and the death of the palm.

Dead palms should be uprooted and all parts carefully burnt *in situ*. Diseased leaves of affected palms may be cut away and burnt and plants treated in this way should be carefully watched for further signs of the disease.

Fungicides may be applied by spraying but this is only advised when nurseries are affected, more as a preventive than a remedial measure. Bordeaux mixture should be used as the fungicide.

Helminthosporium sp.—This fungus has been found intermingled with *Pestalozzia* and may contribute towards the general effect of the disease. It is possible, also, that this fungus itself is the cause of a disease similar to that of *Pestalozzia palmarum* though I have no records that such is the case.

Botryodiplodia sp.—In December of 1914 a disease was first found in this country which I now attribute to a fungus, a species of the genus *Botryodiplodia*. At one time I thought that this disease was an exaggerated form of attack of *Pestalozzia palmarum* and in a circular letter sent to members of the Association, dated 5th February, 1915, I described the effect of this attack, but in a note at the end of the letter added that *Diplodia* among other fungi was found with the *Pestalozzia* and that I could not then say which fungus was responsible for the full effect of the disease. This letter together with photographs is published in "A Practical Guide to Coconut Planting" by R. W. Munro and L. C. Brown. The first noticeable sign of the disease is that distal end of a leaf withers and droops, almost breaking away from the rest of the leaf at a point of weakness, varying from one foot to three feet from the top, but remaining attached, hangs directly downwards as a pendulous section. These withered ends of the leaves on affected trees are most characteristic in appearance. It is possible at first sight to mistake these signs for attacks of brown beetles or leaf beetles but a cursory examination will prove the presence or absence of the obvious signs of the boring of the beetle. The drooping end of the leaf is at first yellow but finally has the usual brown appearance of a withered coconut leaf. The fungus spreads into the lower part of the leaf travelling down the leaf-stalk and eventually the whole leaf becomes yellow.

As the fungus affects the tissue of the leaf-stalk a brown mark is produced and is especially noticeable on the "lower" or "outer"

surface. If affected trees are not treated at this stage the fungus finds its way to other leaves and the spores quickly spread the disease to other palms.

Soon, the fungus growing rapidly in the tissues after the first stages, all the leaves are killed and hang down alongside the trunk, the leaf-stalks being broken at all positions.

At this stage the youngest leaf is affected, the growing point succumbs to the attack and the palm dies. Almost immediately a bacterial decay sets in in the tissues at the apex of the stem resulting in the production of an evil smelling mass. This is not to be confused with "bud-rot" which is a distinct and specific disease and will be described later. Remedial measures must take the form of cutting away the affected parts of leaves at the earliest stages. It is necessary to look for the brown mark on the leaf stalk mentioned above in the description of the disease and cut away the diseased leaf at a point at least one foot below the proximal end of this mark to ensure cutting at a point beyond the limit of diseased tissue. In all cases this method has proved eminently satisfactory. All diseased leaves and dead palms must be burnt *in situ* and not carried away through the fields to be destroyed in another place. The disease is spread by means of spores which are air-borne. Unless great care is taken in the treatment of the disease local epidemics are caused and many palms may be killed.

It is interesting to note here that Fredholm in Trinidad decided that the rot appeared in two forms: one caused by bacteria; the other following an initial attack by a fungus which he called *Diplodia*. Copeland in *The Coconut* fully quotes Fredholm's paper. In many respects his account almost describes the effect of *Botryodiplodia* on palms in this country but as I have already pointed out "bud-rot" is an absolutely specific disease in this country. Bacterial decay almost invariably takes place in the apex of the coconut stem after a palm has been struck by lightning; when red beetles have killed all the forming shoots or when the palm is affected by any disease or pest the final stage is a rot of the apex.

I have stated above that *Botryodiplodia* is the fungus causing the disease but I have no absolute proof that this is the case for I have failed to obtain characteristic results after infection on leaves of young palms. However, I have been able to obtain good cultures of *Botryodiplodia* from portions of affected leaves where no other fungus was present. On dead parts of the leaves many fungi are to be found living saprophytically and among these *Metasphaeria Cocos* and *Pestalozzia palmarum* predominate. Another difficulty is that *Botryodiplodia* is usually a wound parasite and yet many palms in a group may be attacked by this disease. It is possible that there is another fungus associated which is perfectly parasitic in its nature or there may be other agencies.

A vigilant watch must be kept for outbreaks of the disease. By careful work almost all loss can be prevented; by carelessness all affected palms, and perhaps very many in a group or groups, may be lost. The treatment mentioned above is quite reliable whatever the causal fungus may prove to be.

Bud-rot.—Cases of this disease have been reported on several of the estates visited regularly by me.

The characteristic feature of the disease is the rotting of the terminal bud and surrounding soft tissues including the apex of the stem. The first sign is the turning yellowish white of the young leaf which has just opened; following this the central unopened leaf becomes discoloured and in a short time all the unopened leaves and the growing point or apex of the stem decay and putrefy, the whole "cabbage" being converted into a soft, foul smelling, putrid mass. In the majority of cases which I have seen the older leaves appear at the stage when the "cabbage" decays to be quite healthy.

There is no indication of any organism other than bacteria in the affected parts of diseased palms in the Malay Peninsula.

Earle, Smith, Jonston, and Petch all considered that the disease was attributable to bacteria. Butler, the Imperial Mycologist in India, described in 1906 a severe epidemic of disease among palmyra and other palms in the Godaveri district of the East Coast of India. The disease was confined to a limited area in the delta of the Godaveri river. The cause of the disease was stated, as a result of field and microscopic examination, to be a fungus belonging to the genus *Pythium*, a description of which, under the name *Pythium palmarum*, was published in 1907.

All these reports have been made within the last few years. "The History and Cause of the Coconut Bud-rot" by Jonston, published by the United States Department of Agriculture, gives a very full account of the disease, and the author of that paper has shown quite conclusively by repeated inoculation experiments that the West Indian "bud-rot" is due to bacteria almost identical with *Bacillus coli*.

It is believed that birds and insects are carriers of the disease. Whether or not the wounds are necessary for the introduction of the bacterial organisms, which are certainly pathogenic, into the tissue of the plant I am unable to say, Rorer found that he was able to produce the disease by pouring a culture of *Bacillus coli* into the crown of a healthy tree which apparently was unwounded.

When the apical growing point is affected there can be no remedy. To save other palms it is necessary to cut down all dead trees and destroy all affected parts with as little delay as possible. It may not be possible to burn the infected material but every effort should be made to get rid of it. By drenching with Bordeaux

mixture and burying the decayed and diseased tissues with a quantity of lime I think one would apply the second best remedy. Whatever the method, it is of the utmost importance to destroy infected material and so prevent any possible transmission of the disease by insects.

Root disease.—No root disease has been found in this country. Stockdale regarded root disease in Trinidad as the most serious of the three diseases he described—root disease, leaf disease and “bud-rot.” Palms exhibiting a wilted appearance with their leaves turning yellow should be examined by an expert. This appearance is not uncommon but I have invariably found that the effect is due either to poor soil or in the cases of some young palms to some unexplained condition.

Meliola palmarum.—A black fungus which causes the sooty appearance is found frequently on leaves.

It has never been found necessary to adopt any remedial measures as the fungus does not permanently damage the palms.

INSECTS PESTS.

Oryctes rhinoceros.—This insect is the common “brown beetle” of the Malay Peninsula or sometimes known as the black beetle.

I need not give any description of the beetle or its mode of attack. Preventive measures are most important and they must take the form of collecting the larvæ of the beetles and destroying possible breeding places. Debris of coconuts should not be allowed to lie about but should be collected and destroyed periodically. Traps have been used on some estates but not with any great success as usually the beetles have a vast number of potential breeding places to choose from. On a clean estate, scrupulously cleared of all coconut debris, traps of the kind used in Samoa, where the beetle was first discovered in 1910 and were supposed to have reached Upolu Island in a shipment of rubber stumps from Ceylon in 1909 or 1910, may give good results and are worth a thorough trial. Copeland gives an account of Freiderich’s traps in his book “The Coconut” which is here quoted: “For the making of a trap a hole is dug in the ground from 9-12 feet square, and about 2½ feet deep. Rotten coconut stumps, plantain stems and soil are put into it and over the top large leaves such as coconut leaves and plantain leaves are placed rising perhaps a foot above the surface of the soil. Into these pits the female beetles penetrate to lay eggs and the male beetles to find the females. What beyond digging the traps is necessary is that they should be opened at regular and not too distant periods (six weeks to two months), or that the beetles (and larvæ) in them may be killed in some way.”

The leaf beetle, *Xylotrupes gideon*, needs no description. Means of preventing attacks must take the form of collecting the beetles.

Rhynchophorus ferrugineus or *R. Schach.*—The palm weevil or "Red beetle" as it is known to planters is capable of doing much more injury to the palm than the brown *Oryctes*. Unlike the latter this insect passes through all the stages in its life history on the host plant. The destructive stage in the life history is the larva, not the mature beetle as in the case of *Oryctes*.

The insect is well known and need not be fully described. Preventive measures must take the form of preventing egg-lying and that of destroying the insects whether adult or in the larval condition. All wounds should be tarred, no green leaves should be pulled off as in this process wounds are obviously made, and the burning or scorching of leaf bases and fibrous tissue at the bases of leaves either intentionally or accidentally is particularly deprecated as injuries so caused provide suitable means of entry for these beetles.

Brontispa frogatti (Sharp).—This little leaf-eating beetle of the family *Hispidae* is quite commonly found on coconut plantations in the Peninsula. It was described by Frogatt as the worst pest of the Solomon Islands in young plantations. This was reported in 1903. Both adult and larvæ feed on the leaves of the coconuts.

Preuss states that it and two other species were known in 1911 in New Guinea, the Bismarck Archipelago, New Hebrides and the Celebes. In New Guinea this beetle is known as the "Heart-leaf beetle." It is a small beetle 7-10 mm. or $\frac{3}{10}$ to $\frac{2}{5}$ -inch long by 2 mm. wide. The head is dark brown, the thorax and first legs orange in colour and the rest of the body a shining blue-black." The head is very small, the eyes project in the sides, the front is produced into a lancet-shaped point standing out between the basal joints of the stout antennæ.

The wing covers or elytra are covered with very fine and regular pits arranged in parallel lines. These do not show except under a lens.

The larva when full grown is as long as the adult. It is flattened and usually found closely adpressed to the surface of the leaf. "The head is small, lobed, with short jaws on the under side of the head: the small legs are divided at the extremities, forming two rounded feet. The abdominal segments, eight in number, are furnished in the sides with a slender, rounded, fleshy tubercle; and the anal segment has the tips flattened and produced into a pair of short, incurved, flat calliper-like processes, which curving inwards, form a perfect crescent between them." The beetles crawl into the folded leaflets of young opening leaves and lay their eggs in this position. The adults and larvæ living in between the two halves of the close-folded leaflets eat away the tissues, and as a result the leaf does not open properly and when it does open partially it is malformed, the leaflets have grey brown spots or in bad cases the whole leaf is a dirty grey black and dried up and has much the same appearance as it would have had had it been burnt prior to opening.

In the Solomon Islands tobacco and soap wash is shaken into the still unfolded leaves.

Preuss recommends the use of nitrogenous fertilizers to help trees to resist the attack. The only way, however, found successful is the cutting away of all affected leaves and burning them together with the insects. This method has been successfully employed on several estates where the trees are periodically found affected.

Hidari irava and *Erionota thrax*.—These two butterflies are the coconut skippers of the family *Hesperiidæ*.

They are very much alike both in appearance and their method of attack. I shall not give any description.

The result of a bad attack, when very many caterpillars are feeding, is that all the tissue of the leaflets, except the midrib and perhaps patches of soft tissue here and there, is eaten away. Almost all the green soft parts of hanging leaves, in fact all leaves except those which are still erect, have been observed to be thoroughly eaten until only a skeleton remained.

The life history of these butterflies is short, from six to eight weeks. It appears that the pests are quickly parasitized as I have no record of a single instance of this pest remaining after the second brood. The best remedial measures, when practicable, are the catching of the butterflies and picking off and collecting the cocoons. Spraying or any other remedial measures have not been found necessary.

Thosea cinereomarginata.—The larva of this moth is a green slug-like caterpillar recognized by having along each side of the body a row of spinous tubercles. Pupation takes place in a hard oval cocoon which opens at one end in a distinct lid for the emergence of the imago. These cocoons are commonly found attached to the under side of leaves of palms.

The larvæ of this pest eat the softer parts of leaflets until as in the case of the skippers mentioned above only the midrib is left. I have seen groups of palms temporarily seriously affected but in this case again I have never thought it necessary to apply remedial measures.

Mahasena sp.—This moth is not a serious pest, and has not been observed to attack more than four or five palms in a group. Only young plants are affected, the larvæ or caterpillars live in cases made up of bits of leaves woven together with silk. The case is carried about on the trees by the insect whose head only appears. Only the male insect attains the perfect or imago stage. The female lays her eggs in her case and gradually shrinks up, as the eggs fill the lower half of the case. The eggs hatch and the larvæ make their own little cases. The old female cases must be carried by wind or other agency to palms, but little appears to be known about his part of the life history.

Brachartona catoxantha.—This moth is a serious pest of coconut palms. The moth is very small, only measuring 16 mm. across the expanded wings or a little less than $\frac{2}{3}$ inch. The limited time at my disposal does not permit a full description.

By the time the fourth generation has hatched the insects have multiplied so considerably that a local epidemic is formed. After the fifth or sixth brood, but this varies according to the development of the insects' own enemies and only two broods may appear, the pest disappears "having become abundant enough to let its own enemies or parasites multiply in excess." The parasites of *Brachartona*, among which the most important is a fungus, *Botrytis* sp., and second in importance a Phorid fly, die off when the pest is nearly exterminated or suppressed and after three years (I have evidence to show that three years, not two years, as stated elsewhere, is the interval of time) *Brachartona* reappears as a pest in the same locality. It appears that on each occasion of the reappearance of the pest in one locality the enemies of *Brachartona* develop with increased rapidity reducing the number of broods and therefore the injury caused by the pest. It is early to be quite sure of the facts in this connection but the evidence obtained so far points in this direction. My experience had been that spraying with either kerosene emulsion or London purple as advised by Pratt, or any other insecticide besides being extremely expensive is of little or no value in eradicating the pest.

The following remedial and preventive measures were adopted on one plantation and had the desired result. All the lower leaves of the palms which have been badly eaten, and on which many thousands of the insects were pupating (still in the chrysalis stage), were cut off and burnt. The lowermost leaves of the trees throughout the area in which the flight had been observed were cut off and piled in heaps for burning, this was done to destroy the eggs laid by the moths. The leaves were cut away and destroyed to decrease the numbers of the larvæ which would have developed had the lowermost leaves been left, the greatest number of eggs being laid on the lower leaves.

As soon as the caterpillars (hatching out from the eggs) appeared and commenced to feed a number of coolies were told off to singe the leaves with torches. The torches were made of long poles with a portion of a coconut husk fixed to one end of each. The husk was soaked in kerosene and lighted. By passing the torches along the under sides of the leaves the caterpillars were either killed by the heat or they dropped to the ground. Immediately the caterpillars fall they endeavour to make their way back to the leaves by crawling along the ground and up the stems of the palms. A ring of tar and grease was painted on the stems about a foot and a half above the ground to catch the caterpillars, and prevent them from again reaching the leaves. This was highly successful, thousands of caterpillars

being caught in this way on almost every tree. Besides the torches we used long sticks for beating the leaves to knock off or shake off the caterpillars. Brushes on long handles were also used for sweeping the insects from the leaves.

All the insects were not destroyed, but that their numbers were greatly reduced was obvious on the appearance of the next flight of moths. Comparatively few moths developed. On the reappearance of the caterpillars the same methods were again resorted to, the whole area showing signs of having been affected being carefully and systematically treated. Three months after my first visit the pest had disappeared. Nets were also used for catching moths.

As regards the damage done to the palms by cutting away or by singeing the leaves I do not think it is at all extensive and the palms recover extremely well.

It should be added that under no conditions should any part of the palms except the leaves be scorched. Copeland refers to the risk of such treatment, if applied to the crown, on account of the probable attacks of the red beetle.

Termites.—*Termes gestroi* is said to be a serious pest of coconut palms in certain districts in the Peninsula but on the plantations visited regularly by me the pest is little known and the injury caused is correspondingly of small account.

I have seen palms seriously injured by the insects boring into the tissues of the stem. Generally the injury in itself, except in very young palms or unless nothing but a mere shell of the stem is left, need not have a serious effect. It has been advised that lands taken in from virgin jungle and planted up with coconut palms be clean cleared of all timber. Such measures may be necessary where the attacks of white ants are considered serious but such measures are usually most impracticable and there must be strong evidence that the attacks are serious or are likely to have serious results before the planter will be convinced that he should adopt them. I have never had reason to suggest the adoption of these measures and the usual treatment with the exterminator pump has been quite satisfactory.

Scale bugs.—Scale bugs and mealy bugs are found commonly on the leaves of the palm but none of the many species cause any serious injury as far as I am aware and, therefore, they call for no comment here. The sooty mould, *Meliola palmarum*, is associated with several of the scale bugs parasitic on the leaves of the palm.

Rats.—These animals are enemies of the coconut palm and have caused serious loss in certain district in the country.

In February, 1914, Pratt wrote in the *Agricultural Bulletin*: "The position of priority as a really serious pest to young coconuts in

the Malay States must be given to rats. They have caused immense damage in several districts, completely destroying as much as 2,000 acres in one locality. They are not constant in their attack."

In the same article the author referred to these animals nibbling the base of the palms and eventually eating out the heart, "leaving a hole $2\frac{1}{2}$ inches in diameter."

As I have no experience in dealing with this pest, fortunately none of the coconut plantations it is my privilege to visit regularly have suffered attacks of the pest, I think I can do no better than quote from Pratt's article.

Protection of young palms.—"Out of a piece of zinc, 18 inches long and 12 inches wide, an arch is cut at the middle of the longer edge, measuring, approximately, seven inches wide at the base, and five inches high. The nut itself fits into this arch and by drawing the tin round the tree a cylinder about five inches in diameter is formed enclosing the base of the young plant.

The base of the cylinder on either side of the arch is buried about three inches in the ground thus enabling the top of the arch to fit tightly over the upper part of the nut. No rat can harm a young plant protected in this way, for if access is obtained by burrowing there is no room for the rat to work within the enclosure."

This method seems to have had successful results.

For older trees possibly an adequate measure might be to surround the stem of each palm near the base with a piece of tin in the form of a cylinder or "with a collar of tin several inches wide and attached so that it slants outwards and downwards from the tree." Such a method is too costly to put into practice unless the pest is causing really serious injury.

THE HISTORY AND PRESENT POSITION OF WHITE ANT TREATMENT IN MALAYA.

By P. B. RICHARDS, A.E.C.SC.

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ON considering what subject to select, of interest to both the rubber and coconut sections of the planting community, I thought it might not be unprofitable to traverse the history of the treatment of the major pest of plantation cultivation in Malaya, namely *Termes gestroi*, to endeavour to trace the development of knowledge of the pest and of efforts made to combat it, to see, if possible, where the earlier workers went wrong, and perhaps to extract some lesson applicable to the present.

It is probable that there are some here of long experience of Malaya, and of long memory, who would be better able to discuss the historical side than I. For the earlier material I have to depend largely upon the *Agricultural Bulletin* of the Straits and Federated Malay States edited by Ridley. Of the last three years, during which considerable advances towards the complete control of *Termes gestroi* have been made, I venture to think I need make no apology for drawing upon my own experience.

The first printed record of white ants damaging crops is in an article by Ridley in the *Agricultural Bulletin* of the Malay Peninsula No. 4, January, 1895. He wrote: "One constantly hears of coffee and other trees being destroyed by termites, and the informants seem to think that the insects absolutely eat the roots and base of the stem of the living tree, and so destroy it. I have great doubts of this." Ridley's doubts were based upon several observations. He instanced that on opening termite nests, by which he presumably meant mounds or nests in the soil, undamaged roots of plants might be found traversing the nest. He described how termites "usually so induced by a dead bough" throw up galleries along the trunk and attack the bark, and so "by letting the wood suffer from exposure, injure or kill the tree." "But this," he wrote, "is rare and almost invariably occurs in trees dying from other causes." A young clove tree, the death of which was at first ascribed to termites because galleries were thrown up around the base of the tree under which the insects had eaten away all the bark, was subsequently found to have been attacked by a fungus. "As soon as the fungus had practically killed it the termites threw up their galleries and began to destroy the dead part of the tree." Similarly with two young *Araucarias*, the primary cause of death being starvation through root competition, with a contributing mechanical cause in the compact clay masses of

white ant nests beneath the trees. Ridley then generalized as follows: "Such action is what appears to be generally intended when it is said that a tree is killed by termites, the real cause, being perhaps obscure, is overlooked, and the termites who come to remove the dead tissue are credited with the original injury."

From this article it appears that the typical *Termes gestroi* habit of attacking live trees was not then known. It follows that in 1895 the insect was not a pest of major importance or such a sound observer as Ridley could not have failed to have noted this fact.

It is unlikely that any of the termites observed by Ridley in Singapore up to this time were *Termes gestroi*, and he was probably quite correct in ascribing these particular attacks to diseased conditions. But I think it very likely that his generalization based upon observations of other species was subsequently taken by planters to apply to *Termes gestroi*, and developed into the pernicious idea that the trees lost through white ants would have died anyway, or at best would have been of little use. This fallacious theory of pre-disease has continued almost, if not quite, down to the present.

In 1897, the Linnæan Society published Haviland's "Observations on Termites, with descriptions of New Species." This is the standard scientific work on Malayan termites. Twenty species, including *Termes gestroi*, were described from British Malaya and a further considerable number from the Islands, but they were not treated from the economic side. *Termes gestroi*, however, received considerable attention because "the species is one which deliberately attacks and destroys live trees." The soldier, upon which classification is based, was described in detail, and shorter descriptions given of the workers and nymphs--that is, the winged individuals which develop into kings and queens. Unfortunately, Haviland did not obtain the adult king or queen, and from his failure to find them came to the conclusion that "the same colony often possesses several nests, only one of which is inhabited by fertile individuals whose eggs and young are carried to the other nests." My own experience does not bear out the whole of this. Subsidiary nests are made by *Termes gestroi*, in its feeding places but I have never seen eggs in these. Always the parent nest alone contains the eggs, and every nest containing eggs contains also the queen. Of the habits of *Termes gestroi*, Haviland wrote: "This species is remarkable for its habit of killing live trees. It encases the trunk for a distance of eight feet from the ground, with a thick crust of earth. Under cover of this crust it eats through weak spots in the tree to the heart of the wood, which it excavates, forming there a kind of nest built of wood fibre."

Next in chronological order is a further article by Ridley in May, 1900. A brief description of the soldier is followed by an

account of the attack upon trees which is almost identical with Haviland's account, stating, as he did, that the nest is formed of wood fibre inside the attacked tree.

That *Termes gestroi* was increasing in importance as a pest is evident from Ridley's comments upon the failure of treatment, consisting of scraping down the mud casings and treating the injured surfaces with tar or substances injurious to the insects. Ridley also observed that he had received from Selangor "specimens found destroying Para rubber trees."

It should be noted that both Haviland and Ridley say nothing of the whereabouts of the source of the attack—that is, the parent nest. The subsidiary nests described are obviously one of the sequelæ of the attack.

It is a great pity that the nesting habits of *Termes gestroi* were not then determined as valuable years were lost before more definite knowledge was published and applied. Had planters then known where the parent nests were to be found, and how successfully the pest could be treated through these, *Termes gestroi* might never have been given the opportunity to multiply and establish itself as a pest of such enormous importance.

Nowhere is the copy book maxim "prevention is better than cure" more truly applicable than in the province of economic entomology and to no insect more aptly than to *Termes gestroi*. But for either it is essential to have an accurate and full knowledge of the habits and life history of the insect; efforts at both prevention and cure were shortly made, but without the essential knowledge they were foredoomed to failure.

The unfortunate lack of information about *Termes gestroi* in the early days is in my opinion one of the gravest misfortunes suffered by the Malayan Para Rubber Industry; not alone, or mainly, because thousands of dollars were wasted, and trees lost, but because fuller knowledge would have induced the employment of sound measures of timber treatment, and clean clearing, with all its accruing advantages might have become as much a *sine qua non* of rubber cultivation as clean weeding.

The next two publications threw little further light on the subject. In October, 1901, W. W. Bailey contributed a report in which he describes "Termites" as the worst enemy of his rubber, eating out the heart of his healthiest and best rubber trees. Having tried arsenic, sulphate of copper, phenyl, tuba, kerosene oil, etc., without success, he decided to set coolies on to digging out queens and breaking up the mounds, although he says he had been told by more than one scientist that the queen of the rubber termite was not to be found in mounds. The queens were taken from mounds one to two feet high and each man averaged ten a day. "It may be said," he wrote: "That they are not termites, and it may be true; but one

thing I am certain of, and that is that they are identical with, the creature that is destroying our rubber trees . . . I feel certain that I shall almost exterminate these insects on my estates."

In the light of present knowledge it is obvious that to whatever else species the queens belonged which were dug out of the mounds, they were not *Termes gestroi*, and that not by this method was there any hope of protecting the rubber trees.

In November, 1901, Ridley, writing upon a recent visit to Selangor, expressed his admiration of the splendid coffee and Para rubber trees he saw, but "the drawback was the white ant pest, and it was truly grievous to see fine four-year old Para rubber trees killed by their attacks." Suspecting fungus disease in addition to termites, several trees were pulled up and their roots examined. On one a fungus was found and identified as *Helicobasidium* sp. Ridley observed "I am aware I am on debatable ground as to whether the particular tree I examined which had fungus at its roots was killed by that fungus or by white ants or by both . . . My own theory is that in this particular instance the fungus was the cause."

In a letter from Lanadron in December, 1901, Francis Pears wrote: "The age of my trees is from $2\frac{3}{4}$ years downwards and as yet I have not had a single established plant destroyed by white ants, although certain portions of the estate contain numerous ant heaps such as Mr. Bailey describes; on one ten-acre block as many as two hundred. This, Sir, may slightly bear out your theory that a fungus is principally instrumental in destroying the trees in Selangor."

I believe I am correct in saying that Lanadron was clean cleared of timber before planting. What an epoch making letter that would have been if Pears had deduced the true reason of his freedom from white ant attack, that the absence of timber precluded the possibility of attack by *Termes gestroi*.

E. V. Carey in March, 1902, gave what should have been the death blow to the system of destroying queens from mounds. He described how, having in the pre-rubber days paid out considerable sums in rewards for queens because *Termes gestroi* was attacking the coffee, he submitted some specimens to E. E. Green in Ceylon, who, of course, told him that he was catching the wrong species. Later, when Para, rambong, and coconut were attacked "roots were bared and kept open to the air, painted with tar, washed with Bordeaux mixture, solution of tuba root, sweet flag, Jeyes disinfectant, etc.," without success. Then Bailey of Lowlands tried another method which had met with such "unqualified success" that Carey ascribed to him the credit "of having put us all on the right track." The method was a thorough digging over of the whole attacked area. Carey recommended a modification, contenting himself with digging from attacked trees, $2\frac{1}{2}$ to 3 feet deep for a distance

of not less than 10 feet in every direction, and further following the runways up to the nest and destroying the queen. Even if the nest were not found, the disorganization of the runways was held to be sufficient to prevent the termites returning to the same tree a second time.

It could not be long before this method discovered its weakness. The only effect upon the attack would be to drive it to fresh trees. Moreover, many attacked trees would go untreated because, as Robinson was soon to point out, in a considerable percentage of cases there are no external signs of damage.

By far the most important thing in this article of Carey's is the following note in parenthesis: the nest "is almost always found in a log or the stump of an old tree." It is amazing to me that not until another six years had elapsed was this knowledge applied by treating timber, and that a further six years was allowed to pass before clean clearing as the only perfect treatment for *Termes gestroi* was seriously supported by any of the men engaged in agricultural research in this country.

The first serious attempt to investigate the pest was made by Robinson, now Director of Museums, whose account is published in the *Bulletin* in December, 1904. I can do little more than indicate some of the more important features, and recommend you to re-read the whole for yourselves. A simple key to the species commonly found on estates is followed by a good account of the nests of the mound-building species. The useful part played by these species in converting timber into available plant food is pointed out, and the futility of treating them insisted upon.

