THE CULTIVATION OF HEVEA

A MANUAL FOR THE PLANTER

BY

DR. P. J. S. CRAMER


Ex-libris
Charles Atwood
Lofoid

THE CULTIVATION OF HEVEA.

THE CULTIVATION OF HEVEA.

A manual for the Planter

BY

Dr. P. J. S. CRAMER,

Director of Agriculture in Surinam.

TRANSLATED FROM THE DUTCH BY

STUART R. COPE AND A. CONTENT.

AMSTERDAM — J. H. DE BUSSY — 1911.

INDEX.

B. The upkeep of the plantations.

C. Tapping.

ILLUSTRATIONS.

PREFACE.

In accordance with a decision of the Government dated 30th November 1909, I was charged to break my journey from Java to Europe at Singapore and Colombo, in order to visit the Rubber Estates of the Malay Peninsula and Ceylon, and to investigate the methods of cultivation and preparation of this product.

In order to carry out this investigation, the journey from Singapore to Penang was mostly made overland, and about twenty estates in the Federated Malay States and Straits Settlements were visited, and several visits were paid to the Botanical Gardens at Singapore and Kuala Lumpur.

That this journey has been successful is firstly to be attributed to the assistance and collaboration given me in the most liberal manner by Mr. W. J. GALLAGHER,

Director of Agriculture in the F. M. S. He accompanied me on most of my visits to the estates, showed me his experiments in the gardens at Kuala Lumpur and put figures and other information at my disposal; in a word, he spared neither trouble nor time to make my visit to the Malay Peninsula as successful as possible. For everything which he did for me, I give Mr. GALLAGHER my sincerest thanks.

In Ceylon, I stayed some days at Peradeniya, chiefly with the view of investigating the experiments on different varities of rubber which had been undertaken in the gardens of the Experimental Station, and I received the assistance of Mr. KELWAY BAMBER, who also arranged my visits to some estates in the neighbourhood of Kandy, Kalutara and Avisawella and supplied much information. A word of hearty thanks for his friendly collaboration is not misplaced here.

It seemed appropriate to me that I should report everything I saw in the Malay Peninsula respecting the various cultivations as shortly and accurately as possible. Mr. GALLAGHER was kind enough to examine and correct my descriptions, which are based on necessarily hurried observation. No better qualified expert on this industry could be consulted, and the fact that this scientist has examined my conclusions is the best proof of the correctness of my statements.

These pages are not intended as a study of the cultivation of Hevea in the Straits Settlements in general, but only as a manual for the planter. Long series of statistics, observations at length on problems such as green manuring and catch crops are avoided; for the latter the special literature on the subjects should be consulted; for the former, the Handbook of HERBERT WRIGHT.

In view of the rapid pace at which Hevea planting is proceeding in the tropics, it is to be expected that improvements will continually be effected in its cultivation, cropping and preparation. I hope therefore that planters who may discover new methods will communicate with me from time to time, so that I may avail myself of useful hints in the writing of a second edition of this work. I shall always be happy to enter into personal correspondence with planters.

PARAMARIBO,
November 1910.

P. J. S. CRAMER.

INTRODUCTION.

Rubber Culture in the Malay Peninsula has increased of late years in a way that no other culture has done. The plantations are still extending every year, and this is not astonishing, as the future of rubber, from a commercial point of view, seems hopeful, and because the Malay Peninsula, from its excellent climate, its fertile soil, and the competence of its Planters is well at the head of rubber producing countries, with regard to the production per tree or per acre. The cost of producing the rubber is, however, rather high, as all the labour must be imported. The cultivation of rubber exacts much labour. One cooly per acre of plantation is certainly required. When selecting land for rubber estates, the labour problem must be specially considered.

Not only in the Straits Settlements proper, but also in Johore and the F. M. S. the cultivation of rubber has increased, mostly however in Selangor, in the vicinity of Klang, and in the district between Kuala Lumpur and the sea-coast. Here are most of the rubber estates; wich for a great part almost touch each other. From the bungalows, situated in the more hilly part of the country, thousands of acres of rubber plantations may be seen; right

up to the horizon the rows of Hevea are observable on the sides of the hills. The following statement, taken from the Annual Report on Agriculture in the F. M. S. during the year 1907, gives some idea of the development of the culture in the different States.

The number of acres planted during late years may be estimated at about 40,000 per annum. On an average it may be taken that the rubber becomes tappable at $4\frac{1}{2}$ years, so that it is easy to calculate what the production should be after about 5 years. I quote the following figures on the authority of Mr. GALLAGHER.

Figures showing the increase of plantations in the Federated Malay States:

		acres.				
1901	planted with rubber	4,693				
			1,274	planted in 1902	producing in	'07
1902	„ „ „	5,965				
			4,000	„ „ 1903	„ „	'08
1903	„ „ „	7,239				
			8,000	„ „ 1904	„ „	'09
1904	„ „ „	11,239				
			24,099	„ „ 1905	„ „	'10
1905	„ „ „	19,239				
			42,154	„ „ 1906	„ „	'11
1906	„ „ „	14,338				
			40,744	„ „ 1907	„ „	'12
1907	„ „ „	85,492				
			41,812	„ „ 1908	„ „	'13
1908	„ „ „	168,048				

It may be calculated that from the sixth to the tenth year, the crop per acre increases annually by 20 % and that during the first year of tapping, 200 pounds per acre should be obtained. In order to calculate the increase in production per year, the production for the previous year must be multiplied by $\frac{120}{100}$ and then 200 lbs. per

acre should be added for the five year old trees which are to be tapped for the first time.