Termes gestroi, Robinson remarked to be rare in Nature, and ascribed its abundance on estates to the stimulus provided by unusual quantities of suitable food in the form of rubber trees. The first detailed account is given of the external attack under cover of the mud casing, under which, sooner or later, a non-resistant spot in the bark is reached, through which "the whole body of termites gains access to the interior of the tree which is rapidly eaten out." Robinson also was the first to point out that a large percentage of attacks are made below the soil level, no external signs of damage showing. He opposed the theory of antecedent disease, but pointed out the likelihood of *Termes gestroi* effecting entrance through wounds. The remedies of the time are discussed and dismissed as failures with the exception of powdering the collar and roots thickly with freshly slaked lime after scraping off the incrustation. For the treatment of internally attacked trees an ingenious application of CS₂ vapour is suggested. But there is not a word about destroying the nesting sites. Robinson wrote: "The nests are contained within the trunks of the trees attacked, and are formed of narrow labyrinthine chambers of woody and earthy matter . . .

the whole of the interior of the tree being more or less filled up with this material." Now, this is typical of the subsidiary nests made in live trees where *Termes gestroi* is feeding, and it is probably such nests that Robinson explored and described. Robinson found one nest out of many investigated which contained eggs—that is, a parent colony. Personally, I have never found a parent nest in live rubber, although such do occasionally occur in old rubber where surface timber has gradually rotted away. Always the parent nest has been in a log or stump. One might search long in attacked young rubber trees for a parent colony without success, but if such were found it would only serve further to obscure the general truth. Carey's clue of the logs and stumps was not followed up, and this otherwise valuable report is marred by the failure to provide that most desirable of all information, the location of the main nest.

In April, 1906, E. P. Stebbing, Forest Zoologist in India, entered the discussion because of specimens sent from Mergui Estate. Stebbing, who, of course, had no first hand knowledge of living *Termes gestroi*, urged the need for procuring full information upon its life history. Among points which he indicated as requiring elucidation, there are two of vital importance—namely, "Where do the termites found in the nest in the crown of the root come from in the first instance?" and "Are there any galleries radiating from the nest to other parts of the plantation? If so, where do they go?" Now this is the first consideration of the problem by a trained Economic Entomologist, and it is interesting to note that at once the true line of investigation was suggested.

In May, 1908, Pratt supplied the material for answering Stebbing's questions in an interim report upon his termite work. Tracing back runways from 15 or 20 eight-year old rubber trees, all of them terminated in a nest, about two feet in diameter, constructed round a buried stump. In this nest was discovered the first authentic queen. Runways ramified from the main nests, broadening out in places to form large open spaces from which branch burrows diverged, the larger of these leading to subsidiary nests inside stumps, logs, and fallen trees. This was indeed an important verification of Carey's statement, and laid the foundation of a rational method of treatment. Pratt pointed out that the age of the rubber, and the nature of the soil had little, if any, effect upon the incidence of the attack, but what really mattered was the presence of timber. The supposed deadly effect of langang upon *Termes gestroi*, he rightly ascribed to the general absence of timber on old langang areas. Further promise of being on the right track at last was given in the following passages: "The most important point in connection with the present abundance of *Termes gestroi* . . . is that it attacks dead as well as living wood . . . The fact that it is among the dead wood, and rapidly multiplying has been ignored. It is only when the rubber trees are being attacked that any measures are

taken against its ravages." Pratt then pointed out how useless it was to treat individual trees while there was a constant supply of termites from the nest-log or stump.

Unpublished correspondence of about this date shows that one estate on old lalang land had never been troubled by *Termes gestroi*. The inference would appear obvious, from the presence of *Termes gestroi* in timber and its complete absence in timber-free land, that clean clearing was the soundest treatment for the pest. Whether this inference was made, and dismissed as impracticable for reasons of expense, there is nothing to tell us. Instead Pratt recommended as "preventive measures" the piecemeal method of tracking down the nest by following runways from attacked trees, and a selective method of dealing with timber. Among native timbers known to harbour *Termes gestroi*, kumpas, meranti and pulai were given the place of honour. It was recommended that these should not be destroyed at first, as "they subsequently afford means of locating *Termes gestroi*," and should then be destroyed with the termites.

Now these methods predicate, before treatment, the establishment of colonies in the timber, and probably serious attacks upon the rubber trees. Surely this is not preventive treatment. Treatment after attack may result in eradication, but preventive measures should leave nothing to eradicate.

To Towgood, in March, 1909, belongs the credit of first advocating the preventive destruction of all nesting places.

After pointing out that white ant timbers varied with locality, he went on to describe methods applied successfully by himself. In old rubber these consisted of collecting and destroying all surface timber, and if then there were further attack, to follow the runways down to its source, which was invariably in a buried log or stump, and to burn the whole nest.

One field of six years old Rambong was interplanted with Hevea, and white ant attack on both was particularly virulent. Five months before writing Towgood had cleared the field of all timber, and no sign of the pest had since been seen.

In many young clearings, the timbers suitable to *Termes gestroi* were sought for line by line, sawn through, and burnt if the pest was present.

For future clearings, Towgood recommended felling the favourite white ant trees first, and allowing them to dry prior to felling and burning the rest of the jungle. In this way he hoped to prevent *Termes gestroi* ever getting established.

Now these are all much sounder methods, but naturally they entail greater immediate capital expenditure. Against this Towgood pointed out that in addition to the satisfaction of knowing that the

only troubles they feared—namely, white ants and *Fomes*, were eradicated, there would be less subsequent expenditure in pest work, supervision would be more efficient, weeding costs less, and all work carried out in the clearing would be cheaper.

Towgood, then, advocated clean clearing old rubber, destroying trees which contain *Termes gestroi* in young rubber, and selective burning in future opening. The first was sound. The others were dangerously incomplete even against *Termes gestroi* alone, not to mention *Fomes* and the later discovered root diseases, *Sphaerostilbe*, *Ustilina*, and *Poria*, because any remaining suitable timber in the young rubber might later become infected by *Termes gestroi*, and in the new clearings there is a much greater variety of potential *gestroi* timbers than Towgood suspected. A letter from Johore in December, 1909, lists a further 19 timbers harbouring *Termes gestroi*, Terentang heading the list with over a hundred nests in 40 acres, but the other 18 equally capable of serving as a nidus for *Termes gestroi*, if the favourite timber is absent. The only sure guarantee against *Termes gestroi* attack is to remove, not only every certain, but every possible nesting site. Nevertheless, Towgood was on the right track, and had his advice been followed, improvements in details would have developed.

But just now the sulphur arsenic fumigator was being boomed as a cheap and effective method of treatment. Everybody was wanting a remedy easy of application, certain of result. A prize of £5,000 was offered to the inventor of such. It was not awarded, but public attention was focussed on patent methods, and the universal exterminator was certainly the best of these. And so, unfortunately for those estates now suffering from the many ill-bred of rotting timber, clean clearing was set back a further six years.

In October, 1908, Pratt was transferred from the Medical to the Agricultural Department, and devoted some time to the continuation of his white ant work. You are all familiar with the results as published in *Bulletins*, Nos. 1 and 3, of the Department of Agriculture. The first was largely a revision of the report previously considered. *Bulletin* No. 3, which deals mainly with treatment, is too long for me to discuss in detail.

In blocks in which the jungle had been felled less than six years, Pratt advocated isolating attacked areas by a four-foot drain, digging over the soil to a depth of three feet, and burning all the logs and stumps containing *Termes gestroi*. He did not recommend destroying all logs and stumps but said that the proportion which needed removal was comparatively small. As an alternative method, equally effective and cheaper, to be used whenever possible, he strongly recommended fumigation with sulphur-arsenic fumes. The nest having been located, presumably by inspection, a trench was to be cut round it, left open for a few days to allow repair of the

runways, and then nest, runways and attacked trees were to be thoroughly fumigated. "If a little care and interest are taken" he wrote, "and the treatment carried out as it should be, not only would the cost be very small, but the trees within this area will not again be troubled by *gestroi*."

In older clearings, originally planted with rubber, Pratt considered that in all except peaty soils, most of the timber would have become too rotten to harbour *Termes gestroi* and the nests would have been transferred to the rubber trees. All trees suspected of being hollow were to be bored and fumigated, and any remaining hardwood logs which contained nests were to be destroyed.

In peaty soils, which frequently contain much buried timber and roots, fumigation was to be used wherever possible; if it were not successful recourse must be had to the isolating drain and deep changkolling. Thus was the fumigator given official benediction as the premier method against white ants, and clean clearing relegated to the background with scarce even a nod of recognition.

This bulletin concludes with an exhortation to planters not to be unduly alarmed for the future, inasmuch as, although it is wise and profitable to treat the pest, "there must inevitably result a steady diminution of *gestroi*, among the older rubber," except on peaty soils. Such a disparagement of the danger would in itself have been enough to deter planters from recommending expenditure on clean clearing.

From this time onwards more and more reliance was placed in fumigating, generally with incomplete results. Those planters who tired of the fumigator, usually fell back upon local applications of poisons, with worse results. The pro-fumigants held that lack of success was due to inefficient application of the method, and that with trained gangs and competent supervision all would be well. Late in 1914, I had my first experience of white ant work, and went about an enthusiastic exponent of the fumigating school, but before the middle of 1915 I was satisfied that fumigating, although the best of the palliatives, was at best but a palliative. Perfectly applied by perfect coolies, it might keep the attack down to a minimum, but who possesses the perfect coolies? Was there not some other more effective remedy to be deduced from our fuller knowledge of the life history of the insect?

In nature, under jungle conditions, *Termes gestroi* is a rare insect as compared with many other local termites. It is established in certain dead or dying trees. At certain times there is a flight of sexed individuals from the nest, any pair of which can found a new colony, provided suitable conditions—namely, shelter and dead wood. In the jungle such suitable conditions are seldom met, but on a clearing with quantities of unburnt wood, suitable nest sites are abundant, and even if one favourite type of timber is absent, another

can be made to serve. Hence from one mature colony, inside or just outside a clearing, a considerable percentage of the logs and stumps may be infected. Allow one or two years of undisturbed development, and you have numbers of colonies at great strength, ready to attack rubber or any other suitable material, or to spread the infection by swarms of flying individuals to uninfected areas or logs. Trenching, digging, poisoning, fumigating, tracing runways, and numerous modifications and combinations of these had been tried and found incapable of eradicating the pest. Deep changkolling over attacked areas had been abandoned—if it was ever tried—probably because of the cost. In some places the surface timber was being hunted through for nests, the logs cut open and the queen sought and killed. As it had been frequently stated that *Termes gestroi* had not the power possessed by a lot of species of elevating baby commoners to the position of temporary queen, this looked likely at least to stop any further development of those nests. But this method had soon to be discarded also, as I found, in the remnants of such colonies, substitution queens raised either from undestroyed eggs or very young individuals. It was, therefore, obvious that the whole nest must be destroyed so that no remnant capable of raising substitution queens was left; and not only the nest, but the containing timber, lest later some members of a nuptial swarm should find it a suitable place in which to settle and recommence the trouble. But if in the remains of the nest log, why not in other timber also. So long as suitable timber is left, even if all the *Termes gestroi* in the clearing have been destroyed, the conditions approximate to those of an uninfected new clearing, and in one night a nuptial swarm may reinfest the whole area.

I was thus driven to the conclusion that the only safe preventive and remedial treatment for *Termes gestroi* was absolute clean clearing.

During 1915 I was able to test the method on a peaty block suffering from the heaviest pure *Termes gestroi* attack I have seen. Surface timber was destroyed, stumps were blasted and lifted, and buried logs were prospected for with probes, dug out, and burned. The work was done thoroughly, and the result was excellent. One or two small areas showed re-attacks which were traced to hidden logs, but after these were taken out, no further white ant trouble arose in the block although previously the mortality ranged up to 75 per cent. of the 18 months old rubber. The method, then, was sound, but what of the expense? Would it really pay the average estate to put up the necessary money? I had faith that it would, considering the crop saved, and the reduction in working costs effected, so thereafter, whenever called upon to advise on white ant treatment, I insisted upon the fundamental importance of destroying timber. Some estates provided for the work—others carried on with careful application of their previous methods. But during 1914-15

our knowledge of the mode of attack of certain fungi upon the roots of rubber, and of their immense economic importance, was rapidly advanced, and the responsibility fixed upon decaying timber. With this extra, and even more important case against timber to support the policy of clean clearing, it became possible to advocate as a general estate method what previously might have been considered a counsel of perfection.

In February of last year at a Planters' Association lecture I first recommended the general adoption of this common-sense method. The idea did not at once meet with unanimous approval, but the progress it has made in little more than twelve months has been eminently satisfactory.

Early in 1916, also, I had the opportunity to devote some time to the consideration of coconut pests, and here too *Termes gestroi* proved to be by far the most serious pest, warranting a very considerable expenditure upon preventive treatment.

The same arguments for clean clearing apply to coconut cultivation as to rubber, beetle grubs in the rotting wood replacing fungoid diseases as the supporting reason.

That clean clearing is the only sure cure for *Termes gestroi* attack, I am fully convinced. Of all other methods tried, including the sulphur arsenic fumigator, it must be admitted that they have failed to eradicate the pest. In areas wherein *Termes gestroi* has become established, particularly in old rubber, the fumigator is indispensable, but only as an adjunct—not as the principal method. Within two, or at the outside three years of felling, every available shelter for *Termes gestroi*, and consequently every likely infection centre for root diseases should have been destroyed.

That clean clearing is in general worth while from a financial view point, I am satisfied also. But this is a matter upon which the economist and not the scientist will decide.

To the practical planter belongs the solution of the problem, how best and cheapest to get rid of the undesired timber; whether by double felling; by single felling and clean clearing before planting; by single felling and clearing when the rubber is well up; by disposing of the wood for charcoal or firewood; or what not! The sooner the cheapest and the most effective method is established, the earlier will this, the most desirable of all plant sanitation methods, become a piece of the established routine of estate opening.

**APPLICATION OF THE AGRICULTURAL PESTS
ENACTMENT.**

BY F. W. SOUTH, B.A.

(*Chief Agricultural Inspector, F.M.S.*)

INTRODUCTION.

CULTIVATED crops in any country are liable to two classes of diseases, those occurring in the country, and those introduced from outside. In order to provide means of controlling these two classes of disease in the Federated Malay States, the Agricultural Pests Enactment was passed in 1913 and became law upon its publication in the *Gazette* on 1st August of that year.

THE ENACTMENT.

The main provisions of the Enactment provide for the control of diseases occurring in the country while powers under a certain section enable the Chief Secretary to make rules for preventing the introduction of pests into the Federated Malay States, by prohibiting the landing from places outside the States of any plant or animal likely to introduce a pest and by providing for the treatment or destruction of any plant or animal which has been landed and of the packages, cases, pots or covering in which the same may be contained.

As the known diseases of rubber are common to practically all rubber producing countries in the East, it has not been considered necessary to ask the Chief Secretary to provide any rules in connection with the importation of plants, especially as such importations are not at present extensive in the Federated Malay States.

The measures for the control of such diseases as already occur or may arise in the future may be divided into two classes.

(a) Those requiring the treatment of specifically diseased cultivated plants and

(b) Those requiring the removal of conditions suitable to the introduction or spread of any pest.

The details of these measures are now well known and it is not necessary here to enumerate them, suffice it to say that they involve the employment of a special staff of European officers and Malay subordinates who are invested with the necessary powers, including powers of entry on cultivated land, of removing portions of infected plants for examination and of serving legal notices requiring the carrying out of definite instructions for the treatment or control

of any pest or for the removal of conditions liable to favour the introduction or spread of any pest. Failure to comply with such instructions may be dealt with in two ways :

The inspecting officer with the permission of the Director of Agriculture may institute criminal proceedings involving a fine on conviction ; he may also enter the land with assistants and carry out the measures required, subsequently recovering their cost by civil suit.

A further measure in the case of emergency is that the Director of Agriculture, with the approval of the Resident, may place in quarantine any land or any part of land on which diseased plants have been found, and so long as this land is in quarantine no plant or part of a plant may be removed from it except with the permission of an inspecting officer. The Enactment further contains special clauses relating to locusts and the control of the beetle pests of the coconut palm.

STAFF.

The foundation of the necessary staff was already in existence when the Enactment came into force as powers as inspecting officers under the Enactment were given to the Assistant Inspectors and Sub-Inspectors of Coconuts who had previously worked under the Inspector of Coconut Plantations, Mr. L. C. Brown. On the retirement of the latter his duties devolved on the Chief Agricultural Inspector to whom control of his former staff was also given.

Certain additional European and subordinate officers were appointed and all subsequently had to be trained in that part of the work relating to rubber for which purpose a certain amount of time was, of course, necessary.

INSPECTION WORK IN THE KAMPONGS.

When work under the Enactment first commenced two outstanding matters required attention—namely, the beetle pests of coconuts and pink disease of rubber.

Coconut beetles—Owing to the enforcement of the Coconut Trees Preservation Enactments which were in force previous to the passing of the Agricultural Pests Enactment, the measures necessary for the control of coconut beetles were well known to the majority of the Malay subordinate staff and of the small holders in the kampongs. The continuation of this work was, therefore, a matter of routine, involving no particular difficulties. It had been insisted on for some years and the small owners were accustomed to carry out the simple measures required of them by the inspecting officers : a certain number of prosecutions were, however, necessary in order to maintain efficiency.

Owing to the rise in the price of rubber towards the end of 1915 and the continued high price during 1916, there was a general tendency in both these years to cut out coconuts interplanted

among rubber trees and even to clear land containing mature coconuts for the purpose of planting rubber. These conditions emphasized the importance of the coconut inspection work as the coconut refuse, if left lying about, would have provided an opportunity for a rapid increase in the number of the red beetles. This was avoided by regularly insisting on the destruction by burning or burial of the trees cut out. During 1915 a few serious local outbreaks of black beetles, particularly at Kuantan and Seremban, called for special attention. No serious outbreaks were recorded in 1916. At the present time the Seremban trees have been free of beetles for over a year and have much improved in appearance.

Pink disease—In contrast to the routine treatment of coconut beetles that of this disease had to be commenced at the very beginning. The disease was practically unknown to small owners throughout the country and was of comparatively recent occurrence; moreover, it is not one which frequently results in the death of a tree: for these reasons its importance was not generally recognized by Asiatic owners, while at the same time the subordinate inspecting staff, of whom the majority had only worked on coconuts and the remainder were newly appointed, were not acquainted with its various manifestations. It was decided, therefore, to allow a period of twelve months to elapse before taking legal action to insist on its control. During this period the subordinate staff were taught the symptoms and treatment, small holdings were regularly visited and their owners were shown how to recognize the disease and what must be done to control it.

The actual method of treatment recommended was to cut off the diseased branches well below the last signs of infection and to burn the diseased portions immediately. Smooth cut surfaces subsequently treated with tar were required. Owing to the care necessary when treating this disease with tar, as is done on the majority of estates, it was not considered a suitable method to recommend for use in the kampongs.

At the beginning of 1915 it was thought that a sufficient period of education had elapsed, and the measures previously recommended for treatment of this disease were subsequently insisted on by law. The routine inspection work once commenced was carried on steadily throughout 1915 and a large number of cases were taken in Court. Owners were, on the whole, however, very slow in recognizing that it was to their interest to carry out the instructions given and though a considerable number of fines were inflicted there did not appear to be much improvement in the way in which the work required was actually done. Throughout 1916 the regular treatment of this disease has been insisted upon, and, though an improvement is noticeable in certain districts the disease has undoubtedly spread, and in other neighbourhoods there is practically no improvement in

the present condition of the kampongs. The Asiatic does not see the necessity for treating a disease which does not often kill the tree and which is not eradicated by the most careful and steadily continued treatment. He regards the measures required of him as a nuisance, since they involve work to which he is not inclined, and also as being inefficient inasmuch as they do not result in the disappearance of the disease from his plantation. As a result he prefers paying a small fine of from \$2 to \$10 inflicted on him by the magistrate to expending the same sum in carrying out the treatment required.

The alternative course of action open to the inspecting officer—namely, of carrying out the work in the small holdings and recovering the cost would involve the employment of such a number of gangs of trained coolies and trained mandors, as is at present entirely beyond the resources in European supervision of this Department. All that can be done at present is to use coolies to treat the disease in such of the small holdings as are most seriously infected and have been most consistently neglected.

The satisfactory treatment of pink disease in the kampongs in general can, in the writer's opinion, only be attained as a result of a comparatively lengthy educational process which will gradually accustom the owners to do what is required of them and lead them to recognize that the measures are for their own good. A state of things ultimately should be obtained comparable to that which exists in the routine control of coconut beetles. Attempts to hasten unduly the educative process necessary are certain to be without effect, and only patient and continued efforts will have a lasting result.

The degree of attention paid to instructions varies considerably in different States. In Perak where the disease is most prevalent the instructions receive but little attention. In the one badly infected district of Selangor instructions are often obeyed fairly well especially when a large fine is inflicted from time to time. In the Negri Sembilan the disease is much less prevalent and often disappears entirely for a portion of each year even in those districts which are comparatively the more infected. The occasional cases found have mostly been treated as required. In Pahang work is being somewhat newly commenced and not much can be said about it at present.

Lalang.—Shortly after inspection work commenced, it became evident that the lalang so often present on small holdings should be removed, irrespective of whether these contained rubber or coconuts, more especially when they bordered on clean estates or other clean holdings. In this case also it was decided to commence by giving advice only, until the small owner should become more accustomed to an idea which is entirely contrary to his usual happy-go-lucky methods.

Legal action to enforce removal of lalang, particularly from holdings bordering on estates or other clean holdings, was commenced in 1915 in the States of Perak and Selangor. During 1916 this action was continued steadily and a certain number of cases were instituted in Pahang; in Negri Sembilan no legal action has yet been enforced, reliance being placed entirely on the advice of the inspecting officers, which is fairly frequently adopted especially by Chinese. The process of educating the small holders to realize the importance of doing the work necessary to keep his land free from this serious pest, which not only itself damages the rubber tree but is frequent source of almost entire loss though fire, will be as slow as that of teaching him to treat pink disease and is again to be arrived at only by gradual and steady education.

These then are the three main lines of action which have been followed during the years 1915 and 1916, and the number of court cases which have been taken in connection with them are given in the following table :

COCONUTS.

State.	1915.		1916.	
	Total cases.	Total fines.	Total cases.	Total fines.
		\$ c.		\$ c.
Perak	146	484 50	139	826 00
Selangor	38	134 50	88	488 00
Negri Sembilan	56	406 50	39	151 00
Pahang	2	10 00	8	22 00

PINK DISEASE.

		\$ c.		\$ c.
Perak	225	1,717 50	348	3,979 50
Selangor	2	10 00	6	300 00
Negri Sembilan ... ..	...	...	1	10 00
Pahang	1	5 00	...	...

LALANG.

		\$ c.		\$ c.
Perak	14	107 50	39	332 00
Selangor	1	5 00	16	59 00
Negri Sembilan ... ..	...	...	...	...
Pahang ... ..	...	...	67	98 00

Tapping.—Almost from the beginning of the inspection work the European officers have given advice to small holders all over the country as to proper methods of tapping. During 1915 and 1916 steps were taken to train the subordinate inspecting officers in good methods of tapping and advice as to reasonably conservative systems of tapping allowing a satisfactory bark renewal has since been freely given in all the kampongs by them. At the same time common errors in tapping, resulting in waste of bark, and the serious damage done by severe wounding, have been carefully pointed out. This advice was most urgently required as, on the older holdings in particular, the yield is often reduced to as little as 100 lbs. per acre per annum owing to excessive tapping in the past which has left the trees with a bark so thin that, properly speaking, it should not be tapped at all. Again in many instances previous severe wounding has left the surface of the bark so burred and rough that it is no longer tappable. The advantage of this advice can be clearly seen in parts of Pahang on small holdings which were opened in 1915 and 1916 under the advice of the local sub-inspectors. These trees have not been nearly so severely damaged as have those in some other parts of the State where they are three or four years older. The matter of giving advice as to tapping systems on small holdings is of very great importance, especially in view of the very large area of young rubber recently planted, which will be continuously coming into bearing in the future especially in the years 1919 and 1920 when the large plantings of the past two years will probably be opened. It may be mentioned that two court cases were taken, one in Perak and one in Selangor, during 1916 for failure to obey instructions to improve tapping methods on certain holdings where the whole of the bark had been removed practically down to the wood. It is held that a large number of trees in this condition are exceptionally liable to disease and might serve as a source for its rapid spread. Elsewhere, however, advice on this subject has been fairly welcome and has been followed fairly willingly.

Removal of Dead Rubber Wood.—The result of the Mycologist's work on *Ustulina zonata*, the black line fungus, especially emphasized the importance of removing from small holdings all dead rubber wood, trunks or stumps, irrespective of whether their presence is due to death from disease, damage by wind, or thinning out. Four cases resulting in fines amounting to \$30 were taken in Selangor in 1916 in this connection. This is a point which will receive further attention during the coming year.

Black Stripe Disease.—The most recent disease found to require attention in the kampongs is the "black stripe" disease of renewing bark. This disease was known to occur on certain estates in Perak and is now under investigation by the Mycologist who is also conducting experiments to determine its control and treatment. Up to the month of March last, the disease was not known definitely to

occur in kampongs anywhere, but during that month it was found fairly commonly on kampongs in the Raub district of Pahang by the Assistant Agricultural Inspector, Selangor, and the author. The treatment of this disease in the kampongs will be a difficult matter and can only be carried out by a trained gang or gangs of coolies specially employed by the Department. Both the identification of the disease and its treatment require more or less expert knowledge and the Malay subordinate officers will have to be most carefully trained before such work can safely be left to them.

Steps must, however, be taken early to decide the distribution of the disease in the kampongs and measures must be devised for its treatment.

LOCUST WORK.

In Selangor and the Negri Sembilan the Assistant Agricultural Inspectors have been responsible for supervising the work of destroying locusts, for which purpose a special staff was provided. The work commenced in September, 1913, and continued in Selangor until the end of 1915. A few locusts were present during 1916 and a small staff was kept until the end of the year to watch them. No eggs were, however, laid and the State is now practically free from locusts; unless there is still a small swarm rapidly dying out at Sepang; none are known to occur elsewhere. In the Negri Sembilan work went on continually during the years 1913, 1914, and 1915; the staff was reduced in 1916 as the number of locusts became less and only part of the subordinate staff was left under the direct control of the Assistant Agricultural Inspector. Naturally the locust work occupied much of his time in 1916. At present there are no more locusts in the Negri Sembilan and very little more work is expected there.

The Chief Agricultural Inspector has been in chief control of this work throughout; besides general supervision of this work in Selangor and the Negri Sembilan since August, 1913, he has also had to supervise work on locust destruction in Johore since October, 1914, and in Malacca since March, 1916. In both these States the number of locusts is now much reduced.

WORK ON ESTATES.

The work of European inspecting officers on estates has been almost entirely of an advisory nature. In two or three cases letters requiring the treatment in accordance with the Enactment of one or two diseases, usually pink disease, have been sent out, but in no instance has a court case been necessary to enforce the measures required.

As part of the routine work the distribution of pink disease by mukims has been determined and practically every infected estate is known in Perak, Selangor and the Negri Sembilan, in Pahang the

work is not yet complete. Practically all infected estates have been visited at least once, often more frequently, and have been given advice as to treatment of the disease.

The black line disease, *Ustilina zonata*, being comparatively new, has given planters some trouble and many have asked the inspecting officers to visit their estates and given advice about it. It is now fairly well known and on many estates the removal of all timber, especially thinned out rubber stumps and trunks, is being carried out on all the older fields. The question is under consideration as to whether the inspecting staff ought not to use its powers to require the removal of at least all dead rubber wood from all estates in the interest of the industry as a whole. This treatment would apply also to the other root disease of older rubber, *Poria hypolaterita*, about which advice is often asked.

White ants, *Fomes*, *Sphaerostilbe repens*, die-back, drying up of latex and various bark troubles all give rise to requests for advice from time to time and inspecting officers are more and more frequently asked to visit estates to advise on the treatment of one disease or another.

Recently, that is from the middle of 1916 to date, much attention has been given to two bark diseases. The first is the "black stripe" also known in Perak as "cambium rot," first found in Perak North. The Assistant Agricultural Inspector, Perak North, has, I believe, determined its distribution on estates fairly fully in his portion of the State and is also assisting the Mycologist with experiments to determine its treatment. This disease, occurring as it does on renewing bark is a very important one, and work on its distribution in other States has been commenced. It is known to occur here and there in Selangor in the districts of Kuala Selangor, Klang and Ulu Langat and in the Raub and Kuantan districts of Pahang. So far it has probably been recorded from the Negri Sembilan only on one estate, as it seems preferable to consider the bark disease known there on several other estates to be different, since it exhibits certain differences in symptoms and may not be due to the same fungus.

The second bark disease referred to is this form found in the Negri Sembilan. Its distribution on estates has been fairly fully determined by the Assistant Agricultural Inspector, Selangor, and the Assistant Agricultural Inspector, Negri Sembilan. On the suggestion of the management tapping was stopped on one area in which this disease occurred.

CENSUS OF COCONUT TREES.

It may be mentioned in passing that a full census of coconut trees on small holdings has been nearly completed by the inspecting officers and that the advisability of making a census of rubber holdings to show ages and trees is under consideration.

CONCLUSION.

It will be seen that the activities of the inspecting staff are fairly numerous and show every prospect of increasing largely in the future. Nearly all the lines of work are of considerable importance, as I think will be readily admitted, and new methods of dealing with new diseases may become necessary as time passes and local fungi become more and more adapted to rubber as a host plant. If all these known and possible future diseases are to be kept well under control, the inspecting officers will be kept busy, and in fact the work that is even now necessary bids fair to grow beyond the capacities of the present subordinate staff, so that a scheme for increasing it in the near future is being drawn up in order to keep pace with the needs of small and large planters.

Even the short experience so far available seems to indicate the real value of inspection work for disease control, though the full results obtainable can only be arrived at slowly after many years of careful and patient educative work.

Discussion.

Mr. COOMBS asked Mr. R. M. Richards whether he had in his experience met actual cases of death of coconut palms which could be assigned to *Pestalozzia* and whether under conditions obtaining on the best estates here it was not advisable to leave the palms to recover from the disease themselves. Also if from the point of view of general sanitation it would be advisable to remove the tree creeper so common in old palms.

Mr. R. M. RICHARDS replied that he had seen rare instances of grown palms which had succumbed to *Pestalozzia* attacks. In cases of attacks of this disease in nurseries it was not advisable to leave matters to chance. In reply to the second question he did not consider it necessary to clean up the creeper (a fern) from palms as he had never found the creeper causing injury.

Mr. P. B. RICHARDS asked Mr. R. M. Richards whether he had tried spraying with contact poisons applied with a power sprayer, for the destruction of *Brachartona*.

Mr. R. M. RICHARDS said that he tried all forms of sprayers, except a power sprayer, and found that spraying was inefficient. He stated that singeing and hand collecting was, in his opinion, the only way of dealing with the pest.

Mr. VAUGHAN SMITH asked Mr. South what steps had been taken to control coconut beetles in the kampongs in the Bagan Datoh district.

Mr. SOUTH replied that the usual routine inspection had been carried out throughout last year and a few cases had been taken in court in most months of the year, but the results were not very satisfactory and the Assistant Agricultural Inspector was intending to give the matter his personal attention this year.

RUBBER PREPARATION.

DEMONSTRATION OF EXPERIMENTAL VULCANIZING PLANT, ETC.

A VISIT was paid on the 26th April to the experimental paper-making factory and visitors were shown the plant employed for the complete manufacture of paper from various raw products and the methods of manufacture were explained briefly. The fibre-making machinery for the manufacture of clean fibre from sisal, agave, etc., which is housed in the same building was also inspected. A complete unit of plant on a commercial scale for the extraction of oil from oil seeds of all kind, including copra and Para rubber seed, which is also erected in the same building, was shown and explained.

Visitors then inspected the experimental retort and condenser for the distillation of crude acetic or pyroligneous acid from various local woods, including rubber wood, which was being distilled at the time.

Subsequently a detailed inspection of the experimental vulcanizing machinery and apparatus employed for the testing of vulcanized rubber was made. A demonstration of the methods employed was given, including the mixing, calendering and vulcanizing of the rubber and the subsequent testing of the vulcanized product. Messrs. B. J. Eaton (Agricultural Chemist) and F. W. F. Day (Assistant Agricultural Chemist) explained the processes to visitors and the former gave a brief account of the nature of the variability of plantation Para rubber and showed numerous specimens of the raw rubber, which behaved differently during vulcanization owing to the method of preparation. Numerous questions were asked by members of the audience and replied to. A very keen interest was taken in the demonstration, the plant and methods of testing being quite new to many visitors who had not visited the experimental vulcanizing factory before and had not seen a rubber vulcanizing factory.

Finally visitors were shown the chemical laboratory and took a keen interest in the chemical apparatus and methods employed for the chemical examination of rubber, soils, oils, and other agricultural products.

RUBBER MANUFACTURE AND FACTORY METHODS.

By F. G. SOUTER,

(*Manager, Sandycroft Estate, Perak, F.M.S.*)

It is not proposed in this paper to deal with the subject matter in a general way, and an attempt will be made to confine it to routine work in a factory, as being better calculated to promote discussion and be of practical help to any who require it.

The main object to be attained is the highest possible price for an estate's out-turn in every grade of rubber, and as each grade requires special treatment of its own, I will take them separately, and give the methods adopted for each, on the estate under my charge. No claim is put forward that these are incapable of improvement, but they are the product of many experiments, and consistently high rates obtained for the estate's output in Singapore and London, appear to show that, under existing conditions, the right lines have been chosen to work on, at least as far as this estate is concerned. There are necessarily the elements of variability in climatic conditions, systems of tapping, and types of machinery to be reckoned with, which preclude any idea of uniformity in factory work all over the Peninsula, but I will try to show how these variations can be met to give the best possible results.

It must be assumed that a factory is making its entire crop, including lower grades, and has a full equipment of machinery, sufficient space for coagulating, and adequate smoking and drying accommodation. These requirements are necessarily defined by the quantity of rubber dealt with, and in what form the first latex is turned out, but granted that we are prepared to make either smoked sheet or pale crêpe as occasion demands, to do justice to a crop of anything up to 200,000 lbs., a full plant of machinery would be:—a washer, macerating-roller, crêpeing-roller, smooth-finisher, and two hand or power sheeting-machines, with a 40 H.-P. engine to drive it. A smoke-house capable of holding 12,000 lbs. of rubber would be wanted, drying sheds with a capacity of 10,000 lbs. and a packing-room conveniently near. These buildings should be entirely apart from the factory, but access to them should be by a covered way, and transport of wet rubber from the factory made as easy as possible by trolleys on rails. The receiving-house for latex and coagulating-shed should also be, either a separate building close to the factory, or an adjunct of the latter with a partition to keep coolies other than factory hands away from the machinery. For estates with a much larger output, equipment would be on a larger scale though not necessarily proportionately. Many estates are now putting in a duplicate plant to make themselves safe against a break-down of any essential, and, for those in the happy position of being able to afford the cost, the measure is a very commendable one. With so many high class engineering firms specializing in rubber machinery a planter can get

any type or design of machine he wants, and any pattern of grooving cut on heavy rollers and sheet-making machines. The plant on this estate consists of a 50 B. H.-P. "Mirrlees-Diesel" engine with a 40 B. H.-P. "Crossley" engine in reserve, a "Universal" washer, three new type Shaw's heavy machines, two Shaw's hand or power sheeting-machines, and three old type Shaw's heavy machines. Approximately, 300,000 lbs. are treated in the course of a year and it will be seen that we are practically insured against a stoppage caused by a break-down to any one engine or machine.

The floor of each building should be of good clean cement and immediately under and near the rollers white tiles are an aid to cleanliness.

PREPARATION OF RIBBED SMOKED SHEET.

I take this grade first as it seems to have finally established itself as the most convenient form in which to turn out No. 1 latex, and is made on nearly every estate. It is not essential to have expensive machinery to deal with it, and small estates can make smoked sheet with the bulk of their crop without a heavy capital outlay. It thus justifies its position as first favourite with planters generally. It is also the most interesting grade to make, as so much depends on attention to detail, and neglect of any kind is very apparent in the finished article, though it may possibly pass unnoticed when the sheet leaves the marking-machine. Perfection is more difficult to attain in smoked sheet than in any form of crêpe. because nothing can be done to rectify any mistake at any time during the process of curing. You cannot tear out a piece of bark or grit from a sheet in the same way as in pale crêpe without ruining the appearance of the sheet; you cannot roll it smooth again once it has got torn in the rollers without leaving an ugly mark; you cannot get rid of bubbles once the coagulation has set; "rust" remains for good after the first day's drying, and no amount of scrubbing and washing will rid you of dust or ash which has got on to the sheet before it has a film of smoke over it.

These defects all have their value when the manufacturer's representative has a look at the rubber in the broker's show-room, and a penny a pound less than the best is a serious thing over a year's production from any estate. It is, roughly, \$6,000 on a crop of 200,000 lbs. as much as the manager's salary for the year probably. Most of the well-found estates are now turning out smoked sheet of a high standard, but one has only to look at the range of prices quoted in the brokers' sale reports to see that some estates at least are not getting the best they can. I have been round show-rooms in Singapore with some of the leading American buyers, and they are very emphatic about their requirements in standard smoked sheet. It must be clean, strong, thoroughly smoked, uniform in appearance, and give the same results under vulcanization in the same time in

every shipment. The last is the most important of all from the manufacturer's point of view as it saves time and money in experimenting with each shipment, and if he can rely on an estate's output giving the same results regularly he will buy that rubber and pay full value for it. This serves to show that, having found the right methods in the factory, a manager is ill-advised to alter any part of his process, as any change may have a strong bearing on the results given by his rubber under tests and put the buyers off for some considerable time.

STRAINING OF LATEX.

The first important part of the making of smoked sheet is the straining of the latex. This should be done through fine gauze, 60 mesh, and two sieves should be used—one above the other. The reason for this is that if the sieve gets clogged the cooly in charge invariably rubs the gauze with a piece of rubber till the latex runs freely through, and fine sand and dirt get pushed through with the latex. The lower sieve catches anything of the kind, and no rubbing of the gauze should be allowed on the lower sieve. If this gets clogged it should be replaced by a clean sieve and used on top, the one formerly on top being removed and thoroughly washed to be used again. A sufficient number of spares should be at hand to change continuously.

STANDARDIZATION.

I dilute with cup washings simultaneously with the straining of the latex, both going together through the two sieves. No water is put in the cups during tapping so that the latex is too rich in itself, and the cup-washings increase the output of sheet by about 2 per cent. without any harm being done, as dirt cannot pass through both sieves. There is probably one gallon of cup-washings to two gallons of pure latex in the mixture, and the out-turn on the total gallonage for the last two years has been $1\frac{1}{2}$ lbs. of dry rubber per gallon, variations from month to month being fractional, and dependant on weather conditions. Rain during collection upsets most calculations, and an attempt to preserve uniformity is made during coagulation. In normal weather I can rely on standard latex without the aid of a "Metrolac." Owing to the fact that I have contract tapping at varying rates I have to separate latex from trees over 10 years old from that from young trees. In pan coagulation $\frac{1}{4}$ of a gallon of water is put into each pan. If rain has fallen during collection this is dispensed with and instead of a gallon of latex and cup-washings being put into each pan the latexometer is brought into the picture and sufficient latex and cup-washings put in to equalize as nearly as possible a normal day's size of sheet. I deprecate the use of the "Metrolac" more than is necessary. It means nothing to the ordinary cooly, who, if he has been at the job long enough is a very good judge of the density of latex by

simpler methods, and it is only the incident of rain upsetting the normal state of things, and the varying rubber content of latex during the wintering months that call for a reading of the instrument. These methods are perhaps crude, but they are practical and suited to the intelligence of the factory cooly, and the results have been consistently good. Where tapping is done by coolies on daily wage entirely, bulking the whole of the estate's latex is of course the surest method of ensuring standardization.

COAGULATION.

Having bulked our latex and cup-washings the next step is to add the acid necessary for coagulation. This is done before the latex is put out into pans and a stock solution is kept ready in airtight jars. The solution is made up of 12 oz. acetic acid and $\frac{1}{2}$ lb. sodium bisulphite to one gallon of water—one gallon of this being sufficient for 80 gallons of latex and cup washings. I have tried sulphuric acid on a small scale, but was not very successful with it, and did not continue experiments, the main reason being that we had buyers who relied on uniformity from the estate, and the change of acid might have upset previous vulcanization tests and lost the confidence of the buyers. Pans thoroughly washed are stacked at hand to receive the latex, each containing $\frac{1}{4}$ of a gallon of water and one gallon of latex is poured into each pan with as little delay as possible after the solution has been thoroughly stirred into the bulk. Skimming is done at once with a strip of tin almost as broad as the pan and the pans are placed on shelves in cupboards screened all round by a drop-curtain of turkey-red cloth. The pans used are 16" \times 10" \times 4" and produce a dry sheet 25" \times 11" in the case of latex from old trees and one slightly smaller from young rubber. Coagulation is usually finished by 12.30 p.m. and this allows for latex being brought in carts from outlying fields two miles from the factory. The pans are left untouched overnight. The reason for the added water not being put into the bulked latex is that I found bubbles resulted from bad fusion of water and latex owing to insufficient stirring by coolies when not watched, sheets from the same jar or tank varying considerably. The method used leaves nothing to chance and is therefore preferable. There is also economy in the number of jars or tanks required for containing the bulk of latex before it is put out into pans. In tank coagulation the solution of acid is put into the latex after it has settled in the tanks and before the partitions are placed in their slots. The majority of tanks I have seen do not give such good results as pans owing principally to the fact that the partition laths are not perfectly water tight and permit latex to ooze through from one division to another causing a ragged edge on each sheet which is difficult to get rid of. Most of them are also too big, without enough divisions to deal with the ever varying gallonage. When an estate has tapping done by

several different contractors, whose rubber has to be kept separate, the sub-division of a tank into small compartments is very necessary to ensure an even quantity and equal density of latex in each, every day.

I have been experimenting with a small tank made to contain 40 gallons and have had good results from it. It is light enough to go on a small trolley and be moved about by one cooly up to the receiving tank, and back, when filled, to the most convenient place for dealing with the coagulation. It is made of acid-proof concrete and is 30" × 68" × 9" and makes 34 sheets. The only disadvantage is that the sheets turn out too narrow for economy in rolling, and I am having a deeper one made by the designers, Messrs. R. Young and Co., Penang, to remedy this. The small tanks on wheels seem to me to have many advantages over the large tank on a fixed base.

KNEADING AND ROLLING.

When the coagulated sheet is taken out of the pans in the morning it is placed on a smooth heavy chengai board, and coolies tread it out till it is a firm mass, ready for the smooth roller. This saves rolling more than is necessary and, I believe, retains the strength in the finished sheet. Kneading by hand, or rolling out with a rolling pin, takes longer to get the sheet tough enough to go through a roller without tearing, unless the first rolling is done with the rollers very far apart, and several subsequent rolls are wanted. Coolies soon become experts at treading sheets out evenly, and reduce the thickness to the desired limit quicker than machines can, without tearing. The sheets then go once through a heavy smooth roller set at about $\frac{1}{16}$ of an inch, then through another, set at $\frac{1}{32}$ of an inch, and then through the marking roller set just hard up enough to miss grinding. The setting of the last two rollers is never altered, the adjusting keys being removed entirely so that the coolies in charge have no option in the matter. This ensures uniformity in thickness. The sheeting-machines are 18" × 7" and have speed revolutions at the rate of 11 per minute for the smooth roller and 9 per minute for the marking roller. The grooving on the latter are spirals, $\frac{1}{8}$ of an inch apart, to give a small diamond, and the estate name is lettered round the centre of one roller, the spirals stopping where the lettering begins, and there is a blank space without spirals on the other roller exactly opposite. The main points to be observed in rolling are that sheets must go through evenly without a pull in any direction, and the lettering must be kept equi-distant from the edges of the sheet. If the rollers are set evenly the sheets will go through correctly without any guidance, if started evenly.

Economy in time is effected by having the sheets almost as broad as the length of the rollers. It takes just as long for a sheet 30" × 9" to go through as for one 30" × 15", and the actual difference in

the weight of rubber between the two is considerable. There is no point in having rollers 18" long unless you are to utilize as much of this as possible.

WASHING AND DRIPPING.

After rolling, each sheet is washed and soaked in tepid water to get rid of any protein which causes what is called "rust" in sheet. I have found that without this washing in warm water, sheets have a tendency to stretch "rusty" and it is consequently worth doing properly. After washing, sheets are dripped till all water has left them. They are hung on racks which are thoroughly washed each day, the racks being designed so that each tier hangs free from the drip of the one above it. The stands are in the shape of an inverted V with round laths across to hang the sheets over. Square timber laths are not good, as the sheets take any impression very easily at this stage, and unsightly lines across the sheet invariably result where square laths are used. The dripping racks should be in a sheltered position where no dust can be blown on the rubber. Rolling is usually finished by 11 a.m. and sheets are ready for the smoke-house by 2 p.m.

SMOKING.

Sheets should be put into the smoke-house as soon as possible after the water has all dripped off, as they do not take in the smoke so well if too dry. The only reason for not putting them in immediately after rolling is that water would drip from wet sheets on to finished or partly finished sheets that happened to be directly underneath, and the introduction of too much moisture into the building would retard drying beyond reasonable limits. Racks should be perfectly round and wiped over carefully before sheet is hung on them, to avoid dust getting into the rubber which will not wash off if it adheres before the sheets are fairly dry, and will appear as a cloudy grey line across the finished sheet, where it has come into contact with the dusty surface. Sheets should be turned and moved so that a fresh part is over the racks every day for the first four days of smoking, to ensure every part of the sheet getting smoke through it. The size of a sheet when it goes into the smoke-house is about 30" x 15" and it comes out 25" x 11" so that contraction reduces the square measurement of a sheet by about 40 per cent. It is essential for good smoking that this should not take place too rapidly, and for this reason I believe in slow drying and smoking. Rapid drying closes the sheet against a thorough permeation of smoke and I give 19 to 20 days slow smoking before I consider the sheet is finished, the temperature being kept low and too much up-draft avoided. If a building is of corrugated iron the smoke gets through the joints in the roof quite fast enough, and there is no necessity to have funnels to improve the current. My smoke house is a 60 feet by 30 feet

building of corrugated iron, with 4 furnaces, 6 feet by 3 feet, on the ground-floor on trolleys, and two stories above for hanging. It is divided across the centre into two divisions, 30 feet by 30 feet, by a partition to facilitate cleaning up from time to time. The full capacity of the building is never required, and by having this partition the place can be kept clean without interruption of the work. The smoke house is opened up from 12 noon to 3 p.m. only, when the atmosphere is driest, so that the entrance of moisture is avoided as much as possible. If the roof has had the sun on it for half a day there is less chance of condensation of moisture inside, and creasote drip on to the sheets does not take place. The fires are kept going for the rest of the 24 hours, and only rubber trees cut up into short lengths are used. I have tried coconut husks, but have not derived any beneficial results from them. Rubber seeds give a thick smoke but there is too much oil in it, which is easily apparent on the sheets, and the use of either coconut husks or rubber seeds usually means extra expense which has not shown itself to be justifiable. The lower floor is 10 feet above the ground and is covered with mosquito-proof wire netting to prevent sparks and dust going up with the smoke. The netting has to be brushed from time to time to keep it open enough for smoke to get through, and has to be renewed every 18 months, approximately. The trolleys have a sheet of corrugated iron on stays, four feet above the furnace, to deflect direct heat and distribute smoke. During the three hours when the fires are out and the smoke house is open, finished sheets are taken down and the day's make put in, and sheets of the previous four days turned. It is a convenient time to do this as coolies from the coagulating room are available in addition to those in the drying-shed. To check weights and assist monthly adjustment of stocks, a tally is kept of the number of sheets put in and sheets taken out, and each day's rubber is ticketed with the date. Rubber in store can thus be checked after each consignment if necessary.

FINAL WASHING.

Finished sheets are washed and dried before packing, scrubbed with a horse brush dipped in clean water and hung on racks, the same as those used for dripping, and sun-dried for about 20 minutes. There is always a certain amount of dust which can be got rid of in this way, and the appearance of the rubber is improved. The sheets must be taken in as soon as they are dry, as they would soon become tacky in a hot sun.

PACKING.

Before packing, sheets are picked over and any faulty ones separated to be sold as No. 2 sheet. Absolute perfection in methods, of course, precludes any possibility of spoiled sheets, but in practice it will be found that there is always a small percentage that would have a bad effect on a consignment, and it is better to sell these for a lower

price, and get full value for the bulk of the out-turn. Out of, approximately, 200,000 lbs. of sheet sold in 1916 we had 672 lbs. or four cases, of faulty sheets which fetched \$3 per pikul less than the best, so that the net loss from this cause was about \$15, whereas, if they had been mixed with the good sheets there might readily have been a loss of \$1 per pikul over the whole total sold, or approximately \$1,500.

Without the aid of a press, 168 lbs. of sheet go into one case. It is a convenient quantity as it is $1\frac{1}{2}$ cwts. and 40 cases give three tons. If sheets are made or cut into lengths to fit the cases a larger quantity, up to 200 lbs., can be squeezed in. It always seems to me that the expense of packing smoked sheet is so unnecessary, as properly cured smoked sheet is impervious to damp for a considerable time and it is reasonable to suppose that before long we shall be baling our smoked sheet like wool, and avoiding the expense of Momi and Venesta cases.

PREPARATION OF PALE CRÊPE.

The main points required in the grade are colour and texture, and the attainment of either presents no great difficulties if uniform treatment is accorded every day.

COAGULATION.

The latex is usually coagulated in bulk and the addition of extra water is of no moment as air bubbles are impossible in crêpe. The strength of acid is the same for this grade as for smoked sheet, but double the quantity of sodium bisulphite is wanted unless the rubber is to be rolled the same day. If the sodium bisulphite solution is too weak, oxidation will set in to a certain extent during the night, and the colour of the out-turn will suffer. I use 1 lb. of sodium bisulphite to a gallon of water for 80 gallons of latex with the usual 12 oz. of acid for latex to be treated next morning.

ROLLING.

Strip coagulation in tanks is more economical than mass coagulation as the strip will go easily through a macerator without being cut up, rollers can be set fairly close for the first roll, and once through the macerator brings the rubber to a stage where the crêper and smooth finisher can deal with it. The macerator and crêper should be hard chilled rollers with uneven speeds, the number of teeth in the cogs being 21 for the front roller and 18 for the back one. The smooth finisher should be of softer metal and speeds of 20 and 18. It will be found in practice that a smooth roller will not do such good work when new, as it will when it has been working some months.

After the rubber has been through the macerator once and twice through the crêper it is a question of what style of crêpe is to be turned out, as to how many rolls are necessary in the finisher.

Blanket crêpe has gone out of favour, and thin lace crêpe is now the fashionable form, and to get this of close texture at least four rolls in the smooth finisher are necessary. The first one is done with a single length of rubber as it comes from the crêper, and the result is a thin strip full of holes. This is divided into lengths and three to four lengths put through together, making another thin strip with still a few holes, but getting nearer the right texture. Two lengths of this then go through evenly knitted together, and a final roll of the resultant single length should be enough. The smooth finished rollers are hard up during all four rolls. During the finishing process any soiled or discoloured pieces should be torn off to go into a lower grade.

The finished crêpe is dripped till all water is off and removed to the drying shed to be hung after weighing. Fine crêpe should be ready for packing in six to seven days. It should be pure white when it goes into the drying shed and should not darken beyond a rich cream colour. The thinner the crêpe is made, the lighter will it show up in colour when finished, and if the sodium bisulphite has been properly mixed into the latex the colour will be even.

LOWER CRÊPE GRADES.

For the treatment of lump and bark scrap, of course, no coagulant is wanted, but sodium bisulphite plays a large part in the resultant colour of these. The rolling required is the same as for pale crêpe, but the preliminary treatment consists of washing mainly. It is important to deal with lump immediately it comes in from the field as oxidation has started, which means discolouration eventually, and the further oxidation has gone the worse the discolouration becomes. Oxidized pieces should be picked out by hand, and the lump put into the washer with hot water playing on it. I do this for 10 minutes and the hot water checks oxidation. A final washing of 10 minutes is given with the water turned off above, and the outlet shut below, enough water being kept in to come up to within an inch of the top of the rollers. A solution of sodium bisulphite is added and gets thoroughly into the mass during the washing process. The rubber is then rolled out in the same way as pale crêpe and should be very nearly equal in colour and texture to the first latex grade.

Bark and tree-scrap are washed together as soon as possible after arrival at the factory, and are treated in the same way as the lump, except that 10 minutes' longer washing is required to get rid of all dirt before the sodium bisulphite solution is added.

FOLDING AND PACKING.

The lengths of crêpe are taken down when dry and folded to fit the cases. A rather ingenious folding rack has been in use on Sandycroft Estate for a number of years. It consists of a frame

as long as the length of the case, and the lengths of crêpe are flicked over from side to side with round sticks—three on each side—two being used by the cooly for turning over, the others for keeping the crêpe in place. The sticks are pulled out in turn from underneath and used for flicking over the crêpe into place. When the frame is full the rubber is lifted out and pressed and retains its shape.

One hundred and twenty-five pounds go into each case without the use of a press. Any discoloured or stained lengths are removed to be made up again with an inferior grade before folding.

GENERAL.

It has been impossible in the limited time to deal fully with many essential parts of factory work, and without practical demonstration it is difficult to convey ideas, but I hope that this paper will be of help to some of those attending this Conference. Most of it is routine well known to most managers, but routine, particularly in the case of smoked sheet, is a dull and dangerous business unless constant attention is paid to every detail, and this, I consider, to be the only way to ensure the maximum price for an estate's production.

When a penny a pound on a yield of 360 lbs. per acre means £1 10s. per acre, extra profit, it is surely worth doing everything possible to get it.

**THE PREPARATION OF PLANTATION PARA RUBBER
WITH SPECIAL REFERENCE TO FUTURE
CONSIDERATIONS.**

By B. J. EATON, F.I.C., F.C.S.

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IT is proposed in this paper to submit very briefly the results of the researches on raw rubber manufacture which have been conducted for the past 2½ years at the Agricultural Department by the writer and his assistants and to consider in what way these results are likely to affect the future methods of preparation of the raw product, having in view both the highest quality of rubber which can be prepared and the manufacturers' requirements, as far as we have been able to obtain information in this respect.

As a starting point two axioms are propounded, with which I think every planter and manufacturer is now in entire agreement.

They are (1) The highest grade of wild rubber, *viz.*, Fine Hard Para, which is the premier raw rubber among wild rubbers, so called, on the market, is very uniform. (2) Plantation Para rubber from the cultivated *Hevea* is very variable. Arising out of both of these axioms we have now to consider: (a) In what respect is plantation Para rubber variable and how can this variability be remedied? (b) What are the causes of the variability in the case of the plantation product and what the reason of the uniformity of the product from the uncultivated tree?

I do not propose to enter into any details as to the researches which have enabled us to elucidate to a considerable extent these important problems, since much has already been published by the writer and his collaborators and since confirmed by other independent workers and in a month or two a special illustrated bulletin will be published giving the details of these researches to date. It is only necessary here to summarize the results obtained and, if further information is required on any special point, this may be probably obtained during the discussion of the paper.

Speaking historically, the remarks expressed by Mr. Williams, Works Superintendent of the North British Rubber Company, one of the leading and most advanced of our British rubber manufacturing firms, especially in the organization of scientific research, will form a suitable text on which to hang this discourse. These remarks which were made at the 4th International Rubber and Allied Trades Congress held in London in July, 1914, were as follows:

“My experience is that quite apart from all questions of strength, the question of the vulcanizing properties of plantation rubber is the greatest trouble the manufacturer has to face. Without efficient control, faulty vulcanization undoubtedly will be responsible for loss of time and money. These troubles, in factories where scientific control is not thoroughly organized, may be sufficient to condemn the use of this grade (that is plantation rubber, B. J. E.) entirely.”

Since that date we have travelled far in our knowledge of the vagaries of this wonderful substance and one can say it, with a certain amount of pride, without being egotistical, that the Agricultural Department of the Federated Malay States has had the honour and good fortune of contributing the most important and fundamental researches on the problem.

The above remarks by Mr. Williams constitute the first intimation from the manufacturer of the nature of the variability of plantation rubber. These remarks were confirmed at the same Congress by Dr. Schidrowitz in a paper entitled “Variability” in which figures for numerous cases of such variability were published. Independently, later in 1914, our early researches led to the same conclusions; since which we have been able to discover the cause or causes of the variability and many of the contributing factors in connection with estate factory practice which have an influence on variability.

It can therefore in the first place be enunciated that the principal defect of the plantation product is its variable behaviour during vulcanization, or to put it in the technical terms used by the rubber manufacturer, variability in rate of cure or speed of vulcanization.

The remedy, *i.e.*, the method of obtaining uniformity in this respect, can only be attained after a realization of the cause, and the great aim of scientific research is to connect cause and effect in the world of nature. It may however be argued logically, assuming that variability is due chiefly or entirely to methods of preparation rather than to intrinsic differences in the latex on different estates or from different areas or districts, that uniform methods of preparation will ensure uniformity of product, but even so, we are at much greater advantage if we possess a knowledge of the cause, since it may then be essential only to adopt uniform methods in one or two respects. Secondly a knowledge of the cause of variability will enable us possibly to prepare an improved type of the raw product, having realized that our existing methods are entirely empirical and like “Topsy” have merely “grown.”

Fortunately a knowledge of the cause of variability deduced from our researches, enables us to state that variable methods of preparation are chiefly, if not entirely responsible for variability of

the product, and this being so, we are more easily able to apply a remedy which consists in uniformity of method of preparation. Further the information derived from the elucidation of the cause of variability has enabled us to realize the second problem, *viz.*, the preparation of an improved type of raw rubber and it is essentially with this problem that I propose to deal.

Returning once more to the cause of variability, we have found that variability in rate of cure of the raw product is brought about by two factors: (1) the amount of an accelerator or catalyst produced in the raw rubber from the nitrogenous constituents of the latex by allowing the coagulum to mature for about six days before machining, and (2) the amount of some accelerating substance in the latex which is retained in the rubber by some process of preparation in which all the serum is retained.

The first of these substances, which has the greatest influence, especially in small quantities, we have found to be some decomposition product of the nitrogenous constituents. The second substance exists originally in the latex and is removed almost entirely when the fresh coagulum is converted shortly after coagulation to thin *crêpe*.

In dealing with the first of these factors, I propose only to summarize the factors which will influence the amount of such accelerator in the rubber. They are as follows:

- (1) Amount of moisture in the prepared rubber;
- (2) Amount of serum retained;
- (3) Rate of drying;
- (4) Thickness of coagulum before and after machining;
- (5) Presence of antiseptics, *e.g.*, formalin, sodium sulphite and sodium bisulphite;
- (6) Influence of different coagulants;
- (7) Excess of coagulants, especially of certain coagulants;
- (8) Influence of smoking;
- (9) Influence of artificial methods of drying;
- (10) Action of various chemicals on the finished rubber in retarding or accelerating rate of cure;
- (11) Concentration of latex;
- (12) Action of water as a solvent.

In dealing with the second accelerating factor the factors which influence the amount present are:

- (1) Concentration of latex;
- (2) Effect of water as a solvent on the finished rubber.

Whether other factors, such as the nature of the coagulant, or an excess of coagulant, antiseptics and other chemicals or smoking, have an effect on rapidly curing rubber, the rapidity of cure of which is due to some constituent of the latex normally

removed in the serum by the machining of fresh coagulum has not yet been ascertained, but is probable. In support of this we have the fact that Fine Hard Para which is comparatively slow curing, contains all the serum constituents and should be rapidly curing, but the vulcanization is retarded by the smoking process.

Dealing briefly with the factors involved in the variability of the first type of rubber in which the vulcanization is accelerated by the amount of some protein degradation product formed during the maturing of the coagulum by natural biological processes, the following factors accelerate rate of cure :

- (1) High moisture content up to a certain limit ;
- (2) Large amount of serum ;
- (3) Thickness of coagulum up to a certain limit, which affects the rate of drying ;
- (4) Slow drying ;
- (5) Concentration of latex ;
- (6) Action of certain chemicals, especially the alkalis, soda and potash and their carbonates.

The following factors retard the rate of vulcanization :

- (1) Low moisture content in the prepared coagulum ;
- (2) Removal of serum ;
- (3) Rapid drying ;
- (4) Thinness of coagulum which produces rapid drying and is also responsible for the removal of serum by machining ;
- (5) Presence of antiseptics, especially formalin, also boracic acid and tannic acid ;
- (6) Certain coagulants, *e.g.*, the mineral acids especially hydrochloric, sulphuric and hydrofluoric acids and certain salts especially the alums ;
- (7) Excess of coagulant—the effect of excess of weak organic acids, such as acetic, formic, citric, tartaric and oxalic is not very marked, while excess of the mineral acids has a marked retarding effect ;
- (8) Smoking ;
- (9) Artificial methods of drying—not very great in the case of thin crêpe, which is the only type of rubber subjected to artificial methods of drying ;
- (10) Dilution of latex with water ;
- (11) Action of water as a solvent.

With regard to the second factor responsible for variability in rate of cure the influence of various factors in retarding the rate of cure has not yet been investigated, but it is probable that smoking, mineral acid coagulants and alum and other antiseptics and chemicals will retard vulcanization.

THE UNIFORMITY OF FINE HARD PARA.

In my opinion the sole reason for the uniformity of Fine Hard Para is the law of averages. Each ball of Fine Hard Para probably takes from one to two months to prepare and thus any daily variation of the latex in concentration, etc., or any variation in the temperature or other conditions of the smoking process employed, are averaged. This indicates at once a method for rendering plantation rubber more uniform in bulk, *viz.*, the mixing together in each case, of rubber prepared on different dates.

Having summarized the causes of variability in plantation Para rubber and shown the principal factors which have an influence on the problem and stated the probable reason for the uniformity of Fine Hard Para, it can easily be seen what remedies should be adopted to secure uniform results. It is obvious that the problem is not excessively difficult on any one estate for one type of rubber, but that considerable difficulties arise in the endeavour to make all estates carry out a similar practice.

In considering the problem of variability we must at once realize that uniformity can only strictly apply to one type of rubber. Thus thin pale crêpe is intrinsically distinct from smoked or plain sheet and as long as there is a market demand for this grade, which will probably be always, since this type of rubber has created its own market for specific purposes for which no rubber of darker colour could be employed, it is impossible for estates to make one uniform product, since thin pale crêpe, from its mode of preparation will almost certainly always have a different rate of cure to smoked sheet. It might be suggested that this type of rubber be made as the sole first grade. The answer to this is that thin pale crêpe is almost always inferior to smoked or plain sheet in tensile properties and hence should not be used for articles in which strength rather than colour is a desideratum.

It is thus evident that for present demands we must prepare at least three and probably four grades of plantation rubber, that is either two first grade and one second grade or two first grade and two second grades. The probability is that four grades is the minimum, since it does not seem desirable from our researches to combine all lower grades. The best solution is probably the preparation of pale crêpe and one other first grade and the preparation of two lower grades as follows: No. 1 lower grade crêpe to consist of lump, skimmings and picked scrap, and No. 2 lower grade crêpe of bark shavings plus earth scrap.

It is not proposed here, however, to deal with lower grades but with first grades only, although in one respect, the question of "lump" rubber or cup and bucket coagulations, is of interest, as will be seen later.

The problem therefore with which we have to deal in connection with the preparation of first grades, is whether we are going to be content to produce pale crêpe and smoked sheet as carried on at present or to endeavour to substitute another and an improved type of rubber in place of smoked sheet and it is this problem primarily with which I propose to deal briefly, leaving the subject open for discussion, after bringing forward the salient facts in support of a new method of preparation.

It would probably be preferable to state at once that the proposed method of manufacture is that which we have styled "slab" rubber, in lieu of sheet.

Our researches have shown that whereas smoked sheet cures in about $2\frac{1}{2}$ to $2\frac{3}{4}$ hours under the conditions employed, "slab" rubber cures in about $1\frac{1}{4}$ hours or less than half the time. Apart from this, "slab" rubber is about 20 to 25 per cent. superior in tensile properties to crêpe and generally superior to smoked sheet. The advantages to the rubber manufacturer of this type of rubber are therefore obvious. Whether a manufacturer would be prepared to pay a premium for such rubber however remains to be seen and for the present it is taken for granted that such rubber would merely fetch the ordinary top market prices obtained for smoked sheet. We, therefore, have to consider its preparation entirely from the producer's point of view (assuming of course that it is not going to fetch a lower price on the market, as it probably would do if judged by appearance only). What are the advantages we must ask ourselves of any alteration of existing methods. Some planters may be very conservative in this respect and prefer a *laissez-faire* policy, but I venture to suggest that, especially at this time, we have no more right to adopt such a policy in our commerce and industry than we have in the conduct of our military affairs and I therefore assume that all planters are alive to the necessity of a change if it can be shown that such a change will produce an improved product.

We have now to consider the possible forms in which such a type of rubber can be prepared, taking note of the advantages and disadvantages of each method of preparation.

There are only three possible forms in which such rubber could be prepared for the market, *viz.* (1) virgin "slab" containing about 20 per cent. of moisture, (2) in the form of crêpe, (3) in the form of dry block.

Of these forms the most suitable when everything is taken into consideration, is the first. The only disadvantage of shipping virgin "slab" is that extra freight has to be paid on about 20 per cent. of water.

The pre-war freight on rubber was about $\frac{1}{2}d.$ or say 2 cents per lb., while the present rates are about $1d.$ or say 4 cents per lb.

If rubber containing 20 per cent. or at a maximum, say, 25 per cent. of water is shipped the actual amount of dry rubber sent for 2 cents at pre-war rates would be 80 or 75 per cent., respectively, that is to say, each pound of actual rubber will cost $2\frac{1}{2}$ cents or $2\frac{2}{3}$ cents at pre-war rates and 5 cents or $5\frac{1}{3}$ cents at present rates of freight. This represents an extra cost on freight of $\frac{1}{2}$ to $\frac{2}{3}$ cent at pre-war rates and 1 to $1\frac{1}{3}$ cents at present rates.

This extra cost has now to be compared from an economic point of view with the cost of preparing, say, smoked sheet in estate factories and this cost is represented when compared with "slab," by the actual cost of machining, since acetic acid or some other coagulant has to be used in the case of both "slab" and sheet.

The lowest factory costs for present first grades is probably about 1.5 cents per lb. which includes oil for engines and acetic acid, but does not allow for capital cost and depreciation of machinery and factory. In the preparation of "slab" rubber, apart from the machinery required to treat 20 to 30 per cent. of the crop which is represented by lower grades, all machinery and consequently a large factory is eliminated.

Leaving aside, however, the depreciation on factory and machinery, the cost of preparation of first grades is probably not lower than the above figure and in the preparation of virgin "slab" rubber the saving effected in cost of preparation will at least compensate for the extra freight even at present rates, while in most cases and at pre-war freights the saving in cost of preparation will probably be from 1 to 2 cents per pound on many estates.

The above figures have demonstrated that virgin "slab" is cheaper to prepare, requiring little care, apart from cleanliness, and that the saving on cost of preparation more than compensates for the extra freight charges on moisture.

Two other disadvantages may be mentioned, *viz.*, difficulty of fixing duty owing to a possible variable moisture content, and secondly the introduction of a new type of rubber may cause confusion among manufacturers. The first of these would be capable of adjustment in a short time and presents no greater difficulty than does Fine Hard Para while the second is not worth taking into consideration, since the manufacturer would soon realize the value of this type of rubber.

With regard to the shipping of "slab" rubber in the form of crêpe, there is no advantage to the producer, in fact possibly a slight disadvantage in that the coagulum after maturing for six days is very tough and therefore more difficult to machine. The advantages lie entirely with the manufacturer who is obtaining a better type of rubber, which is clean and dry, and probably may not, if properly packed, require rewashing.

One disadvantage which has been suggested is the difficulty of distinguishing such crêpe from many specimens of ordinary slow curing crêpe, except from first latex pale crêpe. This is easily surmounted, however, by labelling boxes, as is done at present for different grades and styling the rubber "slab" crêpe or some other fancy name. As a disadvantage it is not worth the consideration of either scientific or practical men, to use a distinction to which I object.

The third method, *viz.*, shipping in the form of dry block, presents one or two advantages, especially from the producer's point of view. In the preparation of dry block, the rubber has to be crêped thin, wormed on a special cutting machine, vacuum or hot air dried in this form and then pressed into blocks. Assuming we are leaving the coagulum for seven days, crêpeing can be carried out on the 8th day and the rubber prepared ready for shipping on the 9th day. A great saving in factory space is thus effected and also in packing space. It is recommended that the blocks be made about $1\frac{1}{2}$ to 2 inches thick. Rubber prepared in this manner has been examined in our laboratories nearly two years ago and found to give excellent results.

There is, of course, no improvement of quality in such block, the question being entirely one of economics.

The disadvantages, of course, of preparing the rubber in this form are very similar to those in the case of preparing and shipping as thin crêpe, except that drying space and packing space is saved.

I trust that the facts stated above will, especially at the close of the present war, when manufacturers are able to return to more normal conditions and to carry out experiments, stimulate further interest on the part both of the producer and manufacturer in a problem which has not only proved very fascinating as a piece of scientific research, but which is, in my opinion of supreme importance.

It may be useful to state in conclusion that manufacturers have expressed considerable interest in the results obtained and on all sides have added confirmation to the results obtained at the Agricultural Department.

One other fact, to which reference has been made before, in connection with the advantage of preparing "slab" rubber, is that lump or cup and bucket coagulation can be mixed with first latex rubber, since this rubber if left for the maturation period before crêpeing is essentially "slab" rubber. This means, therefore, an increase of first grade rubber, and should prove especially valuable on those estates where natural coagulation is abnormally great.

Discussion.

Mr. PINCHING asked Mr. Souther what he meant by standard latex.

Mr. SOUTER explained that he meant the standard that he was accustomed to in his factory.

Mr. EATON, in reply to Mr. Pinching, explained the need for managers to carry out investigations into the latex standards of their estates, and also replied to certain questions asked by Mr. Malet in regard to the influence on rubber of dampness in the factory.

Mr. IRVING said that, apart from the minor points raised so far, Mr. Eaton's paper was of prime importance in regard to the valuable information he had given them regarding what he called "slab rubber." He asked whether any steps had been taken to ascertain the views of manufacturers on the matter.

Mr. EATON replied that they had taken no definite steps because manufacturers at Home were at present very busy in regard to war work and could not be induced to deal with matters of that kind till after the war. But American manufacturers had always taken interest in such things and a few of those engaged in the industry here had even tried the method he had explained. He stated that about half a ton of that rubber in the form of crêpe had already been forwarded to one of the best known rubber manufacturers in America for their opinion but so far nothing had yet been heard in reply. He also understood the American General Rubber Company was sending forward rubber of this kind to their own rubber factories in America. A further point he wished to emphasize in regard to his previous remarks in the paper was that, as the rubber he had mentioned usually required rewashing, it could be packed in gunny bags, which would mean an additional saving in cost. According to experiments which he had recently carried out, the best method of preparing "virgin slab" was to hot air dry it at about 120° to 130° F.

A member asked whether the General Rubber Company's product was in "slab" or crêpe.

Mr. EATON said he believed it was "slabs" $\frac{3}{4}$ inch thick.

COCONUTS.

OBSERVATIONS ON COCONUT EXPERIMENTS.

BY G. E. COOMBS, B.SC.

(*Economic Botanist, F.M.S.*)

AND

W. S. COOKSON,

(*Manager, Dindings Coconut Estates, Dindings, S.S.*)

AS a Conference subject this subject is almost ideal as heretofore experiments in coconut culture have been laid down on any but uniform lines, and an occasion of this nature provides opportunity of indicating—for purposes of discussion—some of the guiding principles which should direct the evolution of methods.

The experimenter in agricultural science and in particular the experimenter in that part of the science which deals with crop production, where experiment is directed to the causation and actual measurement of increase of crop returns, has to approach his object with extreme caution, for he is called upon to work with material of widely varying natures and, if the extent of these variations is not examined critically he is exceedingly likely to arrive at erroneous results.

It is a point of fundamental importance that before judgment in the sense of an expression of actual measured yield-effect, can be passed on the values of different treatments given to any crop, the facts of the variation in yield which blocks of the crop show under as far as possible uniform conditions must be determined. With this knowledge, logical interpretation may be placed on results obtained. The method has been evolved to a high degree of perfection in experiments with annual crops and in this case accurate experiments can be carried out on land of small dimensions, but the case of permanent crops, *e.g.*, fruit trees, though amenable to precisely similar methods, presents added pitfalls and difficulties.

The factors which determine production of fruit in any stand of trees are :

- (1) The constitutional natures of the trees. Any block of them, unless they are of pure stock, may contain a number of varieties or sub-varieties of varying productive powers ; these varieties will contain individuals of varying productive powers ; and this cumulatively variable individuality, may be expressed by the presence of very precocious bearers and those approaching sterility.

- (2) The factors which govern pollination and fertilization, It will be seen that the more precise the method of pollination, be it for example a case of unfailing insect pollination the less will be the variations expressed as a result of it.
- (3) Various cultural factors such as soil, water supply, climate, etc.

Of these three groups it will be evident that group (1) presents great difficulties, and the effect of the individual in the fruit production of any set of trees on a limited area may be very great and almost of itself decide the dimensions of the experiment.

In experiments of the nature under discussion there are two distinct problems, the one of patches of backward palms—palms obviously “not doing” as shown by their general appearance—and the other of the stand of good palms. This latter is again two fold in its aspect that of the young and that of the old palm.

As concerns the former, the planter being aware of the cardinal points of coconut culture, knows in a general way the physiological requirements of the palm. He can often make a very shrewd guess at the cause of the backwardness of any one pocket of palms; he knows the value of an extra drain here and of a little cultivation there as means to improve their condition, and can achieve much good by intelligent application of the knowledge of husbandry which he possesses; and though he is the first to acknowledge that he is often quite unable to speak of his results in terms expressing actual measurement, the fact that he actually achieves good will not be denied even by the scientific purist. But what may be spoken of as agriculture in its best sense deals with issues far less clearly defined than these. It deals with the detection of differences of much smaller magnitude. This being so it must be acknowledged that personal judgment on the best forms of cultivation, on the values of different leguminous cover crops or different manures, or on the much disputed point of clean weeding in an estate of uniform palms is but a flimsy deciding factor; these, however, are the very points which the investigator in his efforts to make a good stand of palms yield yet more, is called upon to decide. The differences in nature of these two problems have hitherto not been sufficiently appreciated. It is the latter problem with which these observations deal. As mentioned above the problem is a dual one. With respect to the problem of the young palm it is a matter of recent history since the Department of Agriculture was asked to undertake a comprehensive series of experiments on young palms. The problems put forward for solution were the values of different kinds of manures, of different leguminous cover crops, of different forms of cultivation and of combinations of each of these treatments, a large number of varied treatments being

involved. It may, therefore, be of advantage if the arguments which prompted the demand for caution, and asked that a number of preliminary records might be obtained prior to the formulation of any actual scheme—avowedly theoretical though many of them then were—are given.

Reference has already been made to the mixed natures of the palms in any field of an estate, and the manner in which their individual capabilities would affect yield has been indicated.

We have to add to this, however, the variation which will be caused, the extent has as yet not been investigated, by the varying periodic productions of the palms before they reach their periods of stationary production.

Thus a quantity of palms will commence fructifying at a particular period; these will show a definite incremental curve to the attainment of a more or less stationary maximum production which will be attained in a more or less definite time; but for each of the different sets which fructify at different subsequent periods there will be an incremental curve possibly different from the others, as there will be different periods up to their "stationary productive stages." Add to these the variations which may be attributed to chance pollination and it will be seen that the following variables have to be considered:

- (1) Variety of palm,
- (2) Individual palm,
- (3) Time of initial flowering,
- (4) Time of attainment of stationary yield,
- (5) Lengths of periods between (3) and (4);
- (6) Pollination,
- (7) Culture,

and, in a crop such as this where the ultimate gain comes down to "oil content,"

(8) Copra and oil content at various stages in growth, *i.e.*, physiological considerations.

Though as far as can be ascertained no work of analytical nature has been done on the "populations" of palms in estates, and the effect of many of these variables may ultimately prove to be of small dimensions, it seems a moral certainty that the method of division of a stand of young palms into blocks, giving different treatments to some of the blocks and using others as "controls," even if a large number of the latter are taken, will for the detections of small differences due to culture be of very little, if any, utility. It appears perfectly useless to speculate on blocks of palms averaging up; it seems a matter of pure chance to count on any sympathy being

shown in the trend of the yield—curves of controls. The facts *have* to be investigated. Results of utility could be possibly procured after a number of years but on the lengths of the period it is difficult to hazard a guess.

Some of the facts are being investigated on Tumbuk Estate (Mr. F. H. Dale) and will, it is hoped, be communicated from time to time but the difficulties of any manager in executing work of this kind are very great.

The case of old coconuts presents a simpler issue. After a period of years of bearing the palms reach a stationary maximum-production-period which we may assume is a fairly long span ere the loss of fruit due to oncoming senility supervenes. In the absence of records, it would perhaps be safe to assume, that after 10 to 15 years, all the palms in any field of an estate would have reached this stage or have so nearly approached it as to cause little fluctuation, and now the disturbing factor so bafflingly difficult in the young palm is excluded. Thus it becomes possible to procure more comparable data of the yields of blocks of palms over a period of time, the collection of which data constitutes the preliminary work mentioned above as a basis on which to calculate the size of experiments for the attainment of results of accuracy.

Without going into the long explanation as to the particular method it may be stated that this has actually been done on Gapis Estate where by taking preliminary records of yield over a period of six months, it was possible to initiate experiments on eight blocks of 100 trees each, using two as controls, and one pair each for the trial of three manures, in the detection of differences over 15 per cent.

In Ceylon experiments have for some years been conducted on a basis—not of absolute yield—but of proportionate increase in plot-yields from period to period, that is, that each plot used has been used largely as its own control. There is little doubt that this method provides information of great utility. Manurial treatment to permanent crops is a cumulative business and records over a period of years on blocks of palms irrespective of control plots gives very useful information. In the Chilaw experiments recently published the yields from January to February in two consecutive years were compared, the result of treatment being displayed in proportionate increase in yield from January to February of one year to January to February of the next year. The method given as in vogue there is not without its utility in the detection of differences of considerable magnitude, but there its utility (and in this particular instance it is well illustrated) seems to end, for the yields of the plots untreated show tremendous variation and the causes of these are quite unexplained. It seems impossible to put any general interpretation to the results obtained.

Turning to methods in use in the West Indies we find an extremely helpful article in the *Agricultural News* for May 1916. Here the writer brings out very forcibly the value of uniformity of method. Thus:

“It is thought that were there more uniformity of methods amongst investigators, there would in all probability be much better agreement as regards results. There has been too strong a tendency in the past to lay out manurial experiments according to personal ideas rather than to scientific ideas.

“With present methods the truth about the effects of manures on trees can be more usefully expressed in words than in numbers?”

This latter fact is as true as it is desirable that it be changed. If investigation has not gone far enough to provide data sufficiently precise on which to base actual yield experiments, then it is our task to initiate work which will have that end in view. The way may be long, but it will undoubtedly pay in the long run.

As concerns the method in use in Trinidad and Nevis, both of which are outlined on the article quoted, to which attention is strongly urged, it appears that they also cannot be expected to produce accurate results. The two methods are given as follows:

(1) Trinidad—

$$\text{Gain or loss} = \{(V_1 - V_2) - (C_1 - C_2)\} - m$$

Where V_1 = value of yield from manured plot,
say 1915-16.

V_2 = value of yield from manured plot,
say 1914-15.

C_1 = value of average yield from two control
plots, say 1915-16.

C_2 = value of average yield from two control
plots, say 1914-15.

m = cost manuring.

(2) Nevis—

$$\text{Gain or loss} = \text{value of } [\{n + (n_2 - n_1)\} - c] - m$$

where n = average number of nuts per tree picked
between two annual applications of
manure.

n_1 = average number of nuts per tree picked at
beginning of experimental year.

n_2 = average number of nuts per tree picked
at end of experimental year.

c = the $n + (n_2 - n_1)$ value of the control.

In the case of the former, the value of the results seems dependent on the uniformity of the yields of the two control plots and their agreement with the yield of the plots now treated in the years prior to their treatment, while in the case of the latter the use of the control is quite subordinated, one only being used, and no indication of the range of variation or the causes of variations in the plots under uniform treatment is obtainable.

As far as published results go, and certainly as far as theoretical considerations direct experiment, the only rational way where experiment is framed on yield estimation (there are numerous cases where growth-record experiments may be used to advantage) seems to be the utilization of the results of an initial investigation of yield-differences over a large number of blocks of palms similarly treated, and the value of controls as a check certainly seem to lie in the detection of the range between their maximum and minimum values.

It is difficult in a paper of this nature and length, to indicate clearly the interpretation which the experimenter will put to his records, but the citation of the points above mentioned may not be without interest in the light of what follows.

Taken together they lie at the basis of the problem which every estate manager is confronted with, *viz.*, estimates—the one concerning which he thanks his good fortune if his figures of crops for any period in advance approaches the figures of the actual crops produced.

It has been mentioned previously in this paper, that experiments are in hand to investigate the question of the incremental-crop produced in young palms. Whatever values may be ultimately determined by experimentation as being theoretically possible, there is the ever present fact that the arrears in the number of ripe nuts obtained under present conditions and methods are disproportionately great, and here we approach the question of “falling nuts.” So far, the actual numbers have not been obtained for mature palms but it is extremely probable that they are of high magnitude. In general the nuts which fall may be placed into the following categories:

- (a) Those which are unpollinated and therefore unfertilized;
- (b) Those which are pollinated but in which fertilization does not eventuate;
- (c) Those which are pollinated and fertilized but which are thrown off in the run of the physiology of the tree for reasons of the trees' inability to carry them. Nutritional factors—water supply in particular—will here play an important part, and may possibly largely determine periodicity in crop production.

In young palms category (c) will probably account for a larger number than has been previously supposed and similarly in the case

of old palms with defective nutrition but there seems little doubt that by far the greatest number may be accounted for by actual lack of fertilization and from the observations which it has been possible to make, of these the over-whelming majority are those in which pollination is never effected, *viz.* (a) above.

It is a fact of general observation that in tropical flowers, those in which pollination is never effected predominate in very large numbers over those in which it actually takes place.

Though the facts are not worked out and these arguments are somewhat speculative (they are quoted merely for the purposes of discussion), it seems safe to assume that "nuts" which actually swell to the size of a man's fist, have been fertilized. There may however be, and probably is, swelling in the sense of growth taking place, during the interval between actual pollination and fertilization, but these facts are as yet undetermined.

Actual fair-average counts made on three estates in the country disclose the following figures for falling nuts in a year's crop of 4-4½ years old palms. Dindings 50-60 per cent., Bagan Datoh 60-70 per cent. and Tumbuk 50-60 per cent. In discussing the magnitude of the effect of the contributing causes the following observations on the pollination of the flower may be of interest. The flower is dependent for its pollination on insects or on wind. As an insect flower it falls short of the general attractive mechanisms of scent showiness, and produces only a very small quantity of nectar. As a wind flower it lacks the generally present pendulous stamens, the much expanded stigma and other characters, though it produces a prodigious quantity of smooth pollen. Indeed, nature seems to have provided a means anything but precise for this particular palm, and it seems fairly conclusive that this is the reason which may be ascribed above all others to the cause of falling nuts. If this is the case then it is very evident that variations in climate in this country may have a less far reaching effect than has hitherto supposed in deciding periodic production. The problem is full of interest and it is here suggested as being of great importance. On one side we hear the behest "Keep bees, you will ensure a fuller crop" but the query raised by the other side as to where to find this actually demonstrated is as yet un-answered. The matter should be worked out by a botanist and entomologist in co-operation. At the moment some experiments on hand-pollination are being executed. The field is practically clear and there are a number of pressing problems. These include the collection of data on the productivity of varieties and individuals carried out to the final oil-content factor, as a basis of seed selection; the productivity of hybrids on the lines of Henry's work, the causes of periodicity, the utility of the prevention of first fruitings as an insurance for larger subsequent crops, the causes of sterility, the question of toxicity of grass, the utility of leguminous covers on various types of soil, etc. All of these open up other

issues to the worker on biology. Whether the work the results of which can but be on the main a heritage for others is worthy of execution will perhaps be decided by those whose immediate interests are involved. These remarks, many of which the authors agree are raised on matters uninvestigated or unproven will not be valueless if they merely stimulate interest.

Discussion.

Mr. R. W. MUNRO said: If I may make a passing reference to the last paper, I wish to say that it is a most instructive as well as a valuable contribution, for which both Mr. Coombs and Mr. Cookson deserve our thanks. We know that Mr. Cookson is very keen on this branch of agriculture—(hear, hear) but he is not in the country at present, and we are sorry that we are not able to discuss it now so much as we should wish to. We hope, however, to have it printed and we can then study it. Some of the remarks that Mr. Coombs read to us have an application to other products as well.

HEALTH AND SANITATION.

HEALTH AND SANITATION ON ESTATES.

By DR. S. H. R. LUCY,
(*Senior Health Officer, F.M.S.*)

IN considering the problems connected with sanitation upon estates in the Federated Malay States I propose in the first instance to speak from the point of view of a sanitarian concerned with the opening up of virgin jungle for cultivation and the employment thereon of immigrant labour.

SITE FOR COOLY LINES.

Much trouble and expense in the future may be saved by a judicious choice of site for lines, it is within the experience of many of you, for one reason or another, generally the occurrence of severe malaria, that it has become necessary to abandon certain line sites, much financial loss being thereby entailed, especially when the lines and wells were built of permanent materials.

In the early days of coffee or rubber planting it was the common practice to choose for a line site the edge of a ravine or swamp, the main factors which determined this choice being the easy access to water, a shallow hole in the ground provided a sufficiency, or the unsuitability of the land for cultivation.

In the first stages of opening an estate it must often be impossible to fix upon a permanent line site, it is however not usually difficult to find a temporary site that has no obvious disadvantages, the main points to be considered are accessibility, configuration of the land, and its relative distance from ravines, swamps, and alienated or unalienated land over which you will be unable to exercise any control.

ACCESSIBILITY.

A central site may be too remote to suit the convenience of your coolies, but it renders more easy the work of your labour gangs and a site which abuts upon a busy road or crowded village may present many objections.

Within limits there can be no doubt that concentration of your labour is desirable, where there are congregated large numbers, of coolies they are healthier and happier than when scattered about the estate in small parties. Concentration facilitates supervision, it used to be considered a danger in the case of an outbreak of

contagious or infectious disease, in practice this is not the case, the permanent materials of which lines are now constructed are readily disinfected. The line site should be flat, clean weeded and free of all cultivation. There should be not less than 50 feet between each set of lines and at least 200 feet between the lines and the cultivated area. If this allowance of open space is made it will be found, that for say six sets of lines of 20 rooms each, about six acres will be required for the line site. That is none too much for the accommodation of nearly 500 persons but it is a great deal more than is afforded upon the majority of estates where the mistake has been made of planting up close to the lines with the idea that the rubber can be cut back later on, only too often the manager is unable to harden his heart when it has come to cutting out rows of trees well grown and ready for the knife. It must never be forgotten that the lines will, as time goes on, become surrounded by a dense wall of cultivation which in the case of rubber may be 40 feet high and unless that wall is far removed from the lines the labourers will not get sufficient light, air, and sunshine. Apart from a deficiency of these three essentials to health there is in this country a special danger from cultivation close to cooly lines for it means that the ground adjoining the lines remains damp and in the rainy seasons sodden, conditions eminently suitable for the propagation of hook worm disease. In this connection it should be remembered that the direct rays of the tropical sun have most powerful sterilizing properties. Labourers will acquire no disease from contact with a clean weeded sunbaked line site, a grass grown site may be more picturesque, but refuse rice and debris from the lines will be deposited in the grass, flies will breed in it and become a nuisance and a dangerous factor in the spread of diarrhoea, dysentery or other intestinal complaint. There should be plenty of light in the lines, unfortunately both coolies and anopheline mosquitoes prefer darkness and gloom, light will not hurt your coolies but anophelines will and it is therefore well to insist that light shall not be blocked out of the rooms. A further valuable precaution is white-washing of the lines within and without at frequent intervals. It has often been noticed that anophelines are difficult to find in white-washed rooms whilst in adjoining rooms that have not been white-washed they may be found in numbers. In this country anophelines certainly avoid bright daylight and sunlight. It is stated that in the Panama Zone anophelines will remain hungry rather than fly three feet out into the sunlight to bite a person standing in the sun. In the choice of a line site it is important to avoid the proximity of ravines and swamps. Ravines may afford a water supply, they will certainly produce malaria. Swamps are less harmful, and it may be said that ravines and grass grown ditches in which there is a trickle of clear water should be looked upon with greater suspicion than permanent swamp or old

mine holes. Hill sites are unsuitable, there are usually ravines at the foot of the hills and in any case coolies don't like hill tops, they are too cold for them.

The boundaries of an estate should be given a wide berth for whether your neighbours are the Government, another estate or native holdings you cannot control their actions, all your sanitary measures may be in vain by reason of the omission of your neighbours to adopt suitable precautions.

It is not possible to state at what distance from ravines or swamps it is safe to house your labourers, we do not know what is the diameter of the magic circle the centre of which the anopheline will fail to reach, but it is certain that the further your lines are from their breeding grounds the less trouble will you get from malarial fevers.

The management of an estate situated anywhere in broken hilly country will be amply rewarded in the future for any amount of trouble, taken in the earliest stages of development, to find a spacious and flat area of land and to reserve it as a line site. The disregard of this measure of prudence is common, it has been and will continue to be a source of serious embarrassment and expense, there are comparatively few estates the labour forces of which are housed upon the best available site on the property.

A good deal of emphasis has been laid upon this matter of the choice of sites for lines on account of the extremely important bearing that it has upon the health of labourers and further for the reason that, the immediate outlay entailed by the abandonment of lines which have been put up on an ill chosen site and the erection of new lines upon a fresh site which is generally under well grown rubber is rarely faced. Estates go on year after year expending money upon attempts to improve the sanitary surroundings of their lines, all of which expense might have been avoided by the exercise of foresight in the early days of development.

COOLY LINES.

Of the three common types of lines in use the plan to be adopted is not generally of great importance. On those estates where the level of the subsoil water is very high, raised lines are to be preferred, this type admits of cooking operations under the lines and the smoke from the wood fires has some deterrent effect upon mosquitoes, coolies have been known to complain of the cold in these raised lines, another complaint is that the height of the steps or verandah is a danger to their children, a more common and real disadvantage is the difficulty that there is to ensure that the space under the lines is kept clear of obstructions and in a reasonable sanitary condition, coolies will board up the space for the purpose of keeping their cattle, goats or fowls and constant supervision is required to prevent it.

The ground floor type of lines seems more popular with coolies and it has the advantage that it is readily supervised and kept clean. Overcrowding of lines must be avoided, a minimum of 30 feet of floor space for each person must be insisted upon. Regular inspection by a responsible person is necessary, where this is neglected the lines will become dirty and evil smelling, and what is even more serious light and air spaces soon become blocked up by boarding, sacking or other obstruction.

The question of sites for bungalows must next be considered, the choice and maintenance of suitable sites for the European staff is no less important than for the labourers, frequently too little consideration is given to this matter. Many of the quarters of the managers and assistants are unsuitably placed on sites which are hemmed in at a few yards distance by dense and lofty cultivation. Apart from a lack of sufficient ventilation upon such sites and the increased nuisance and danger from mosquitoes which find a safe harbour in the rubber around the house, the depression to mind and body from living amidst these surroundings has a very adverse influence upon the health, even the occasional visitor to estates must have been struck sometimes at the sombre gloom of an old rubber clearing. Europeans cannot live and thrive in such environment and to expect from them continuous good work and good health is to expect the impossible. A large clearing should be made round each bungalow, it is unnecessary to up-keep extensive gardens but the wages of a one or more coolies to keep cut a few acres of grass-land round the house should never be grudged.

WATER SUPPLY.

An ample supply of good water is a valuable asset and is worth much trouble to secure. When coolies can get plenty of good water for both cooking and bathing purposes at or near their lines they are less likely to make use of ditches, ponds, or streams, when in the field. Most of the rivers and streams in this country become highly polluted soon after they have left the hills in which they rise, it is therefore of very doubtful advantage to have a stream running past the lines, nothing will stop the coolies from using it and its purity must always be suspect. The best sources of supply are from protected hill catchments, the water being brought to stand pipes at the lines, the great value of such a supply is evident, it is usually almost unlimited in quantity and its purity is generally above suspicion. The initial outlay for construction of head works and laying of pipes may be considerable but the expenses for upkeep are small. Upon those estates where such installations exist the management is relieved from much anxiety which is inevitable when shallow wells of uncertain purity constitute the only source of supply for a large labour force. Where a hill supply is impracticable wells must be sunk and it is advisable to have bores put down in order that

an adequate supply at a good depth may be located. Water can be found by digging a few feet below the surface almost anywhere but these shallow pits, they cannot be called wells, do not afford a safe supply and if dug during the wet season they are apt to fail in the dry. All shallow wells, that is wells less than 50 feet in depth require most careful protection against pollution by surface washings or soakage from cess pits. For the lining of wells concrete cylinders should be used rather than brickwork, concrete is less porous than brick and the use of concrete cylinders renders any subsequent deepening of the well more easy than if brickwork is put in as a lining. The greater depth to which the concrete cylinders are sunk the less likelihood will there be of contamination from the surface. In no case should these cylinders be sunk for less than 15 feet. It is not desirable that wells should be close to the lines, freedom from contamination must be secured and the nearer the well is placed to the lines the more difficult does that become. Wells should be far removed from the outfall of line drains, latrines, cattle sheds, and rubbish pits. The ground surrounding the well should be guarded from gross pollution for several hundred feet. A pump is a necessity and it is recommended to procure it from a reliable firm and to pay a good price for it, cheap pumps are quite unsuitable for estate use, they are rarely in working order for more than a few months. A light cover should be placed over the well, this should not exclude air, it is intended to prevent accidental or deliberate fouling of the water. The discharge from the pump should be at a distance from the well and should be provided with a concrete platform sloping to an impervious drain to take away waste water.

CONSERVANCY AND RUBBISH DISPOSAL.

Some system of night-soil disposal is a necessity, labourers must not be permitted to foul the ground by indiscriminate defecation—a habit to which they are accustomed but which they must be broken of. This fouling of the soil is a real danger to health, it conduces through the agency of house flies to the dissemination of dysentery, diarrhoea, typhoid and other complaints. The repeated contamination of the soil by faecal matter inevitably tends to the propagation of hook worm disease and that disease in conjunction with malaria is a grave menace to the efficiency of a labour force. Latrines of whatever type adopted should not be far from the lines, the closer they are placed the better, provided of course that where pits or trenches are used they are outside the line reserve. Latrines should afford plenty of accommodation, those for men and women should be separated and sufficient shelter for decency's sake should be provided by the use of screens. Latrines must be roofed over to protect them from rain, they should also have drains dug round them to keep out storm water. A liberal supply of lime must be used to prevent the breeding out of flies. Pit or trench latrines must be placed at a

good distance from the wells. When possible the well should be on the upper slope and the latrines on the lower slope of the line site. Cooly lines cannot be maintained in a proper sanitary condition unless it is the special work of some one to keep them so, one or more line sweepers must be employed whose daily duty it is to sweep out the drains, collect all refuse, rubbish, tins and bottles from the line site and its surroundings and dispose of it by burial or fire. It is a good plan to have trenches dug between the rubber in which the refuse is thrown and covered with earth each day. The line sweepers must also attend to the upkeep and liming of the latrines, if bucket latrines are in use they should bury the night-soil twice daily at sites which have been selected for that purpose.

THE CARE OF LABOURERS.

Whatever class of labour is recruited each batch should be medically examined as soon as possible after arrival on the estate and all coolies should be rejected who, in consequence of disease, infirmity, or malformation, are found to be unfit for agricultural labour. The prompt medical examination of locally recruited coolies should never be neglected, these local coolies have often drifted in from highly malarious districts and in that case they are certain to be infected in a greater or less degree with malaria. It may not be necessary to turn such coolies away but it is essential that they shall receive special treatment with quinine if they are to be absorbed into the estate labour force. New recruits from the Coast are usually entirely ignorant of the art of food preparation, many of them have eaten rice for the first time at the Coast depôt and still know nothing about cooking it, they are moreover very susceptible to malaria and bowel diseases. It is therefore a wise custom to supply them with cooked rations for not less than six months after arrival, the requisite arrangements entail some little trouble and supervision, but they do not involve any great expense. It may prevent the serious disorganization of a labour force which results from a high sick rate. A daily quinine ration should be given to all new recruits for a similar period. Upon estates where malaria is severe and quinine is given at the hour of morning muster it is well worth while to provide a ration of hot coffee or congee at the same time, large doses of quinine should not be given on empty stomachs, they produce unpleasant consequences and coolies are apt to evade their doses if it is so given. Unless the management makes provision for a hot ration the quinine is commonly taken either on an empty stomach or else on top of a handful of stale and sour rice left over from the meal of the previous day, in neither case can good results be expected. These preventive measures may be thought to be needless for universal adoption in the comparatively healthy Coast districts, but in the malarious country near the foot hills they might with advantage be carried out as a matter of routine by the estate management.

MALARIA.

In its many phases malaria is unquestionably the most serious adversary of the planting interests. It is the one disease which permanently cripples a labour force. When it does not kill outright it may so reduce the vitality and physique of the coolies that they fall ready victims to intercurrent affections such as dysentery and ankylostomiasis. Malaria is conveyed to man through the bites of anopheline mosquitoes, several species are known to be malarial carriers. It is probable as our knowledge advances that other species not at present known to carry infection will be found to be in fact capable of so doing.

For practical purposes all anophelines must be taboo, no effective measures for their extermination or reduction should be neglected. We do not know very much about the habits and capabilities of anophelines and for that reason it is unwise to dogmatize as to the best methods to be adopted to control them. We do know that in Panama anophelines have been found to be swift and strong on the wing and to cover great distances against or even at right angles to the wind in order to obtain human blood. It seems certain also that they avoid strong light, especially bright sunshine.

Conditions are so varied that no single system of anti-malarial measures can be laid down as applicable to all estates. Apart from a judicious choice of line sites, already referred to, there are three principal measures that may be mentioned, these are quinine prophylaxis, oiling, and piping. One or other measure may be all that is necessary but it will commonly be found that a combination of two at any rate is indicated.

The regular medication by quinine over a prolonged period to an estate labour force is no easy matter. It can be relied upon to be effective only when the distribution is under the direct supervision of a manager or assistant. It is a common experience to be told that all labourers get quinine daily and to find that actually only those complaining of fever get quinine and that they get it only so long as they are sick. Where malaria is prevalent the children are certainly infected, it is therefore imperative that they and also the "dependants" should be given the quinine ration.

The spraying of mosquito breeding grounds by means of an oil vapour is becoming more popular, it is, when combined with the clean weeding of streams and ravines, a very effective means for the destruction of mosquito larvæ. In addition it is a method which has the advantage that it is easily extended at a small additional cost. Oil spraying is certainly the most generally suitable measure of mosquito reduction upon estates and rural areas.

The plan of conducting under ground all surface water is without doubt the ideal one for the abolition of malaria. The success of this system is, however, beset by many difficulties. It is at

present undetermined over what distance must pipes be laid in order to free or produce a marked reduction in anophelines in a given area. Serious "washes out" of the pipe lines may occur during floods, the formation of pools and pot-holes by the scour of flood water entails unremitting attention and upkeep. Unless these facts are thoroughly understood and appreciated much disappointment will ensue and a word of warning is necessary lest the management of estates should rush into ill considered and expensive piping operations with the conviction that the laying of a certain number of chains of underground pipes is a panacea for malaria and that all other sanitary precautions may be neglected.

Although medication by quinine, oil spraying and piping have been referred to as the principal measures of prevention against malaria there are many others which cannot be neglected. Extensive swampy areas may often be dried up or greatly reduced in size by cutting a few drains through them. Natural water courses and ditches should be canalized, trained and cleared, small depressions and hollows which in stiff soils are apt to retain water should be filled or levelled. Agricultural drains will require constant attention to avoid silting up and the formation of pot-holes and back waters. Scrub and undergrowth must be cut down, for these afford shelter for mosquitoes and favour the formation of small pools and puddles by retarding evaporation. There is no one specific remedy for malaria, only by an intelligent combination of methods which have been proved to be of practical value will good results be attained.

MEDICAL SUPERVISION AND HOSPITALS.

The prevention of sickness is the first and all important duty of the medical adviser to an estate. In theory it should not be necessary to make arrangements for the treatment of a number of sick coolies. Apart from accidents which will occur in spite of all laws and codes the sanitation of an estate should be so efficient and complete that disease has no chance of a successful attack upon the labour force. There are, however, few estates in this fortunate plight. There are many on which the sick rate is extraordinarily low, it is possible that the happy state of comparative freedom from disease on some of these favoured estates may be attributed to the natural salubrity of their surroundings rather than to the perfection of the sanitary measures that are in force. But we must take things as we find them and on the vast majority of estates there exist conditions which may become inimical to a continued high standard of health in the labourers employed. It is the concern of the medical adviser to the estate to combat these adverse influences and reduce the potential sources of sickness and mortality to a minimum. The main business of an estate doctor being the prevention not the cure of disease, it is evident that this object cannot be attained if the whole of his energy is directed to

the medical treatment of such cases as he sees upon occasional visits to the estate hospital. It is of the greatest importance that there should be a regular medical inspection of lines, drains, latrines, water supply, any anti-malarial works that may be in hand and all other sanitary arrangements. Of no less importance is it that the coolies should from time to time be mustered and inspected by the doctor. On estates where there is little sickness a muster once a quarter is sufficient, but where there is much malaria, in spite of the inconvenience inseparable from a complete muster of the labourers, it is essential that the medical adviser should see every cooly not less than once a month, by this means alone is it possible for him to form an opinion as to the general health of the labourers, the effectiveness of such preventive sanitary measures as are in force or the necessity for further efforts.

In addition to regular visits from a medical practitioner it is the custom on larger estates to employ a dresser, a reliable man should be engaged for his duties are important. The dresser should be present at all musters, he should attend to the minor ailments of the coolies and supply them with simple remedies. If a quinine ration is given he must keep a quinine check-roll in which should be included the names of all labourers, dependents, and children. He must visit the lines not less than once a day to see that they and their surroundings are clean and that the line sweepers keep the drains and latrines in good sanitary condition. Not the least important duty of a dresser is to account each day for all labourers, especially any who are absent without leave from the morning muster or working parties. All rooms should be searched for sick labourers or dependants and every case of sickness immediately reported to an assistant or the manager. A highly skilled dresser is not necessary, he will be apt to keep sick coolies on the estate under his own treatment and report them to the manager only when their condition is beyond his efforts and not improbably also those of the hospital staff. The dresser should find all coolies who through illness are unfit to work and report them to the manager, but the responsibility to obtain prompt hospital treatment for the sick must rest upon the manager and cannot be shifted to a dresser.

HOSPITALS.

It is obligatory upon all employers of native labour to make suitable arrangements for the hospital accommodation of the sick. In the tropics especially diseases are difficult of diagnosis and they are usually rapid in their progress, the treatment applied in the first twenty-four hours frequently determines the issue of the case. It is, therefore, essential from a humanitarian and not less so from an economical standpoint that prompt and skilful medical relief shall be available for the sick. Where small hospitals are put up on each estate they do not discharge these requirements, there can be no

question that the multiplication of separate estate hospitals is from every point of view an unmitigated evil. These small hospitals will be ill equipped and indifferently staffed, apart from an occasional visit from a medical practitioner the patients will be at mercy of men who are unfitted by education and experience to be in sole charge of dangerous cases. To spend much thought, time, and money on sanitary measures on an estate for the purpose of keeping the labourers in good health and then to commit the unfortunates who do fall ill to a hospital where they may have to wait a week before receiving any expert medical treatment is neither good logic nor good business. I cannot too strongly urge the creation of few large and well equipped hospitals to serve the needs of groups of estates, rather than a multitude of small hospitals which are such only in name.

PERSONAL HYGIENE.

A planter's chief concern is for his labourers and he is not seldom careless of his own health. In addition to the necessity for roomy quarters in a carefully chosen and extensive clearing and a water supply that is above suspicion, it is advisable that there should be a screened room in every bungalow, it should be not less than 14 feet square so that it can accommodate several chairs and a table, it should be provided with a double swing-to door. The room should be so placed that it is open on three sides, it should be provided for when the house is planned, the small extempore mosquito proof rooms commonly put up are fit only for meat safes, it is little wonder that they can seldom be used for the purpose intended. Malaria is the cause of at least 90 per cent. of the sickness and invaliding among planters and no precautions against this disease must be neglected in those districts where it is prevalent. Anopheles bite chiefly in the dusk of evening and early dawn, spend these dangerous hours when practicable in a protected room. Never sit about in the open after sunset, especially after tennis or other exercise. Protect the feet and ankles from mosquitoes during the dinner hour by boots or other device. Never sit about in wet clothes, a chill is the most common determining factor in the onset of an attack of malaria. Do not consider the use of a punkah or fan to be a luxury, they are valuable aids to health of mind and body, any one who fails to make use of them is culpably negligent. Take a dose of quinine daily, if you suspect you are suffering from malaria do not rely on the thermometer but consult your doctor who will make sure about it and give you the necessary treatment.

LABOURERS AND STATISTICS.

In certain areas of intense malaria it has at times been found necessary to substitute Chinese for Indian labour. Chinese for various reasons oppose a stout resistance to malaria and bowel complaints, they can live and work and remain in comparatively good health in places where Indians wilt and die. On the other

hand, it has been shown beyond question that vigorous, intelligent and persistent anti-malarial measures carried out by a manager who has a full knowledge of their value and belief for their necessity will bring about so great a change on a highly malarious estate that not only is it practicable to re-employ Indian labour but the sick rate and mortality from malaria can be brought to very moderate dimensions.

The accompanying table sets out the death-rate among Indian labourers in the Federated Malay States during the past six years—

Year.	Average number of Indian estate labourers.	No. of deaths.	Death-rate.
1911	... 110,000	... 7,162	... 65 per mille
1912	... 122,000	... 5,014	... 41 „
1913	... 133,000	... 4,057	... 30 „
1914	... 128,975	... 4,070	... 31 „
1915	... 120,107	... 2,511	... 20 „
1916	... 130,840	... 2,788	... 21 „

If we consider the figures for labourers of all nationalities, Indians, Chinese, Javanese and Malays the reduction in mortality is even more marked but the figures are not so reliable. The Indian figures though they do not include the deaths of infants or dependants are very encouraging. To bring about still further progress there are three prominent measures to which special effort should in future be directed. These are, an extension of anti-malarial works, a more prompt removal of the sick to hospital and an increase in the qualified medical staffs of estate hospitals. The marked reduction in Indian mortality upon estates during the past six years is a great tribute to the successful and earnest endeavours of managers, assistants and their medical advisers, it will doubtless also serve as a stimulus for further effort.

Discussion.

Dr. LUCY concluded his paper by inviting questions and specially asked two members whom he knew had experimented with oil to state their experience.

Mr. HARRISON said that he had tried oil on Midlands Estate with very satisfactory results.

During 1911 the death-rate was 25 per mille, but during the past few years it had been greatly reduced by this means and now amounted only to 1.5 (Hear, hear). That was not due entirely to oiling, but mainly to it, as other methods of subsoil drainage, etc., had also been tried. It was Dr. Watson, who had visited Panama, who suggested oiling. They first tried crude kerosene. They now had their place oiled once a week, costing from \$500 to \$700 a month for about half a mile around. While they had had a hospital admission rate of 50 per cent. previously it was now reduced to 2 per cent.

Mr. GILMAN, who had also tried oiling on Bukit Jelutong Estate, said that, when he started, the death-rate on his estate in August, 1915, was 88 per mille, at the end of that year it came down to 69. In 1916 the death-rate was 3 per mille. This year they had not had a death yet. He had 159 coolies and only had one death, from pneumonia, during the year.

Mr. HUSON asked for more information about the method of spraying.

Mr. HARRISON explained that he employed four coolies in each division with four sprayers, with a definite programme mapped out for each. They used crude oil in 65-gallon drums which were used for liquid fuel. One ordinary kerosene oil tin filled a spraying machine. Every scrap of water in the area was oiled, in fact they even went across the road into the surrounding kampongs and oiled the wells there. (Laughter.)

Mr. JARVIS thought the experience of Midlands, where half a mile of oiling was sufficient, did not agree with the statement that in Panama anophelines would fly a mile against wind, and asked Dr. Lucy what he considered was the limit of a mosquito's operations.

Dr. LUCY replied that as to mosquitoes travelling for over half a mile, he could not say definitely, but many estates which had tried oiling found a radius of half a mile gave good results. It was not possible to lay down a hard and fast rule as to what distance anopheles travelled. In Panama experiments with painted anopheles showed that some travelled as far as 6,000 feet.

Mr. LAWFORD asked what was the safe margin around which water should be oiled?

Dr. LUCY said a great deal of enquiry was necessary before a hard-and-fast rule could be laid down. Certainly half a mile was the absolute minimum, and the further they went the better. Each case must be taken on its merits. As to the habits of mosquitoes, that was a question they knew very little about, though the anophelines preferred clear running water, and were seldom found in dirty water. It was a question which required a good deal of research, and he hoped a man would be appointed to enquire into that in the future. He had seen anophelines in the overflow from factories, but they didn't like it.

Mr. HARRISON said that he would like to know what Dr. Lucy thought about mosquito-proof lines and the leaving of ravines in blukar for the prevention of malaria.

Dr. LUCY replied that as regards mosquito-proof lines he knew of two or three estates which had attempted it. Many years ago mosquito-proof hospitals were started in Negeri Sembilan. There was not the slightest doubt that it did some good, but there was another side to the question. There was immense difficulty in

keeping the wire proofing in order as coolies threw rubbish and dirt at it and very quickly destroyed its efficiency. If they could keep a set of lines mosquito-proof, there could be no doubt as to the good results.

Experience gained in the Government hospitals and the gaols where there was a large amount of supervision showed that the cells and wards only became mosquito traps. He was, therefore, doubtful whether it was a measure that could be recommended for universal adoption.

Regarding ravines being allowed to lie in blukar, that was a means of adding to their troubles above all others. Mosquitoes multiplied a thousandfold in such places, particularly in the deep depressions caused by the footfall of man and beast, and in his opinion it was the best means of propagating mosquitoes. Dr. Strickland's idea was to allow ravines to go back into virgin jungle, and that would not happen in their time.

Mr. HENDRIE said that he could not understand how six sets of lines could accommodate 500 coolies. He also asked what was the best pump in Dr. Lucy's opinion to prevent water wastage, etc. ?

Dr. LUCY replied that as regards Mr. Hendrie's remarks about line accommodation—what he meant was rooms of 12 feet by 12 feet. As regards pumps, the old British village pump was easily procurable. Its cost was between \$150 and \$300 but it had stood for a hundred years and was yet the best principle.

Mr. PINCHING asked whether domestic pets, such as fowls, goats, etc., were detrimental to the health of the coolies. He also asked what distance lines should be away from swamps.

Dr. LUCY said as to the breeding of fowls and live stock in the cooly lines, he thought they should be absolutely excluded. As to the distance lines should be away from swamps, he could only say as far away as possible, though swamps were less harmful than ravines with a running trickle of water.

Another member stated that as about 90 per cent. of coolies from India suffered from hook worm was it not advisable to treat them when in quarantine ?

Dr. LUCY said that with regard to the treatment of hook worm in the quarantine station, the cooly already had to undergo a bewildering series of examinations, quarantine, vaccination, quinine rationing, and many such ordeals, and whether it would be wise to add hook worm treatment was a matter of doubt. About 80 per cent. of the arrivals from India suffered from hook worm. Some coolies had housed the worm for a long time and only when coming to a malarious centre was their health seriously impaired by it. The present treatment was short, but, he thought, rather

drastic, and it would not be wise to treat the coolies for hook worm in the quarantine station, but it might be done as a routine measure after their arrival on the estates.

Dr. DAY said that they had no experiments to show the real value of prophylaxis. When coolies got to hospital it was difficult to diagnose the cases. He agreed that a big hospital had advantages, such as more complete equipment, over the small hospital, but it was to be remembered that cases did not come into hospitals until they were really bad. The main question was to catch the patients early. A man who got ill would never be sent off at once to a hospital that was seven or eight miles away. He, therefore, thought that there was, after all, a good deal to be said for the small hospital.

Dr. LUCY in reply said that there was no doubt that the consensus of opinion was that where quinine prophylaxis was carried out thoroughly and systematically they not only got less malaria, but malaria was less virulent in type. He could not help thinking that quinine prophylaxis had fallen into disrepute to a great extent because quinine was not given as it should be. In nearly every case where he had gone into the question closely he found there were loopholes, a large number of coolies and dependents (including children, who were particularly dangerous) having escaped the quinine prophylaxis. As to the experiments suggested, one would like to see them carried out. But he did maintain that the consensus of opinion was in favour of continuing the quinine ration in areas of infection.

As to group hospitals, on the question of discipline Dr. Lucy did not think that an argument against them. That was a question of administration. As to coolies a distance away not being willing to go into hospital, it was not a question of coolies walking into hospital but of being sent there. That was for the manager to see to.

The CHAIRMAN (Mr. L. Lewton-Brain) concluded the proceedings by heartily thanking Dr. Lucy for his interesting paper.

MINOR ECONOMIC PRODUCTS.

VISIT TO EXPERIMENTAL PLANTATION.

WHEN a visit was paid to the Department of Agriculture on the 26th April an inspection was made of the experimental plantation and nurseries. The visitors were shown round part of the grounds by Mr. F. G. Spring (Agriculturist) who gave demonstrations on various plants of commercial value and it was evident that a keen interest was taken in respect of many of the crops. The visitors were first shown Patchouli (*Pogostemon patchouli*) and in dealing with this plant it was remarked that there was a fair demand, at present, for the dried leaf as a source of Patchouli oil. Some time was then spent in a five-acre block of four years old African oil palms (*Elæis guineensis*) just commencing to fruit. The suitability of the palm and its culture in Malaya were freely discussed. Its possibilities, as a plantation crop, were dealt with and it was remarked that large areas might be planted without affecting the market to any extent. A young rubber clearing, under terraced conditions, was viewed and the benefits derived from this system of planting, on hill land, were explained. Some interest was shown in a number of medicinal plants such as Ipecacuanha, *Croton tiglium* (croton oil), *Erythroxyton coca* (cocaine), *Cinchona ledgeriana* and *C. succirubra*, *Chenopodium*, and Papaya as a source of commercial Papain. Mr. Spring referred to the question of green manuring and dealt with *Centrosema plumieri* and the Sarawak Bean in particular. The following fibre plants were pointed out—Sisal, Manila, Mauritius and Bowstring hems. Plants yielding various commercial products such as oils, dyes and spices were inspected as well as fodder and other grasses, fruits, economic and ornamental trees and plants.

On returning to the Offices the party was shown exhibits of economic products, which were grown and prepared locally. These consisted of—Tobacco, African Oil Palm fruits and a specimen of the oil, Camphor oil, *Chenopodium* seed, Ipecacuanha root, Fibres, Patchouli, Tuba root, *Cinchona* bark, Avocado pears, Indian corn, Artichoke tubers. Seed of *Centrosema plumieri*, *Canavalia ensiformis* and Sarawak Bean (*Dolichos Hosei*) were also exhibited. A collection of photographs consisting of a large variety of crops grown on the experimental plantations was on view.

**THE FOOD-CROPS OF THE MALAY PENINSULA AND
SOME THOUGHTS ARISING OUT OF A REVIEW
OF THEM.**

BY I. H. BURKILL, M.A., F.L.S.

(*Director of Gardens, S.S.*)

According to trade statistics, the Malay Peninsula took from abroad for feeding itself in the year 1915 :

Cereals, costing	... ..	\$23,471,049
Sugar, costing	... ..	5,789,951
Bean seed, and the like, costing	... ..	1,439,278
Vegetables, costing	... ..	1,352,128
Fruits, costing	... ..	1,274,163
Condiments of native food, costing...		1,227,455

paying the bills for these out of income from rubber, copra, sago, tapioca, and pine-apples.

I intend to use the privilege of holding your attention by speaking of these foods which we buy in such large quantities from outside the Peninsula: I shall touch on cereals first, commencing with rice.

RICE.

The year 1915 saw nearly fifty-two million dollars worth of rice enter our ports, and we kept twenty millions worth to feed ourselves. It came from Rangoon, Saigon and Bangkok chiefly. That which came from Rangoon was the overflow production of a population of about one soul to an acre of paddy: it is a growing population, and it has been calculated that in fifty years it will eat up its own produce, or in less than fifty years if the accepted plan of cropping should be changed. The same growth of population is occurring in Indo-China and Siam, and will have a similar result. Java has already filled up in a wonderful way, and has greatly changed its crops, with the result that it no longer sends overseas rice in the same way as formerly. The Philippine Islands have ceased to export and import. These changes are worth thinking over; and the more one thinks the more important does rice growing appear to be in the Malay Peninsula.

Rice, unfortunately, pays comparatively poorly: so that officers charged with the duty of insuring its extension are confronted with great difficulties. Rice cultivation in the East is, at it were, the handmaid of all other cultivation—without rice the others could not exist—and it is paid in the manner of handmaids.

I propose to pass quickly along the ends of the avenues leading from the present position to greater profits, but merely glancing down them.

Rice is, on the whole, the more uncertain in its return the less the area grown: and being a crop of small cultivators there is a need of securing co-operation in working the larger areas. The great plains of Lower Bengal have been worked for rice for ages and carry such a population that the produce is only exported in the years when the yield is considerable. In the course of time these plains have acquired a peculiar flora and a peculiar fauna, in response to the annual submerging of the surface of the land, which keeps out the dry-land weeds of more than ephemeral duration, and excludes by rendering homeless all ground-nesting animals or insects which pass one stage of their life underground. Thus it has come about that these Bengal plains are relatively without rats, and when plague established itself in Calcutta the villages long enjoyed immunity on account of their isolation. As they are relatively without rats, so are they relatively without some other pests which are known to do great damage here. The long ages of cultivation, its persistence and its completeness have thus wrought changes favourable to the crop in its relationship to other life. Rats in Malaya are possibly the worst pests of small areas of rice, and birds next: after them come insects. As regards birds it is obvious that the more cleared the land the freer it may be; and the same also in respect of elephants and wild pigs: so that the wide co-operative area in a large way escapes these.

Co-operation is wanted for irrigation.

It is most interesting to observe with the eye of an ethnologist how in Malaya this needed co-operation has been obtained—how in Java, for instance, much of the land is held by the village collectively and parcelled out annually for rice-growing: how in the Malay Peninsula religious ceremonies have been adopted as a means of bringing the owners to work collectively. The fumigation of the seed with benzoin, and the prayers in the mosque, and all the poetry gathered about the soul of the rice is an equivalent for the prosaic scrap of paper on which a District Officer is empowered to write thou shalt repair thy runnels on this date and plant thy paddy on that. Whatever our feelings may be in regard to the liberty of the subject, I anticipate that no one will wish to contest the argument that the sawah is an unit, and that it is wise to coerce the cultivators of it just as they have been coerced in the past; because the State is the better off for the complete cultivation of any area of rice land.

The next matter is the extension of the rice lands.

Rice cultivation, bendang or wet rice cultivation and not ladang or dry rice cultivation, has established for itself two vigorous centres in the Peninsula, the one in the north, the other in the neighbourhood of Malacca. To the north it came as an extension only. Great and wonderfully settled kingdoms once existed from the Bay of Bengal to the China Sea across the belt of land from Rangoon to

Saigon: they were very populous before their prosperity invited attack from the north, and before the restless centuries came when Shan, Burman and Siamese wasted each other's lands and carried off wholesale each other's subjects, not for domestic slavery but to maintain their own wasted fields. The Kedah rice fields were the southern fringe of the cultivation of these kingdoms. On the other hand, the Malacca rice lands came to be what they are out of an overflow from Palembang or Menangkabau in Sumatra, when "the egrets on flapping wings" crossed the Straits to set up colonies on a coast which undulated like their own home. Both extensions invited European establishments in turn, Malacca first when the Portuguese found trade possible and profitable, and the Kedah area next, when Francis Light after living in it, built up the settlement of Penang upon its edge, well chosen and not foodless like the decaying settlement of Bencoolen.

There was something in the success of Malacca and Penang which might have read a lesson thirty years ago in the opening up of the Federated Malay States, to those who tried very earnestly to settle small colonies of rice growers in various places. So many of these colonies perished from their smallness. It had been easier then to have built on to the edge of that which existed: and it appears easier now to work at the extension of the Krian rice area than to dissipate efforts in diverse directions. I look upon Krian as the area for results in rice. But turning to Malacca, it must be noticed how limited, there, is the field for expansion, and that the problem is the maintenance of the sawahs and the getting of the landholders to rise to overriding those disadvantages to which they have been put by the washing of silt from the cleared uplands on to the paddy land.

Although rice grows in water, soil aëration is most important to it. Stagnant water is very inimical. There needs to be a movement over the surface; and there must be a movement through the soil. The best rice land is particularly open in texture. It is the practice to grow in the Peninsula one rice crop only in the year and to let the weeds riot on the land during the rest of the twelve months. When sowing time is coming round these weeds are ploughed in and make valuable green manure. Such a practice is by no means confined to the Peninsula but is very wide spread where rice is grown: its working has been studied particularly in Southern India, and it has been found what an important additional part the ploughed-in weeds play in the aëration of the soil. Down that avenue which points to greater profit from paddy by taking a crop from off the land in the fallow we may only look, bearing in mind the need of the fields of this green manuring which the second crop would disturb.

There are various places in the East where a second rice crop is grown in the fallow time, a quicker growing and less profitable

rice than the main crop; and in Java, where for one place this is done, the embankments are peeled of their turf that it may be thrown under the plough, or in Travancore, branch-wood is collected for the same purpose, or in Japan, special crops of the *Leguminosæ* are raised, all of which practices point unmistakably to the need of the green manure which weeds give in this Peninsula. In Travancore the system of cutting branch-wood became a danger to the State, for the hills were being completely denuded; and control had to be enforced. Under control it would be possible to permit it in Malaya.

Two rice crops per annum means the broadcasting of one: and broadcasting is very inferior to transplanting. Transplanting of rice, twice repeated, is even beneficial, just as it is to some of our garden annuals. But the second rice crop must forego the transplanting; and it is also the less profitable on account of the larger amount of seed that has to be used.

Crops, other than rice, which are used in the place of the fallow are, in Java, generally beans, chillies, ground-nuts, sweet potatoes yam-beans and yams: and each gives a certain amount of stems useful for green manure. More rarely do the Javanese plant maize, sorghum or the smaller millets. Maize is used as a rotation crop in the Philippine Islands. Trials of some of these might be made in the Malay Peninsula, demonstration following success; but to bring about any general use seems most unlikely.

The American farmer cheapens his rice crop by the extensive use of machinery, both for sowing and for reaping: and he is forced to avoid the valuable transplanting. He has firm subsoil which carries the machinery and moreover he is protected by tariffs.

All through the East scientific officers are investigating the races of rice for their Governments, seeking for the most profitable, and finding out the conditions demanded by them. But the work to be done is enormous. There is an Indian proverb which says that of the races of rice and of Rajputs there is no end. And Nature appears to intend to have none: for she crosses rices grown intermixed to a small extent. Miller's machinery, however, demands large uniform grain; and as the mill is by so much a more economical institution than domestic husking, so it is to be encouraged: and the growing of few races within the area served by a mill becomes desirable. We have before us then the harmonising of the two needs, the grower's of a prolific return, and the miller's of a suitable grain. I do not know whether we have two hundred or three hundred races of rice within our borders,—we certainly have many; but I am sure of this that the Malay's methods of cultivation are not consistent enough to tell us which of the races known to him are the best: so that I think we have his races to test, as well as the larger number that might be brought in from outside.

The Malay has a sound practice of taking his seed-rice from the best part of the field: but scientific selection by pure-line cultures would do much more for the crops.

I have brought into view selection last: and I think that in point of time it comes last as a means of improving the prospect on growing rice. I think, but I may be wrong, that the first results should come from the work of the agricultural engineer, and administrative measures taken to ensure protection against pests, not animals only directly injurious but the worse evil—loss of plough-cattle by disease. As to the work of the agricultural engineer, I should like to refer to that practice in Java, whereby rice land is let out for sugar growing, not to recommend its use here, but to call attention to the improved irrigation and working of the soil which the sugar mills apply to their crop and which exercises a beneficial influence upon the rice crop following the cane.

In the Philippine Islands the knot of rice improvement has been cut by tariff protection.

MAIZE.

Maize appears to demand the place of second cereal for the Malay Peninsula: and a good sign for its adoption here is that its area has had considerable extension lately in Java, where it has become an article of export. Before maize reached Africa, sorghum was the staple crop of the south, the bulrush-millet that of the sub-tropics, and ragi that of the tropics themselves. Maize has shown a tendency to oust them all. It does not show the same tendency to oust rice, where that crop predominates, and I think the reason of this to be that the housewife must cook maize for twice as long as rice; and where she is used to boiling rice, given maize, she makes the household ill from serving up half cooked porridge. When maize shall assert itself in India, it will be by spreading down from the hills of the poor tribes who eat millet or from the wheat-eating north-west. If its use can be spread in the Malay Peninsula, it might be forwarded through the planters encouraging it.

Maize is a very wide-spread crop, and gives races suitable to quite dissimilar climatic conditions. The races fall into groups, of which the sugar-maizes are the most toothsome and are used as a vegetable: the flint-maizes are good for storing, and the soft maizes are not. Various races have been introduced from time to time into the Peninsula and lost sight of again, because the market did not exist for them: the two or three which we have left, persist as garden plants. It is hard to find what races have been tried.

The crop is not on the ground for long. Some races take only two and a half months to mature, others take three, and up to or beyond four months. With a crop of such short duration, it is not difficult to find a season, having the last month relatively dry,

wherein it might be raised. Maize likes a good soil, but it does not remove much from it; and it permits cultivation to be continued while it is growing.

RAGI.

The third cereal for Malaya is perhaps ragi—*Eleusine coracana*: but after rice and maize none is worth much consideration.

Ragi is grown in India on poor lands, and in the Himalaya largely fulfils the function of furnishing beer. Elsewhere in dry seasons and over dry areas the quantity grown increases, a fact which speaks against a wide use of it here. It is on the ground for six months.

SORGHUM.

Sorghum holds in India a very much higher place than ragi, but for areas where there is no forest; and in them at harvest-time the air resounds with the din of boys acting as scarecrows, or the incautions passer-by may find himself bombarded with clay pellets intended for the flocks of small birds which demand such a large toll out of the crops. In forested areas sorghum is rarely grown and then in the less productive feathery paniced races in small quantity.

The smaller millets would only be grown here by Sakais and the like.

SUGAR.

The second group of food-stuffs on which the Peninsula pays so greatly is sugar. But sugar-making has unfortunately recently died out for economic reasons, and it cannot be made to pay until labour is again cheaper.

It is believed that there were Chinese cultivating sugar-cane in the area, now Province Wellesley, before the founding of the Settlement of Penang. And it is recorded that in 1800 labour had become too expensive for it to pay. Then again the situation improved and in 1836 there were Chinese in the Province who, on quite a considerable scale, made sugar either black or clayed according to the state of the market which they watched very closely. From Province Wellesley the industry spread into Krian: but it never really developed so as to send its produce beyond the local markets. And after one big effort at working with the best of machinery sugar making died out.

The modern sugar industry is a wonderfully developed one: efficiency to the last degree is needed: big central factories pay best because of the economy in working: every advantage has to be sought for: the cane must come to hand in steady and adequate supplies, and the by-products must find a sale. Then again very much of the sugar produced comes to the market with tariff protection or artificial aid: and from all this I do not see any way of reducing the sugar bill of the Peninsula. That cane which is grown for eating seems eminently suited for the purpose, and the introduction of new races is hardly called for at the moment.

PEAS AND BEANS.

I pass to the third group of food-stuffs, namely, bean-seeds and the like.

Rice-eaters cannot live on rice alone and always seek some food which provides them with nitrogenous substances. Most of them seek fish: but where the caste system forbids fish too sternly and beans are procurable, beans are used. It is very interesting to observe the schism among the Brahmins of India whereby those of Bengal, beans apparently not having been easily procurable, have permitted themselves fish to save the race: and there are Brahmins also in Kanara who have gone the same way. The Burmese in a corresponding dilemma have developed a plea that he who takes the life pays the penalty, but he who eats the fish is blameless. The Malay free from the trammels of Buddhism or Brahminism, balances his diet with fish. But failing fish or some sort of flesh, beans are almost a necessity, and the demand of the Peninsula for them will always be great. - We get them from the side of India and we get them from the side of China. We produce none.

One of the chief reasons why we do not raise any, and I think the chief reason, is that bean crops are the produce of a more advanced condition of agriculture than ours. Further it is certainly to the Malay a more congenial occupation to fish than to till his rice land for a second crop.

Peas and beans are always rotational crops, sometimes of a more complicated rotation, but generally merely alternating with rice. Where they fall in the system depends on the climate. Thus in Assam they are sown on the last rain of the wet season to be watered afterwards by dew and an occasional storm. In drier places they occupy the land in the rainy season. Here they would take the place of the rice land fallow, as in Assam and as in Java; but they could also be a subordinate crop to maize, at another season.

The chief of the bean crops of Java is the soy bean—*Glycine soja*. It returns, at 3-4 months, it is said, more or less 3,200 lbs. per acre, which is more than the Manchurian soy bean usually yields in Northern China. Let it be remembered that there is considerable difference between the flat-seeded Java plant and the round-seeded Manchurian plant: and that the unsatisfactory results of experiments in the Malay Peninsula with Manchurian seed in no degree prove the Javanese plant not worth growing.

Java, second to *Glycine*, grows in rice land various species of *Phaseolus*, notably *Phaseolus radiatus*, the Mung of India, *P. vulgaris*, the French bean, and *P. lunatus*, the Lima bean: also there are others. We know that we can grow these horticulturally in the Peninsula: and though I have no knowledge of any agricultural experiments, it is quite probable that success might attend them.

Success might also attend the growing of *Phaseolus calcaratus*, *P. Mungo* and perhaps *P. aconitifolius*, all common in India, as well as the Japanese *P. angularis*.

I anticipate no success with the chick pea, *Cicer arietinum*, and the lentil, *Lens esculenta*; as they favour a drier climate, and are only to be found in Java at considerable elevations. The Field pea, *Pisum arvense*, also, for our plains is out of the question.

Ground-nut cultivation has latterly been a source of large profits on the sandy river banks of Burma. But it is grown for oil and not for eating, for which purpose there are distinct varieties differing much in the chemical composition of the seed: and I prefer to consider the ground-nut as an oil seed, and not as a food.

Voandzeia, the Bambarra ground-nut, is more ideally a food crop, but it is of doubtful importance.

Vigna catieng and *Cajanus indicus* both grow well here, and are used as vegetables: but they furnish abroad seeds for eating. The latter yields for three years if it be appropriately cut back; so that it is not a crop like the other beans and will not take a place in alternation with rice. *Vigna catieng*, under the name of cow-pea, takes a very important place in the agriculture of the United States where the climate is not suited for clover; but it is not grown there for the seed, but for stock feeding and for green manure. Collection of the seed-harvest is laborious as it has to be done by hand daily; and it is never large.

Two other leguminous crops may be mentioned, namely, *Canavalia*, the sword bean, and *Mucuna* or *Stizolobium*, the velvet bean. Sword beans are eaten somewhat extensively in Mysore and some parts of the Bombay Presidency, and are grown a little in the Malay Peninsula. The seeds are quite wholesome, but the pod is generally consumed here unripe.

CONDIMENTS.

I turn to condiments of native food. They are the last group of the food-stuffs for which I gave you trade returns: but I take them next as they are in such a large measure sold dried, and therefore like cereals and beans travel easily and are stored. I consider under the head of condiments such foods as onions, garlic, chillies, giuger and cardamoms, which are in general use for flavouring and mixing with the more bulky substances that make up native food.

Onions can be grown in the Malay Peninsula, but perhaps not commercially, as the damp climate is unsuited for the arrest of leaf growth and the formation of a bulb. A few trials with them are recorded but no attempt has ever been made to ascertain exactly what can be done by seeking out the races (they exist) which do best under damp tropical conditions. Onions are grown

at quite low elevations in Java, and quite widely through India near towns: but it will be admitted that the drier north and north-west of that country is better for them than the south. However, I would remind you that an onion industry has spread downwards into the West Indies from the north, by the choice of races appropriate to the climate.

Garlic is more suited to the climate of the Malay Peninsula than the onion: and considering how large are our importations, experiment with it is desirable.

Chillies can and should be grown extensively through the Peninsula. They can be raised easily and fruit from the age of four months forward. Rain may cause some injury to the fruits by encouraging the growth of a fungus and perhaps also by encouraging the attack of the little fruit fly. Chillie drying is never to my knowledge resorted to in the Peninsula.

Ginger cultivation is, I am glad to say, extending in Malacca, where the climate is particularly suitable to it. The cultivators are Chinese, who sell their produce green for distribution through the country round. They grow it in ridges, in the accepted way: and it is on the ground 8-9 months. What their yield is, I do not know, but it should be 4,000 lbs. per acre. The Javanese grow ginger for the supply of that island.

Cardamoms can equally well be grown: not the greater cardamom—*Amomum subulatum*—but the lesser cardamom—*Elettaria cardamomum*. It was grown in the Botanic Gardens, Singapore, in 1875, with the idea of turning it into a crop and it is known to have fruited. It is cultivated in two varieties in Java. It requires rich soil and the proper place for it would be stream banks at the foot of hills. Twenty years ago the planters of Ceylon took up its cultivation for export and soon flooded the limited market. It is not for export that I suggest it, but to cancel our import.

The Curcumas, *C. longa*, Turmeric, and *C. Zeodaria*, Zeodary, can be grown in the Peninsula without difficulty to the complete meeting of the local demand. The first requires a little care, but the second is absolutely at home. They require similar treatment to ginger.

The tamarind fruits most unsatisfactorily in the south of the Peninsula; and as to the north I have no data. But in Java it fruits; and a supply is available for export. As it is quite a good roadside tree, it might be so planted with the chance of it being also remunerative by fruiting.

VEGETABLES.

Vegetables may be divided roughly into greens and roots, with this important difference that greens will not travel as a rule and roots will. In consequence of the ability of roots to travel

we obtain a supply of them from overseas more easily than we obtain a supply of greens: and therefore we are in a measure with something corresponding to tariff protection spread over the latter.

Foremost of roots is the potato, a truly great plant, which originated in the Andes of South America, and was only spread thence by the help of European voyagers because they were the first travellers from its temperate home who crossed the too hot tropics to other suitable temperate parts of the world. I have spoken of the difficulty of arousing an interest in maize as being in the cooking. The potato, despite its excellence, suffered on its arrival in Europe from the same disadvantage of unfamiliarity: and it was a century and a half before it really displaced the wheat dumplings which were the accompaniment to flesh when it first crossed the Atlantic. After a time it was brought out to India, and in the north grown as a cold weather crop, or in the hills in summer where it now extends to 9,000 feet. It penetrated, at some date unknown to me, to Java; and it is grown now at 5,000 to 7,200 feet. It is in the Philippine Islands, and has become a very important article of food among the mountain tribes of Luzon: but it cannot be grown satisfactorily at low elevations and particularly in the Southern Islands: so that at 3,000 feet in Mindanao the State has thought it desirable to make an attempt to raise enough for the European population.

The races of potato in the East are several and they ripen some in as little as 80 days and others in as long as 150 days.

But even taking the quickest there appears to be no reasonable hope of raising crops in the plains of Malaya, so that, as in Java, the places from whence we could provide ourselves are on our hills: and there would appear to be no difficulty in finding areas near markets quite suitable. In 1896 a 70-day race was raised in Penang, but was diseased. Excellent potatoes have been raised above Taiping.

For the lowlands there are available several substitutes for the potato—*e.g.*, the greater yam, *Dioscorea alata*, the African yams, the tapioca plant, the taro, *Alocasia*, *Colocasia*, *Amorphophallus* and the yautias (*Xanthosoma* spp.). Most of them yield more heavily than the potato, but they are on the ground for a much longer time. The outturn of potatoes at five to six months in England is about 8,000 lbs. per acre, and in a few extremely favoured localities up to 13,000 lbs. The outturn of *Colocasia* after as long a period is about 6,400 lbs., of *Alocasia* somewhat more, of *Amorphophallus* 8,000-16,000, of the *Dioscoreas* in nine to ten months 20,000 lbs., and of tapioca up to 25,000 lbs.; but the period of tapioca may run to over a year.

The Malays eat a good deal of tapioca, and grow it for the purpose, so that the cultivation needs no advertising and the Peninsula takes no imports. But I mention the plant here because, to the best of my knowledge, the trial of only a very few of the very

numerous existing races has been undertaken. Generally, through the East are 2-4 races: but Travancore is said to have as many as 20, and there are 40-50 in Brazil, with a still greater variety in the mountain-valleys of Colombia. In 1886 and 1889 several were introduced into the Botanic Gardens, Singapore, but what became of them is not to be ascertained.

Many people, by confused thinking, blame the tapioca plant for the lalang wastes, instead of the system of land tenure which led to them. Tapioca has done right well for this country: and it is such a robust plant, that exhaustion of the soil must follow heavy cropping with it. Praise it for its robustness and protect the land for future generations.

Colocasia antiquorum is quite a widely grown crop: it is a very important crop so near Europe as Madeira. It is also wild in the East: and from the inedible wild plant there runs a fairly complete series of transitions to the edible cultivated plant, of which there are several races, some specially suited for making into puddings, others used as bread is used, and others boiled as a vegetable. The Chinese call it *Yu* and rely very largely on it in their own country. The natives of India also use it freely. Therefore if produced here, it should hold a place in the market.

Alocasia indica is used through India like *Colocasia*: it is cultivated sparingly in the Malay Peninsula, and apparently, rather more so in Java. *Alocasia macrorrhiza* is like a large edition of the last, more truly tropical in the climate which it prefers, and so a little more cultivated in these parts than *A. indica*.

The *Xanthosomas* are American plants, not yet used as crops in the East, though promising as far as their garden cultivation goes. There are three well known—*Xanthosoma sagittifolium*, *X. atropurpureum*, and *X. violaceum*. The Bureau of Agriculture of the Philippine Islands is experimenting with them.

Amorphophallus campanulatus, the elephant's foot yam, furnishes a food largely used in India, but not in the Malay Peninsula. An ally, *A. Konjac*, is cultivated by the Chinese in their own country.

On *Dioscoreas* I have been busy experimenting for some time. I know that I have got better races than those which appear in the local markets. I know that they are easy to grow. But as with maize, cooking is the local obstacle to their general adoption.

The Jerusalem artichoke can be raised easily in the Malay Peninsula, but not with full vigour in the plains. Cantley used a good expression as regards onion cultivation which applies to the artichoke too, namely, "it is more or less worth cultivating."

Radishes develop too much pungency in the plains just as their relatives the rapes do in India. Carrots have been made to produce fleshy roots in the plains, but never to produce excellent ones. Beetroot has been got to do fairly well.

All the last four, the artichoke, the salad onion, the carrot and the beet, might be produced commercially on hills that are near to some of the larger markets. The true spinach and that excellent little cucurbit the cho-cho, might also be produced payingly in the same places. Endive could be grown too.

In the genus *Brassica*, the Chinese cabbage is the only one really suited to the plains: but it is inferior to the European members, of which the cabbage, the brussels sprout, the knol-kohl, the turnip and the kohlrabi appear likely plants for the hills only. But mustard and cress might be grown anywhere if the hills could produce the needed seed.

There is no difficulty in raising lettuce, and watercress.

Tropical spinaches are easily found: and one, *Basella alba*, might very well be common in estate gardens. *Amarants* can also be raised easily for spinach, and are better than the kangkong (*Ipomoea aquatica*) which the Chinese cooks serve up. Beet leaves can also be used for spinach; and there is a Javanese spinach, *Talinum verticillatum*, which is not used in the Malay Peninsula.

I pass to those vegetables, which are at the same time fruits.

Peas cannot be expected to succeed on the plains, but do well in the hills. There, and in the plains as well, French beans can be raised. But better for the climate of the plains are *Dolichos lablab*, *Vigna catieng*, *Cajanus indicus*, and *Psophocarpus tetragonolobus*. The last named, I consider, at its right age, a most excellent vegetable. The first named, in one of its best races, is a table vegetable in France: but its worst races are, about maturity, dangerous.

Of Cucurbits, I believe that all the following can be grown if means be devised to protect the fruit from the little fruit flies, *Benincasa cerifera*, the wax gourd; *Cucumis sativus*, the cucumber, *Cucurbita melo*, the melon; *Cucurbita pepo*, the pumpkin; *Cucurbita maxima*, the gourd; *Cucurbita moschata*, the musk melon; *Citrullus vulgaris*, the water melon; *Luffa acutangula*, the loufah; *Momordica charantia*; *Lagenaria vulgaris*, the calabash; and *Trichosanthes anguina*, the snake-gourd. The Chinese raise some in paper bags and those generally of inferior races with firm skins. Just as the papaya protects its fruits by a milky juice, so may it be possible to prevent the attacks of the fruit fly by chemical means.

The tomato and the brinjal can be so readily grown that no more need be said of them.

Vegetables repay rich soil so well that the chief problem in regard to them is manure. Near our larger towns every hollow of good earth is likely to be given over to them, and a better use there could not be. Pig fattening brings a certain supply of manure to the market gardeners who till them: but manures generally are here costly: so that a limit is put to our supplies by reason of the difficulty of getting, and maintaining when got, the fertile soil

required. The difficulty is greater in the hills but I believe something could there be done on a small scale by means of branch-wood manuring.

FRUITS.

The treatment of fruit in the Malay Peninsula is disappointing. Formerly when the plantations were fewer and isolation was greater, the owners found time to plant fruit trees near their houses: but until again quite newly there has been none of this done. In the towns men come and men go, having acquired no more knowledge of the fruits of the land than another alien—their Chinese cook—imparts with a spice of his own interest. Fruit growing is, I think, far behind what it should be.

The typical fruit of the country is the durian, borne on a tree of forest size and armed against bats, birds and squirrels. Its counterpart of the Amazon forest is the Brazil-nut, alike borne on a big tree and heavily armoured. The durian can take care of itself: nor does it need encouraging in the way that many other less gross fruits do.

The fruits suitable to the Peninsula are so many that I cannot give time to them severally: I propose instead to give a list of them, both those for the native and the European customer, and then to end with remarks on a very few. I shall divide the list by the size of the plant that bears the fruits.

(i) Trees of some size—

- Aegle marmelos*, the bel;
- Artocarpus incisa*, the bread-fruit or sukun;
- Artocarpus integrifolia*, the jack;
- Artocarpus gomeziana*, the tampang;
- Artocarpus lakoocha*, the tampang manis;
- Artocarpus polyphemia*, the chempedak;
- Baccaurea molleyana*, the rambai;
- Baccaurea parviflora*, the setambon;
- Baccaurea malayana*, the tampoi;
- Bertholletia excelsa*, the Brazil-nut;
- Canarium commune*, the kenari;
- Diospyros mabola*, the mabolo;
- Eugenia aquea*, the jambu ayer;
- Eugenia brasiliensis*, the Brazil cherry;
- Eugenia malaccensis*, the jambu bol;
- Mangifera foetida*, the bachang;
- Mangifera indica*, the mango;
- Mangifera odorata*, the kuwini;
- Nephelium lappaceum*, the rambutan;
- Nephelium malaiense*, the mata kuching;
- Nephelium mutabile*, the pulasan;
- Sandoricum indicum*, sentol;
- Sandoricum radiatum*, the kechapi;
- Terminalia catappa*, the Bengal almond.

(ii) Lesser trees—

- Achras sapota*, the chiku ;
- Anacardium occidentale*, the Cashew-nut ;
- Anona muricata*, the soursop ;
- Anona reticulata*, the custard-apple ;
- *Anona squamosa*, the sugar-apple ;
- Averrhoa bilimbi*, the blimbing ;
- Averrhoa carambola*, the carambol ;
- Bouea macrophylla*, the kundangan ;
- Bouea microphylla*, the ruminiya ;
- Carissa carandas*, the carounda ;
- Citrus aurantium*, the orange ;
- Citrus acida*, the lime ;
- Citrus decumana*, the pomelo ;
- Citrus medica*, the citron ;
- Citrus limonum*, the lemon ;
- Eugenia uniflora*, the pitangi ;
- Ficus carica*, the fig ;
- Garcinia mangostana*, the mangosteen ;
- Lansium domesticum*, the duku ;
- Psidium gujava*, the guava ;
- Psidium acre*, the little guava ;
- Persea gratissima*, the avocado pear ;
- Spondias dulcis*, the Otaheiti apple ;
- Spondias mangifera*, the hog plum ;
- Vitis vinifera*, the grape ;
- Zalacca edulis*, the buah salak ;
- Ziziphus jujuba*, the jujube.

(iii) Large sub-herbaceous plants—

- Carica papaya*, the papaya ;
- Cyphomandra betacea*, the tree tomato ;
- Musa* spp., the plantain.

(iv) Climbers—

- Passiflora edulis*, the passion fruit ;
- Passiflora laurifolia*, the buah susu ;
- Passiflora quadrangularis*, the grenadilla.

(v) Herbs—

- Ananassa sativa*, the pineapple ;
- Hibiscus sabdariffa*, the rozelle.

The list includes dessert and stewing fruits. It includes two plants suitable only for the hills, *Cyphomandra betacea*, the tree tomato, and *Passiflora edulis*, the passion fruit.

It includes a few plants which cannot be produced commercially, notably the grape and the fig, but which can be grown as toys with care. It includes several trees which are suited to places such as Malacca and Kedah, but not to Singapore, and probably not to Selangor. Out of the complete list some which are little

grown, but particularly recommendable, are the carounda, the carambol, the ruginiyya and the rozelle—all for stewing, and the Brazil nut, Brazil cherry and Avocado pear for eating. Of many of the trees, there are far better races than those commonly grown, the rambutan is a case in point, and so is the duku. Selection work on these is in hand at Singapore. The mabolo is worth planting: but it is to be remembered that many trees are male only.

For our horticultural establishments, lines of work of much promise appear in the improvement of the fruits of the genus *Citrus* and the genus *Anona*. It is desirable to experiment with stocks and grafting: it is desirable to establish in the Peninsula recognized races from grafted stock, a line of work hardly touched as yet. The men able to help in this are pre-eminently the planters.

CONCLUDING REMARKS.

My paper has been, of necessity, somewhat discursive; and therefore, in concluding it, I shall draw a few thoughts together in order to give them prominence.

This country is a new one: and the newness brings disadvantages as well as advantages. Compared with India it is, as I once heard an eminent American scientist say, as fresh air to an overpopulated house which wants airing. Though a house be overpopulated, it is at any rate with the necessities of population in it. The variety of produce in India comes from the long time that it has been lived in, and the consequent artificial surroundings, the most obvious of which is that field has been joined to field, and the woodland cleared. It is generally accepted that this means a change of climate, which makes the ripening of crops somewhat easier: from which comes the deduction that without our forests, without our light airs and frequent precipitations, many of the crops of India and many fruits would perfect themselves better than now. But that gain would, I think, involve a loss of considerable magnitude. Consider the whole world; and you find in it less land surface with the moist calm air which rules here, than with the alternation of dry and wet seasons. Should we then wish to enter the hurly-burly of the heavier competition?—not if there are enough paying crops suited to the rarer condition. Our best, rubber, is one such; tapioca is another, and more could be quoted. I believe at present, that the interest of the whole Peninsula lies in guarding the climate jealously: and for that purpose our mountain forests are essential. We do not want extensive planting over them as in Ceylon, nor the clearing of them by grazing as on so many of the Indian mountains, nor the wanton wandering cultivation that has made the grass lands of tropical Africa. But for our own food supply it would be quite well to anticipate a certain amount of production upon them; and it is not waste to experiment with European vegetable production in hill-gardens.

As to production on the plains, rice demands first attention, not only as the most important, but because successful rice growing draws other crops after it as members of rotations. For its increase, the north of the Peninsula appears to be the region of results. And towards such an end State aid as regards irrigation and pest suppression appears justified.

For fruit culture, Malacca has always appeared to me one place where good might come of efforts expended. The country side there is nearly full; an approach to Indian conditions is being realized: there is already an export trade: roads, if not for joy rides, are abundant and transport backwards and forwards is easy from all parts.

The vegetable proposition hangs too much on the need of good soil, manure and near markets, to admit of particular localization. It is for all parts of the Peninsula.

To reduce our bill for condiments appears a little more difficult: and to reduce that for sugar impossible.

FOOD-STUFFS IN MALAYA.

By F. G. SPRING, N.D.A., F.L.S.

(*Agriculturist, F.M.S.*)

THIS paper is written with one object and that is to endeavour to stimulate interest generally in connection with the growing of food-stuffs in Malaya. There are very large areas in cultivation, here, but the part devoted to food supply is, in comparison, almost conspicuous by its absence. The European planter does not appear to have seriously considered the growing of such crops and it is evident that the Eastern races have, to some extent, ceased to practise what was, but a few years ago, their livelihood. It is surprising how few residents take an interest, in the subject, even as far as a vegetable garden is concerned and food production on estates, to a minor or any extent, for one's own labour force is, I believe, unknown. The cooly is not the one to further the growing of such crops. He may have his small plot of land but further than that he cannot be expected to go. The smallholder, particularly the padi planter, is the main support of what food materials are produced in this country and it is desirable that he should receive every encouragement. The larger planter has often opportunities of growing quite a variety of crops which would be of general benefit. Young rubber and coconut clearings, in the early stages of development are suited, in some cases, for the growing of food-yielding crops of short duration. I am fairly confident that a new clearing can support one or perhaps more annual crops, which take a matter of a few months to mature, without, to any appreciable extent, injurious results to the permanent crop. The culture and tillage required for the reception of a temporary crop, in many cases the primary tillage of the land, would I believe, compensate for the chemical constituents removed from the soil. In addition to this, the refuse material will, on application to the land, improve the mechanical condition of the soil which is of great importance, particularly in the tropics. I do not wish it to be understood that I favour the continued removal of one or a rotation of intercrops but I do think that short lived catch-crops might with advantage be grown, for a time, on first class land which is free, or comparatively so, from timber.

Many uncultivated pieces of land in, or adjoining estate areas might be profitably utilized for the growing of food-yielding plants of a more permanent nature.

The labour required for the proper culture of such crops is perhaps the most serious obstacle, for estates do not generally have a superfluous stock of coolies. Annual crops of this nature require more cultivation than is usual with rubber and coconut plantations. A good deal of supervision, particularly during the planting and harvesting seasons, is necessary.

The writer is well aware that this branch of agriculture is not attractive to planters as a class, but this is, in all probability, due to the all absorbing interest of rubber cultivation rather than to the knowledge gained from practical experience, as to the possibilities of such crops.

I now propose to deal briefly with a number of food-producing plants which can be recommended if immediate production of food-stuffs is required.

MAIZE.

This cereal is of great value as an article of human food. The ripe grain is used for the production of flour and meal. The green cobs form an excellent vegetable. In rubber or coconut clearings, not exceeding two years old, I see no special objection to the cultivation of this cereal. Hickory King and a red grained Malay variety have given fairly good results here, but I do not think it can be expected that our yields will equal that of India or Ceylon. Maize requires moderately rich soils and may be grown two or three successive seasons on the same plot. In this country it probably does best in land recently brought under cultivation which has a good proportion of humus in the soil and is friable in nature. Poor soils, stiff clays and sour lands are undesirable. A thorough preparation of the land is considered essential for the production of large maize crops but with virgin land, as it would be mostly grown on here, this is not so necessary, at least for the first few crops. The land may be changkollled or forked to a depth of a few inches and the seed sown broadcast, after rain, on a well prepared surface, at the rate of 10 to 15 lbs. per acre, as a sole crop, and lightly turned under; a fine surface tilth is of primary importance. The seed may also be dibbled in at distances of 6 inches in rows which are 3 feet apart and thinned out, when the plants are well established, to 12 inches in the row. Surface weeding is continued and care taken not to disturb or break off any of the roots. Weeding might be done, during the time the crop is on the land, slightly deeper than is usual, in order to retard soil evaporation. The crop takes three to six months to mature depending on the variety and the conditions under which it is grown. If the cobs are required as a vegetable they are pulled while green, otherwise the cobs are left until the leaves surrounding them become shrivelled. Proper drying and storage of the freshly harvested crop are of very great importance as the seeds are most liable to weevil attacks.

In several respects maize lends itself as a catch-crop. In the first place it is an annual, which occupies the land for a few months only, and this is an important attribute as an intercrop with young rubber. It is possible to continue the ordinary estate weeding and permits of periodic deep cultivation if required. The remaining stubble when changkollled into the land would improve considerably

the mechanical condition of both light and heavy soils and this combined with the improved tilth should compensate for the material removed in one or two harvests. This would apply to other cereal crops but not to the same extent with root crops. The growing of this cereal, or others mentioned below, might be seriously considered by those who have the necessary requirements for their proper culture. I might add that the Department of Agriculture will be pleased to assist as regards procuring of seed and advice as to planting.

RICE.

I do not propose to deal with this cereal as its importance in Malaya is well known but I would like to mention that hill padi and other native food crops, such as millet, Job's tears, etc., open up more possibilities than has hitherto been supposed.

JOB'S TEARS.

Thrives well in this country and is cultivated to some extent by the Malays. The grain of the cultivated variety is said to be sweet and wholesome and amenable to ordinary methods of milling. Certain forms of the grain are roasted, then husked and eaten whole and used to some extent as a substitute for rice.

MILLET.

A fairly good crop from a small area of the common millet was harvested at the Kuala Lumpur Government Plantation. The seed is sown broadcast on prepared land and lightly covered. The crop takes about four months to mature. The grain is considered digestible and nutritious and is eaten whole, being cooked like rice.

GROUND-NUTS.

The Spanish pea-nut, small Japanese, Senegal, Mozambique and Tambo ground-nuts have been experimented with at the Kuala Lumpur Government Plantation at different times with varying degrees of success. The time of sowing and harvesting are most important factors as regards yields. Planting must be done during a wet period but at such a time that the plants reach maturity in the dry season. I may safely say that a good yield will not be obtained should the crop be lifted during the wet season, the seed at such a time is not fully ripened and most subject to rot. Harvesting in dry weather is essential. Previous to sowing, the land requires to be lightly forked or chankolled, but not too deep, as the nuts would then be liable to be formed at a greater depth and thus increase the cost of lifting. The nuts are shelled and the seed sown at distances of 18 inches apart each way. Personally I favour planting on ridges as I think a more reliable and constant crop is obtained than on the flat, the nuts are not so liable to rot and the cost of lifting is less. Little after-cultivation is necessary beyond surface weeding but this must be carefully done, so as not to interfere with the nuts which

are developed at a small depth under the soil. Three to five months, according to variety and nature of soil, are required to produce a crop. A light friable soil is best suited. The nuts are collected when the leaves begin to wither. If the seed is to be kept for any length of time it must be well dried in the sun before being stored. The Bambara ground-nut, the fruit of which is somewhat similar to the ordinary ground-nut (*Arachis hypogæa*), did very well and is perhaps more suited to this country as it is not affected to the same extent by seasons. Ground-nuts may conveniently be grown as an intercrop.

I will now refer to a number of root crops, the cultivation of which is sadly neglected here. It is surprising that residents who have in most cases every facility for growing them do not as a rule produce such foods for their own tables, particularly those any distance from a market.

YAMS.

Some 20 varieties of yams were introduced from India, Ceylon and Barbados and experimented with by the Department. I have no hesitation in stating that they can be successfully grown in Malaya; the weight of individual tubers compares favourably with those of other countries and no special difficulty is experienced in their culture. Suitable soils are sandy loams but deep cultivation and good drainage are more important than quality of soil. The land should be forked or chankolled to a good depth in order to enable the tubers to develop properly. The soil is then put up into ridges 3 to 4 feet apart and the seed tubers planted on the ridges at distances of from $1\frac{1}{2}$ to $2\frac{1}{2}$ feet depending on the variety. The object of raising the ground is to ensure better drainage, to do away to some extent with deep trenching and to make the conditions for lifting the crop more easy. In this country planting could be done at any time but the wet season might be taken advantage of. Near each plant is placed a stick for the creepers to grow upon. The stick should be from 12 to 16 feet high. A common practice is to plant up trees for support. It is not uncommon to allow the plants to trail on the ground but this method is supposed to decrease the yield slightly. The crop takes from nine to eleven months to mature. At the end of this time the leaves become brown and drop, and the stem dies down; this indicates that the tubers are ready for lifting. The tubers should be lifted as required, as they do not keep long when exposed to the atmosphere, but when left in the ground they keep for quite a long period. The yields depend on the variety grown, suitability of soil, cultivation, etc., but generally speaking it varies from 4 to 10 tons per acre, approximately the same as the yield of potatoes. In Malaya, yams are seldom if ever seen, but in the West Indies, particularly, they form a standard diet both for Europeans and natives, the latter living largely on this food. Being more nutritious than the potato they form one of the most

important foods of the tropics: In several countries they take the place of the potato and are considered by many people superior to it. They have been frequently recommended for extended cultivation in India in times of famine as they are not affected by long periods of dry weather. In such countries as Malaya, where a large proportion of the population is almost entirely dependent on the rice crop for their food, yams might, when the price of rice is high, partly serve as a substitute.

SWEET POTATOES.

These are often looked upon as yams but this is not the true use of the word. The type of soil and the depth of cultivation required are similar to those for the yam. They may be grown on flat ridges 3 feet apart. The stem cuttings are planted on top of the ridges at distances of $1\frac{1}{2}$ feet, but when grown on the flat the cuttings are placed 2 feet apart each way. The tubers may also be used for propagation purposes but the former is the general method. The crop is best lifted during dry weather.

JERUSALEM ARTICHOKE.

This root crop, which is easily grown, does exceedingly well in Malaya and gives very good yields, probably as large as in any country. The soil is deeply cultivated previous to planting and maintained clean during the period the crop occupies the land. The best time for planting is just as the young shoots are appearing on the tubers and is done at distances of 2 feet. The crop takes from three to four months to reach maturity. The tubers are ready for the table when the leaves begin to wither and dry. The plants thrive well in most situations but preference should be given to reasonably rich soils.

VIGNA CATJANG.

This bean has for a number of years been successfully grown at the Kuala Lumpur Government Plantation. There are several forms of the plant, the one commonly grown in this country by Chinese market gardeners has long pods and is often sold as a substitute for French beans. The crop is ready for collecting in about two and a half months. It does well on light alluvial soils or loamy lands. When cultivated on a small scale it is generally grown in prepared nursery beds, the seed planted in rows 18 inches apart, the young plants being trained to grow upon sticks, two or three plants to each stick. In India the seed is sown broadcast on prepared land.

TAPIOCA.

Tapioca has been grown fairly extensively in Negri Sembilan and Pahang in the past few years, the export from the former State during the years 1914 and 1915, being 21,585 pikuls and 17,235 pikuls, respectively. If grown for any length of time on the same area, manuring will ultimately have to be resorted to as a means of securing good yields and for this reason it is best grown as a sole

crop. In Pahang it is cultivated fairly extensively as a catch-crop amongst young rubber but I am extremely doubtful if this is to be recommended. Tapioca is propagated from stem cuttings, 6 inches long, the cuttings being half buried in the soil in a sloping direction at 4 feet distances. The crop takes about one year to reach maturity.

SUGAR-CANE.

I merely wish to refer to this as a food substance which was extensively grown in Province Wellesley at one time and to a smaller extent in other parts of the country. The growing of sugar-cane as a plantation crop here is now non-existent but it is cultivated to a minor extent, especially by market gardeners.

SAGO PALM.

This palm is a native of Malaya and yields the sago of commerce. It is found chiefly in swampy flat situations and is particularly common in some parts of Perak and Negri Sembilan. There are fairly extensive areas where this palm would flourish and which perhaps, with the exception of padi, are unsuited for other tropical products.

FRUITS.

Before closing this address I would like to refer briefly to the question of fruit culture. This important branch of agriculture is largely ignored by the European planter. There are a considerable number of fruits which flourish here, but few private gardens have anything like a representative collection. Suitable lands in the neighbourhood of the larger towns might be profitably utilized for the growing of fruit trees for I feel sure that a ready market would be secured.

The following fruits can be successfully grown in Malaya—custard-apple, bullock's heart, soursop, cherimoyer, mangosteen, roselle, durian, blimbing, carambola, pumelo, lime, citron orange, langsat, duku, rambutan, pulassan, avocado pear, chiku, *Passiflora laurifolia* and papaya. The following fruits show some promise—Java almond, Cashew-nut, pomegranate and wood-apple.

VEGETABLES.

The following vegetables are worthy of extended cultivation—lettuce, endive, kohl-rabi, snake, bollh and wax gourds, cucumber, tomatoes, spinach, carrot (short horn varieties) *Coleus tuberosus*, brinjal, yam-beans and arrowroot.

Discussion.

The CHAIRMAN (Mr. L. Lewton-Brain) offered a few remarks at the close of the paper: After regretting the small attendance of planters at a discussion of such importance, he pointed out that the subject could be divided into two parts: first the growing of vegetables by individuals for themselves and second the general food supply of the country. Far too few planters grew their own

vegetables or planted up fruit trees. It was perfectly easy to do so, but it certainly required personal attention. The question of the general food supply of the country is of great importance not only to the Government but also to the planting community as large employers of labour, which is dependent for its food on imported supplies. Taking the staple food of the country, rice, approximately three times as much is imported into the Federated Malay States annually as is produced; the figures are roughly 60 million gantangs imported, against 20 millions produced. The Government is doing a great deal to increase the food production by smallholders, particularly by the bringing under irrigation schemes areas suitable for the cultivation of padi. Experimental work now being carried out by the Agricultural Department promises to lead to considerable increases in yield from the areas at present under cultivation. These efforts, however, could not be expected to produce immediate results and at the present time the difficulty was to maintain the area under padi at its present level; the cultivation of rubber has made the smallholder so prosperous, that he is not anxious to undertake the more laborious and less profitable work of growing padi. Could not more be done on and by estates to increase the production of food-stuffs? In all other countries, he had worked in, where there was a resident labour force, on estates, the labourers grew most of their own food-stuffs. In the West Indies, for example, the negro labourer grows his own sweet potatoes and yams, so that some fish and a little pork occasionally is all he needs to buy. In this country there is practically nothing of the sort done at all and the estate labourer is entirely dependent on imported food. As Mr. Spring has pointed out, there are many kinds of food that can be grown here and probably in course of time will be grown. It is, however, not a healthy state of affairs that an agricultural community should be content to go on depending on imported food to such an extent. He was hoping to-day to raise a discussion that would show whether something could not be done to improve matters on estates as regards food production, what the difficulties were and how they could be dealt with. It was regrettable that the small attendance would rob the discussion of much of its value.

Mr. B. J. EATON, Agricultural Chemist, said that the subject was as interesting as it was important to them all. But in view of the small attendance that morning he thought the question should be raised whether some means could not be adopted by which a greater interest could be aroused in the matter. He did not think that, in view of the extent of the many estates they had, there would be any very great difficulty in setting aside a small portion of land on each estate for growing at least a proportion of food required for the labour force on the estate. It was the planter who should take an interest in the matter, and it was through him that they could hope to interest others. He was aware that managers of estates

were unable to take action without the sanction of their directors. Especially at this time the problem was a very important one, and the time was very opportune to discuss it in the District Planters' Associations. (Hear, hear.)

Mr. BERENGER, of the Taiping Gardens, in supporting what Mr. Eaton had said, remarked that he had for a long time taken an interest in the matter, not from the theoretical side alone, for he had been 10 years on rubber estates and knew the conditions of things. There was certainly a large number of products that could be grown. The ordinary cooly, as they knew, had no idea of even looking after himself, so that they should do these things for him. A small portion of land might be set apart and the cooly would very soon know what to do with it. Some assistance might, of course, be given in the form of fertilizers. Such things like basic slag and other chemical manures could not, of course, be got easily now, but there were some by-products, like coconut poonac and ground-nut meal, that would be very good.

The speaker described a certain experiment with this meal on lalang-ridden land which gave surprising results. Cattle manure in this country was not very rich, as it was usually exposed to the weather, so that such elements as phosphoric acid, etc., were washed away. He knew of some planters who said that they had even gone to the extent of buying cattle for the sake of the manure, but the results were not very encouraging. There was no reason why it should not succeed if they did it properly. Some of the bigger estates ought to go in for something in the nature of practical farming and they would find that it did not cost very much, nor would the labour required exert any great strain on their resources.

Mr. PINCHING, after saying that there were several estates that used cattle manure, remarked that in regard to the growing of food-stuffs on estates he was afraid most planters would say that they had enough on their hands with rubber. He believed that some estates had made efforts of one kind or another but had not met with success. One estate even tried to grow rice but found that they suffered a great loss.

Mr. A. G. G. ELLIS, Assistant Agricultural Inspector, spoke of an estate in Perak where the manager gave his coolies small plots and offered a prize for the best kept garden. The coolies became quite interested and excellent results were achieved. He had suggested the same thing to others, and he believed that it was being taken up.

Mr. COOMBS replying to the query as to the possibilities of planters producing rice on estates stated that without wishing to in any way disparage efforts in this direction he felt that it would be of service to indicate the following points: (a) That dry land padi is essentially a "first crop" from newly-felled jungle land or from

land which has had time to recover by fallow or rotation of crops. (b) That it is not tolerant of shade. (c) That it must be planted in fairly large areas to minimize the depredations of pests. (d) That planting has to be timed to catch the rains. (e) That the yield to be obtained under the best of conditions could be estimated at 300 gantangs of padi per acre—*i.e.*, approximately, 150 gantangs of rice, which on the basis of six gantangs of rice per cooly per month worked out to the index of one cooly consuming the produce of half acre of land. He stated that he had an open mind about the matter but that any success would he thought be largely dependent on the extent of co-operative effort. Turning to the question of wet rice he could not express optimism concerning the results to be obtained from planting "wet-rice" in swamps. He stated that the only way to make swamps produce a satisfactory crop was to make conditions such that the land might be swamp no more. He showed how certain areas in this country produced rice in quantity per acre second only to Spain and indicated the ways by which production could be still further increased.

Another speaker remarked that fruit cultivation on estates was difficult, owing to the theft of fruits by coolies when the fruits came to maturity.

The CHAIRMAN said that Mr. Spring's paper was prepared in order to get the views of planters as to whether it would be possible to improve conditions, but as so few planters were present, he did not think it was any use continuing the discussion. He would therefore call upon Mr. R. W. Munro to read his paper on "Liberian Coffee."

THE CULTIVATION OF LIBERIAN COFFEE.

BY R. W. MUNRO,

(*Managing Director, Morib Plantations, Selangor, F.M.S.*).

THIS paper is written principally with a view to encouraging other payable industries in this country (few other countries having equal advantages) submitting that the policy of giving general support to one product only cannot be based upon any sound argument.

No statistics are available regarding the area at present under cultivation, but the latest returns including all varieties give the figure of 2,268 acres on estates; this is probably interplanted with rubber or coconuts.

Since rubber has proved all along so attractive it is not surprising that comparatively little attention has been paid to coffee, but, if figures prove anything, the cultivation would seem hardly to have received the recognition that it might have done.

At the time when a good deal of attention was being given to it, and a very considerable amount of British capital invested, it was more or less acknowledged that quite a useful return on the outlay could be obtained with the price standing in Singapore at \$22 to \$25 a pikul (the cost of production being then about \$12 to \$15 per pikul). It should be stated here that the value of the dollar was about 3s. 6d. That the prices ruling during the boom from the years 1893 to about 1899 were 50 per cent. higher than the above, and also how it suddenly dropped to an unpayable figure have become matters of history, and there was hardly a planter in the country who was not badly hit. Prices rallied in the most unexpected manner later on, so that in the year 1905 coffee was in great demand again in the local market at \$30 a pikul.

The original decline in prices was supposed to be due to the Santos valorisation scheme, and other causes unconnected in most cases with the question of quality, or of the actual supply and demand.

Planters got tired of being told that they were suffering because they insisted on producing a low-grade article, especially when it became known that whatever value was placed upon it as a beverage decocted from the raw material it was looked upon as being an absolute necessity to the commercial world for carrying out the usual trade methods, mixing it with Arabian, and other grades, and selling it as the finest "Mocha." Looking at the prices that have been ruling for some years past (it is quoted to-day at \$45 per pikul) the so-called low grade article appears to command a considerable amount of respect.

It must be realized that at the time mentioned above, when this product was being exploited here, there was not a great deal of knowledge at the disposal of the planters as regards its economical cultivation. Most of the knowledge available was brought from Ceylon, where species other than "Liberian" had been in vogue, and to which this country was entirely unsuited, and we realize now, that a great many of those who encouraged the planting of Liberian coffee here, and who honestly believed in it, to the extent of risking, in some cases, considerable fortunes, hardly possessed sufficient knowledge either of the industry or the conditions necessary to make a success of the venture; they were at the same time attracted by big figures in consular reports from Brazil and elsewhere.

Planters of the present day would, we think, soon doom to comparative failure some of the propositions of those days when land was so often chosen for coffee without regard to the requirements of the tree itself. Land chosen in the Ulu containing, as we know, not a vast depth of "humus" was rarely dealt with in a manner calculated to conserve all its resources, and became, from one reason and another (mostly by allowing the top soil to be washed by heavy rains into the ravines) much impoverished, and actually in many cases incapable of bearing average crops after the first few years without the aid of artificial manure.

The best and steadiest crops were recorded from lands of a peaty nature in the low country, where the only coffee worth looking at still exists and is yielding a handsome profit to its owners.

It has been the aim and object of a large proportion of planters, since the rubber industry was started, to find something in the way of a catch-crop that would prove to be an assistance in reducing the cost of upkeep. Different varieties of coffee have been interplanted, and in many instances a very considerable revenue obtained.

One well-known company paid quite a respectable dividend for a few years waiting for the main product to mature, but generally speaking the policy of introducing catch-crops with the above idea cannot claim much support, and the scheme is for many reasons a dangerous one. It might be assumed that the planter would eliminate the catch-crop at any expense as soon as he is satisfied that the main crop is suffering, but, in the face of concrete instances, unfortunately no such assumption is warranted.

Again, the catch-crop as a rule receives little or no attention in the way of cultivation, and cases are recorded where coffee as a catch-crop with rubber has been condemned on account of the soil being described as unsuitable when it might have yielded quite a good return under conditions altogether dissimilar.

Under normal conditions a small crop may be looked for in the third year from planting and the tree may be considered to be in full bearing after the fifth or sixth year.

Dealing with the various works incidental to the actual cultivation in this country there would appear a necessity for many changes in methods that in former times were considered orthodox.

PLANTING DISTANCE.

Planting distance in coffee, as in every other tropical product, gives rise at the outset to a considerable amount of discussion, the variety of opinions occasioned chiefly by the dissimilarity in soil conditions, situation, etc.

At whatever height the tree be topped, or even if it be not topped at all, the spread of the lower branches indicates the inadvisability of anything like close planting. Diametrical measurements of trees with specially vigorous growth have in some instances been given from trees topped at $5\frac{1}{2}$ feet showing as much as 20 feet across, but although under the most favourable conditions such a result over a large area is highly improbable, still, the adoption of a much wider distance than used to be considered correct is to be recommended.

The undesirability of allowing the lower branches to overlap, or even to meet, is very soon obvious when heavy blossoms and crops begin to be visible, and when the cooly, whether he be engaged in the works of weeding, cultivation, or gathering the crop, makes his way down the lines not only with difficulty but at the serious expense of the newly-set crop which is often destroyed in large quantities.

Should the policy of $5\frac{1}{2}$ feet topping be adopted, the distance for planting may reasonably be given as 15 ft. \times 15 ft. or 12 ft. \times 20 ft., the former giving nearly 200 trees to the acre, and the latter 180.

High coffee (untopped) has never been greatly in vogue in this country, though in Java and Sumatra the system has many supporters. It entails a great deal more expense in maintenance such as pruning, etc., ladders also are required for picking the crop, these are costly in manufacture and upkeep, and it is doubtful if proportionate results are obtained.

SELECTION OF SEED.

There is just as much to be said in favour of careful selection of seed, as in other products; and it is unnecessary to state that the cherry should be perfectly ripe. In preparing for the nursery, care must be taken after the process of separation from the pulp is complete to mix well with dry ashes, and spread out in a warm place, not exposed to the direct rays of the sun. Deep planting in the nursery is a very ordinary cause of failure in germination; the seed need only be placed to a depth of 1 inch, but the nursery requires top-dressing with fine soil after heavy rains. A safe distance at which to place the seed is 5 to 6 inches apart, and a heavy attap shade is a necessity. Plants taken from the

nursery with four pairs of leaves, including the fish-leaf, withstand transplanting better, as a rule, than at a much later stage—*i.e.*, provided that the shade over them in the nursery has been previously lightened to allow of the necessary hardening.

In any event the process of transplanting is a delicate one, requiring much close supervision, especially to see that on a hot day the plants put in are not left for any length of time without shade, and the greatest care be taken to avoid a bent tap-root by cutting the exposed portion with a sharp knife before it leaves the planter.

Some six to eight months from planting, the young trees under normal conditions will require suckering, and also attention to the selection of the one-stem on which the tree is eventually to be brought up. Seed at stake, if carefully handled, will give excellent results, and planting by this method is much to be recommended under certain conditions.

The time from blossoms to crop may be counted roughly as ten months and two heavy crops a year are as a rule reckoned on, May-June and December-January, when the estate, unless supplied during the year with more labour than is actually required, is sometimes hard put to it to maintain itself in good order, and to harvest the crop at the same time without loss. Pruning and handling will, all the year round, take up a large amount of labour and superintendence. The forcing climate makes it necessary to get in a round of pruning every two months; it should in reality be done every six weeks.

SHADE TREES.

The prevalence of shade trees on nearly all the old coffee estates in the Peninsula was the outcome of a firm belief brought from other tropical countries where varieties of coffee other than Liberian were found to thrive better under certain forms of shade.

Here the climatic conditions, and those generally under which Liberian coffee is grown, do not appear to call for the same treatment and generally speaking the trees appear to do better without it, especially as we have yet to find a leguminous shade tree (no other varieties could in any case be recommended) that is not actually harmful in some degree by its tendency to get out of control.

Time and space in this short treatise will not permit of going into the various methods of curing and preparing the article for the market any more than it will of entering into anything like detail over cultivation, maintenance, soil conditions, and many other vital questions connected with the industry, but a rough outline of what is required for the treatment of the crop subsequent to the picking will act as a guide for the present.

Needless to say, the factory site should be chosen at a spot where an ample supply of water is available all the year round; the thorough washing of the beans after leaving the pulper playing

so important a part in the preparation for the market. First of all the choice of a really efficient pulper is very essential, although, at first it is not advisable to put down an expensive plant. The capacity of a single cylinder "Lidgerwood" pulper is sufficient to deal with crops from 100 acres, or more, and space should be left in the factory for extension, when supplementary machines can be manipulated by the same driving power. Selection of an economical running engine capable of working pulper, huller, and water pump is a matter of no little importance.

The situation of washing and fermenting tanks also is a question requiring careful deliberation. The practice of bringing unripe cherry into the store must be condemned at the outset because a crop in this form cannot be dealt with by any pulper and the result is a dead loss. The pulped beans are run into a fermenting tank, scuddled into a heap, covered with wet gunnies, and kept there for about 60 hours. This is the system mostly employed in Java at the present time.

If pulping takes place say at 5 p.m., the heap, to prevent over fermentation should be turned over the following day about noon and again covered; if this be repeated the following morning, the coffee can be thrown into the washing tank the same evening and remain soaking until the commencement of the washing process on the morning after. When a very thorough washing has been effected the coffee becomes what is known as "wet parchment," and is removed in bags or baskets to an open barbecue (or if artificial heat is used, to the drying house), where it is kept constantly turned over until the drying process is complete. The "dry parchment" is then dealt with by a huller which turns out the finished article, the only process remaining being the grading and sizing of the beans according to market requirements.

PESTS AND DISEASES.

The cultivation of the product under discussion having as is well known, and as we have just remarked, gone almost entirely out of favour for so long a period, it is not possible even to conjecture what enemies are awaiting us should we once more decide to exploit it.

I think that we should at the outset assume the fact that while having the opportunity of gathering an amount of useful information regarding the industry in general from planters in Java who know that we should not enter the field as serious competitors, soil conditions preclude the possibility of its being carried on under exactly similar conditions as those obtaining in that country.

We possess none of that volcanic soil on this side, and the possibility presents itself that we might on this account be less immune from diseases; this is a question, however, for the scientist, rather than the planter, but requires all the same, a reasonable amount of deliberation.

In dealing with diseases of coffee we do know that leaf-disease is so pronounced and so universal that the plant is practically born with it. Young plants in the nursery, existing under any but congenial conditions will often suffer to an extent uncredited, and failing to respond to the usual Bordeaux-mixture treatment, wear a most distinctly worried look until isolated, as it were, in its proper place in the field. It is encouraging however to know that the plant, when once well established in the best surroundings, carries on as if no sickness existed, because, unlike so many of its relations, its constitution is strong enough to throw off the disease without the aid of artificial remedies.

The functions of its tap-root are such as to be specially intolerant of wet feet, so that it would be futile to engage in the industry at all unless perfect drainage can be obtained. Unlike rubber, the coffee tree, although possibly existing, can be of no use without its tap-root. A tree planted with a twisted tap-root will inevitably succumb to attacks of various sorts, as there is no provision apparently in nature to enable it to hold its own by the aid of its lateral roots only.

With the non-existence of the tap-root it matters little whether *Termes gestroi* or *Fomes* get to work or not because the tree is practically doomed.

Progress of science, and application of scientific methods have disclosed a very much wider field in a comparatively short period, and it is with this knowledge that I would advocate the necessity of embarking upon (what I may be forgiven if I term) a new industry with very different premises, and on lines of a broader nature than the old coffee planters were taught to work upon. I would say that clean-clearing of sub-soil timber will be a question for urgent discussion, and should receive the consideration that it deserves.

Touching lightly upon pests, no one who saw, and has been made aware of, the damage done to estates by the caterpillar of the bee-hawk moth, would enter upon the cultivation with the idea that, given good prices, all would be well.

Assuredly this pest will make its appearance again, but the knowledge of remedial measures is more available now than it was, and for safety and insurance against the spread of this devastating pest I would strongly recommend that no large areas be planted without dividing-belts.

From the foregoing I trust it will be clear that the writer is in no way posing as an expert in the cultivation (I would say that with only superficial knowledge at our disposal we have yet to find one) but is actuated by the conviction that the prosperity of the country means prosperity for the individual, and if ever there was a time in the affairs of the Federated Malay States when everything should be considered with a view to its permanent prosperity it is now. No

one can deny us when we say that the country is an agricultural country and what possibilities are contained therein we have yet to discover.

Statistics of prices of Liberian coffee paid per pikul at Singapore during 1912 to 1916:

1912	January to June	...	...	nil.
"	July to December	...	...	\$36.50
1913	January to June	...	...	39.00 to 42.00
"	July to December	...	...	39.00
1914	January to June	...	...	39.00 to 39.50
"	July to December	...	...	24.00 to 39.50
1915	January to June	...	...	28.00 to 40.00
"	July to December	...	...	28.00 to 37.00
1916	January to June	...	...	32.00 to 45.00
"	July to December	...	...	40.00 to 45 00

Discussion.

Mr. P. B. RICHARDS asked Mr. R. W. Munro whether he did not think coffee robusta would do equally well as Liberian? He mentioned a plantation he had seen in South Perak where robusta was planted between the rubber over about 250 acres when the place was being opened. The manager was so satisfied with the result of this catch-crop that when opening up 250 acres more he interplanted this also with robusta. He knew that other small-berried varieties had been tried, but he was not able to say what success attended these. He did know, however, that coffee robusta had given very satisfactory results. Speaking of the diseases mentioned by Mr. Munro in his paper, he was sure efficient spraying methods would get them under.

Mr. MUNRO, in reply to Mr. Richard's question, said he was not prepared there to tell them much about coffee robusta, but he had known cases where it had been a success. His remarks on soils dealt with the question only from the point of the requirements of Liberian coffee and he was not familiar with the other varieties referred to. He had heard of a good variety which had been tried with success in Java where robusta was also tried, but he believed they were now giving preference to the Liberian variety there because they believed it to give a sound and confirmed crop. As regards the pest he had mentioned, he said it might shortly make an appearance, and he suggested that remedial measures would be adopted now, as the scientific methods now prevailing would make it easy to deal with such pests.

Mr. P. B. RICHARDS remarked that another point was that Mr. Munro mentioned Liberian coffee as thriving on rich alluvial soils, whereas, the robusta crop mentioned was grown in the uplands, on laterite soil, not especially abundant in humus. He wished to emphasize that at least one grade of coffee would grow well on the uplands.

Mr. MUNRO thought there was very little doubt that the Liberian variety would grow in any soil provided it was good alluvial soil.

Mr. G. E. COOMBS thought that in regard to the present value of coffee robusta people in Java had found that robusta gave best results, the only drawback being that it required some form of kiln drier to ensure the complete removal of the "silverskin."

Mr. MUNRO said that he had no details at hand in regard to coffee robusta but the prices of Liberian coffee per pikul for the past five years were as follows:—In 1912 the highest price reached was \$36.50; in 1913, \$42; in 1914 it ranged from \$24 to \$32; in 1915 from \$24 to \$40; in 1916 from \$32 to \$45.

Mr. BERENGER remarked that they had a far readier market at Home for robusta than for Liberian coffee.

Mr. MUNRO spoke of planting seed at stake which, he said, had given good results under certain conditions. But he himself was in favour of young plants being put down. If they did plant seed at stake they must have the same shade as in the case of plants.

MINOR ECONOMIC PRODUCTS IN MALAYA.

By F. G. SPRING, N.D.A., F.L.S.

(Agriculturist, F.M.S.)

CONSIDERING the very large profits derived from plantation rubber, in the past few years, it is not surprising that other crops, with the exception of coconuts, have received little or no attention. A planter knows, approximately, what may be expected from his rubber plantation and is, therefore, chary of growing a crop about which there is any speculation. As long as rubber remains about two shillings per pound or over, it is not to be expected that general interest will be taken in other directions, but should the price ever reach the neighbourhood of one shilling per pound, then capitalists would, there is little doubt, be on the outlook for other industries. It is satisfactory that many enquiries have been received, for some time past, regarding the cultivation of a number of crops, for it is greatly to be desired that other agricultural products be developed in Malaya.

A large amount of work is required to be done before a crop can, with any certainty of success, be recommended to the planting world. One must first inquire as to suitability in respect of soil and climate and then consider its possibilities on a financial basis. With small areas it is possible to make accurate records of when plants come into bearing, obtain yields, etc., in respect of each plant but it is difficult to say from individual yields, or even crops obtained from a few acres, how they will behave when planted on a large scale and to give costs of production, yields and probable profits with any degree of certainty.

On the Government Plantations we have experimented with many plants of economic importance, mostly on a small scale, but the more promising on somewhat larger areas, and I now propose to deal briefly with a number of the crops.

AFRICAN OIL PALM. (*Elæis guineensis*.)

This palm has long been grown in Malaya as an ornamental plant, but it is only during the past few years that its financial aspect has been considered in this part of the world. The palm would appear, from its distribution in the Peninsula, to thrive on most soils, but a rich humus, fairly damp but well drained, would probably give the best results. Rainfall is an important factor but Malaya is well adapted in that respect. In Africa, according to some authorities, the palm comes into bearing in its sixth or seventh year. At the Kuala Lumpur Experimental Plantation several acres were planted up in December, 1912, and a number of the palms began to form fruits towards the end of 1916. Further evidence of early crop production, here, is also available from a number of

eight-year old plants which came into bearing in their fifth year. Records of individual yields have been kept for the past three years and these compare favourably with yields obtained in Africa, the home of the industry. It is stated that full grown trees in the Western Province of Southern Nigeria yield from two to twelve bunches of nuts annually; an average sized bunch contains at least 200 nuts and the weight of the latter varies from 7 to 21 lbs. The pulp of palm fruits contain about 60 per cent. of palm oil while the kernels yield, approximately, 48 per cent. of palm kernel oil.

The oil palm is propagated from seed. The nursery beds should be raised, made of fairly rich humus soil and near a water course if possible, to ensure the proper humidity of the soil. The seed may be planted about 18 inches apart each way at a depth of from 1 to $1\frac{1}{2}$ inches. The beds require to be artificially shaded and in dry weather regularly watered. When the seedlings are 1 foot high they may be transplanted into their permanent quarters which may be from 20 to 25 feet apart. Holing similar to that of rubber planting is greatly beneficial and tillage around the palm essential, if heavy crops are to be obtained. The palms require to be kept entirely free from other plant growth which is frequently found, particularly on the older uncultivated plants.

In West Africa the oil palm trade is handicapped by transport difficulties and lack of machinery. The industry is, more or less, in the hands of natives and as long as it remains so it is unlikely that there will be any rapid advancement. It has to be considered, financially, how a well managed property in Malaya with good transport facilities and modern machinery would compare with the somewhat primitive methods of West Africa. It might be mentioned that the world's demand for this oil is very large.

FIBRES.

A sample of fibre, which would appear to be *Eurercæa* sp., grown at the Kuala Lumpur Experimental Plantation and prepared by hand labour, here, was forwarded to the Imperial Institute, London, to be examined and was reported on as follows: The length of staple varied from 2 feet 8 inches to 6 feet, with an average of 4 feet 3 inches. The fibre was examined for tensile strength and elongation in comparison with a standard sample of sisal hemp and taking the East African sisal hemp as the standard, the ratios are as follows:

			Present sample.		Sisal hemp from East Africa.
Breaking stress	...	...	56	...	100
Extension	...	...	225	...	100

The above figures indicate that the present sample has only 56 per cent. of the strength of the East African sisal hemp but it is $2\frac{1}{4}$ times as extensible as the latter. The fibre was submitted to a firm

of merchants who valued it at £25 per ton in London, with sisal hemp at £26 per ton (December, 1913). It was further remarked that fibre of this quality would be saleable in large quantities for cordage manufacture and that a more valuable product could probably be obtained by extracting the leaves with modern machinery and brushing the fibre produced.

The following fibre plants, namely, *Furcræa* sp., Sisal hemp (*Agava rigida*, var. *sisalana*), and Manila hemp (*Musa textilis*) have been grown here with a considerable amount of success.

Manila hemp is propagated from suckers which are planted out at distances of about 8 feet. The first crop is collected when the plants are two years old. *Furcræa* and Sisal are propagated by suckers or bulbils, and may be planted out at distances of 10 feet each way. The plants come into bearing in their third or fourth year.

These fibres should not be interplanted with anything which provides heavy shade, but grown as sole crops in preference.

IPECACUANHA (*Psychotria Ipecacuanha*.)

This plant requires a great deal of care and attention but can, unquestionably, be successfully grown in Malaya. Specimens of dried root grown at the Kuala Lumpur Experimental Plantation were recently forwarded to London for sale and the under-mentioned note was received regarding the sample. "The result of the analysis, we may say, compares favourably with other results which have been reported to us. Prices for Ipecacuanha have fluctuated violently during the war and at one time Johore reached 17s. per lb. but high prices attracted unusually large supplies of Brazilian and values have fallen. The demand for this description was chiefly for Germany and has entirely ceased. Present value is about 8s. per lb." Propagation is by root, stem and seed. Root cuttings are made about $\frac{1}{4}$ inch in length and planted in a horizontal position in boxes containing $\frac{2}{3}$ sand and rich jungle mould. The permanent distance of planting is 18 inches. Ipecacuanha must have shade throughout its period of growth. The plants are ready for lifting when two to two and a half years old and yield from 2 to 3 ozs. of marketable root per plant. The roots require to be carefully lifted, thoroughly washed, sun-dried and all foreign matter removed before being sold. Ipecacuanha can be grown as a catch-crop under moderate shade.

CHENOPODIUM (*C. ambrosioides*, var. *anthelminticum*.)

This plant produces wormseed oil which is becoming of considerable importance on account of its use in the treatment of the disease known as American hook worm, or ankylostomiasis, and it is probable that there will be a fair demand in the near future. Seed was received from Maryland, U.S.A., in the beginning of 1916 and two crops have been harvested up to date. One lb.

of seed, mixed with 10 lbs. of fine sand, to facilitate ease of spreading, is sown broadcast per acre, on a well prepared surface. The plant reaches maturity when about three months old. The weight of unhusked seed worked out at 650 lbs. per acre per crop. It must be noted, however, that this yield was obtained as a sole crop, on good land. About one per cent. of oil is obtained from the seed. The present price of the oil is 12s. 3d. per lb. *Chenopodium* may be grown as a catch-crop as it is not affected by partial shade.

CINCHONA.

About twenty acres of quinine, *Cinchona succirubra* and *C. Ledgeriana* were planted in March, 1914, on Gunong Angsi, Negri Sembilan, at an elevation of 1,500 feet. The plants are very fine healthy specimens and have shown excellent growth. Judging by the present condition of the clearing there seems every prospect that this valuable drug can be successfully grown on the hills in Malaya.

CROTON OIL (*Croton Tiglium*.)

The nuts, obtained from this small tree, yield a medicinal oil which may be administered as a violent purgative. No special care is required in its cultivation. A small crop was harvested, here, when the plants were one year old and there seems every prospect of satisfactory yields being obtained when the plants are more mature. This crop grows on the very poorest of soils; it thrives remarkably well on light laterite and many waste lands could be profitably used in its cultivation.

There are many spices, drugs, oils, scent-producing plants, etc., which are receiving experimental notice but it is not possible to deal with them in this paper. I would like it to be understood, however, that a number of crops, other than those mentioned have shown some promise and that the Department of Agriculture is only too pleased to supply information regarding them and assist in any way possible to further the cultivation of new products.

Discussion.

The Chairman (Mr. L. LEWTON-BRAIN) said he thought he might mention that recently the Penang Chamber of Commerce Committee had passed a resolution asking the Government to consider the question of establishing experimental farms throughout Malaya. This resolution had been sent by the Colonial Secretary to the Chief Secretary, who had submitted it to him (Director of Agriculture) and he proposed to bring it forward at the next meeting of the Advisory Committee of the Agricultural Department. He had been instructed to bring the matter up for discussion at that Conference. The matter fitted in well with what they had just heard, and he might take the opportunity to mention what the Federated Malay States Government had been doing in the matter.

They had Experimental Plantations at Kuala Lumpur and Batu Tiga in Selangor, and on Gunong Angsi, in the Negri Sembilan, where, apart from rubber, many other crops were being tried, including those mentioned in the resolution and many more. At Kuala Kangsar in Perak the Department had taken over the Government Plantation, though they were not doing much with it at present apart from the rubber plot. Before they could get at work on other experimental plots they required a good deal more of money and, also, what was more difficult at present, men for supervision.

Then they had a plantation in Kuala Pilah for Malay agriculture. The Kuala Kangsar Plantation was likely to be of very great use when they could develop their work on other products. Then, in Singapore, the Government of the Straits Settlements had the Botanic Gardens.

All these were very useful, and, indeed, indispensable to show what would, and what would not, grow; what diseases were to be looked out for; the conditions of growth; and what yields might be expected. But, if he might say so, all these were mainly of negative usefulness to prevent unnecessary waste of money as on the results of such small scale experiments they would be able definitely to recommend not to try this or that. But in the case of those products where promising results were achieved they required fuller information before recommending them commercially. They wished to know, for instance, above all, what yields could be secured over a given area, and what would be the actual cost of production to secure that yield on a commercial scale. These points could only be guessed at from small plots.

As a matter of fact these matters had been on his mind for some considerable time, and once they very nearly achieved definite results. In 1914 Colonel Fox, Mr. E. Macfadyen, and he drew up a scheme for a large scale experimental farm where products which had done well in a small way might be tried in blocks of 50 acres or 100 acres. He felt that such a scheme would give extremely valuable results. The scheme was submitted to Government and was approved in principle, and even a reserve was set aside for the purpose to the extent of about 2,000 acres, he believed. It was, however, postponed at the time as it was not possible to carry it further and since then it had not been possible to revive it.

He took it that now that the matter had come up in the form of the resolution forwarded to Government they were asked to discuss there whether they wanted more small scale experimental plantations or one or more of the larger ones.

Mr. R. W. MUNRO said: Those who have read (as most of you doubtless have) the last annual report of the Planters' Association of Malaya will have noticed a paragraph submitting that "a continuance of the country's prosperity must at all times be the main

objective, and the policy of fostering sound enterprises other than rubber should be an encouragement to those who realize the necessity for such a policy."

I believe it to be almost universally acknowledged that, apart from any special consideration for the increased prosperity of the country (which consideration, however, we know does exist secretly in the hearts of us all) other products, although not perhaps of so attractive a nature as rubber, would be welcomed only too gladly, could a satisfactory demonstration be given to the investor as to a reasonable return on the capital outlay. And I am convinced that hopes are more or less widely entertained by both planter and investor regarding the discovery and ultimate commercial success of some other propositions.

Now, perhaps one of the most interesting and astounding facts connected with the exploitation of rubber, which, as a payable industry, has now reached such vast proportions in this and many other tropical countries, is that in its early life a very large number of its supporters never pretended to claim any real belief at all in its possibilities. The whole thing was started as a pure speculation, as there were naturally no reliable figures to work upon.

The small point that you see I am trying to make is that we need not of necessity veto a new enterprise merely for want of figures as to its intrinsic merits. We will all, I think, agree that every new enterprise must be attended by a very considerable amount of risk, and I am quite prepared to believe that as time goes on numbers of people will be found to take risks, as they did nearly 20 years ago, and by doing so enlarge the sphere of planting possibilities, and continue to demonstrate what the resources of the country really are. Personally, I say, may I be there to see.

Mr. PINCHING wished to know whether, if the products Mr. Spring had mentioned were taken up, a market could be found for them. He knew of a planter in Sumatra who had tried ordinary chillies and found that he got a good price for them. This induced him to take up his whole plantation and to put down chillies instead, but the good price had attracted others and when the produce was put out he found there was no market for it. (Laughter.) Such minor products were therefore very doubtful.

Mr. SPRING said he quite agreed with Mr. Pinching about minor products, but if it was taken up on a small scale the Department would be able to know how much was planted up, and the knowledge gained would enable the Department to give such planters a warning note that they should not plant up any more.

Mr. EATON believed that the proposal had been already accepted regarding experimental coconut plantations. He agreed that they did require larger areas in order to acquire information regarding

the commercial aspect of the question. As the attendance that morning was so small they would do well in leaving it to the Planters' Associations to discuss.

Mr. BERENGER said that in regard to large experimental areas, he hoped they would be placed in charge of different men, as one man should not be given the charge of widely different products. It was only by specializing that the best results could be gained.

The CHAIRMAN: As there are so few present, I suggest that the Penang Chamber's proposal be passed on for discussion by the various Planters' Associations.

Mr. MUNRO said that the matter was of such importance that he, personally, was prepared to say that they might even go so far as to say that they might ask the Government to give no more first class land for rubber at all if that was going to be encouraged. But it was no use discussing the matter in that way if the whole thing was not going to be properly threshed out. He quite agreed that it was a matter for the District Planters' Associations now to take up, and he hoped they would discuss it at a very early date.

Mr. COOMBS said that the resolution of the Penang Chamber of Commerce Committee showed a healthy sign of vitality in this country with regard to the development of agriculture. He felt that the subject should be properly taken up and discussed by the various Planters' Associations and that they should formulate a constructive programme.

CLOSING OF THE CONFERENCE.

Mr. R. W. MUNRO, a Vice-President of the Conference, said: We have now finished the last item of our programme and I would like to make a few general remarks, as Mr. Kindersley, although with us now, is still not well enough to be able to speak. It is unfortunate that Mr. Kindersley has not been able to attend any of the meetings we have had.

I think that I would like to say, on behalf of the planting community, a few words regarding the success of the Agricultural Conference. I may remind you that this inauguration of an Agricultural Conference, which is, we hope, to be an annual one, was not the result of a sudden "brain wave" at all. It is a scheme that has been talked about for a very long time. It was certainly about two years before the war started that Mr. Lewton-Brain approached a large number of us about starting it. Of course, there were many things that militated against it and rendered it quite impossible to set on foot so desirable an idea.

That the Conference has been a very decided success was very marked, I think, throughout. I think the interest taken in the papers is difficult to imagine. I believe the small attendance this

morning may be due to the fact that members were, as I may say, rather "fed up." But at the same time we see that by co-operation with the Government we have got to a certain point, and there is no doubt that the result of this Conference has been that we shall not only stand there but advance. (Applause.)

If the fact of the Government not having given official recognition to all these meetings be remarked upon, we might at least remember that it has been quite ready to help us up to a point. The Government has supported us and worked with us in a way that has been of extraordinary value to us as planters. If it was not for the Agricultural Department we would not have been able to undertake this at all. But the only hope that I can express—and I feel that I am also speaking for the planting community—is that I hope this is the first of a series of regular annual conferences. We should much like to see an annual Conference established.

I may also say that there has been a certain amount of criticism of the methods we have adopted. We have heard it said that it was not long enough and that we should have given more time to planters. But we may dismiss that straight away because what we meant to do was to make the inaugural meeting a success, and everything else did not matter so long as we got through that. I think that this is due to the support and the success of the efforts of the Director of Agriculture. We are very glad of the success of this Conference.

The Chairman (Mr. LEWTON-BRAIN) in conclusion, said: I must thank you Mr. Munro very much for what you have said. It has, I may assure you, been a very great pleasure to inaugurate and help on the work of this Conference. On behalf of the Committee I should like to thank all the planters who have been here and supported us so strongly. The interest they showed was far more than I ventured to hope for. I am exceedingly gratified that the Conference has gone on so well. I think that we may take it for granted that it is wanted by the planters, and I hope to ask my friend, the Chairman of the Planters' Association, to nominate a committee without further delay to arrange for the next Conference.

On behalf of myself I wish to thank the Committee and the Hon. Secretary for the amount of assistance they have given me. (Applause.)

The Conference was then declared closed.

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