Increase of production in the Federated Malay States.

1908 .... 1,984,285 $\times \frac{120}{100}$ + 800,000

= 3,181,142 lbs. Actual quantity exported.

= 3,165,000 lbs. = ... 1,413 tons. Custom House Returns.

Difference .. 15,542 lbs.

1909 .... 3,165,600 $\times \frac{120}{100}$ + 1,600,000

= 5,398,720 lbs. = ... 2,400 tons.

(Exported to the end of October 1909, 4,831,823 lbs.)

1910 .... 5,398,720 $\times \frac{120}{100}$ + 4,819,800

= 11,298,264 lbs. = ... 5,043 tons.

1911 ... 11,298,264 $\times \frac{120}{100}$ + 8,430,800

= 21,988,716 lbs. = ... 9,616 tons.

1912 ... 21,988,716 $\times \frac{120}{100}$ + 8,148,600

= 34,535,059 lbs. = ... 15,417 tons.

1913 ... 34,535,059 $\times \frac{120}{100}$ + 8,363,600

= 49,805,670 lbs. = ... 22,234 tons.

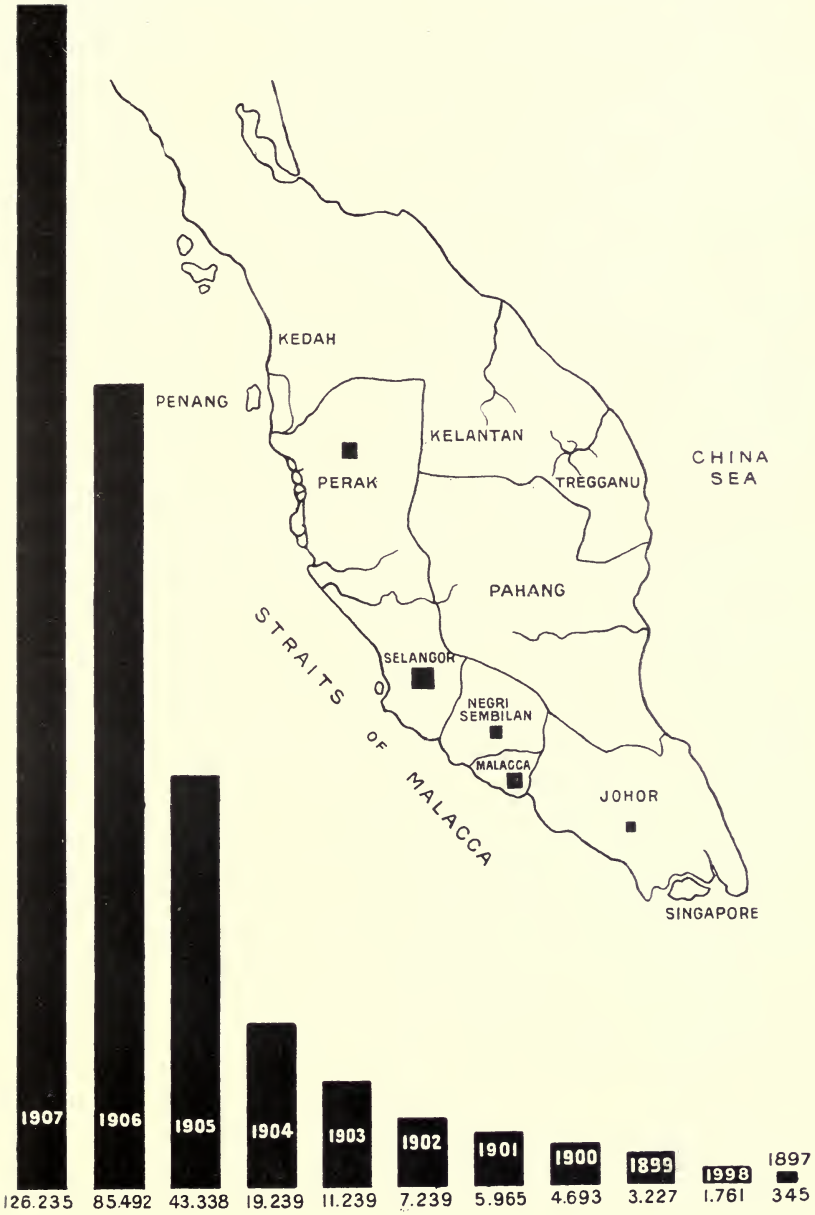
In order to give an idea of the importance of the rubber industry, I quote here a statement of the 1909 crop from some estates in production taken from some of the Straits newspapers.

	Estimated crop.	Actual returns.
Highlands and Lowlands.	(300.000)	341.986 lbs.
Batu Caves	—	43.527 „
Seafield	—	43.490 „
Seremban	(165.000)	228.626 „
Anglo Malay	(430.000)	516.232 „
London Asiatic	—	75.202 „
Golden Hope.	—	51.400 „
Petaling.	—	151.994 „
Beverlac (Selangor). . .	(55.000)	76.969 „
Linggi	(372.000)	527.000 „
Sungei Kapar.	(60.000)	114.000 „
Lanadron	(250.000)	249.247 „
Damansara.	(160.000)	203.007 „
Selangor	(300.000)	323.919 „
Labu.	(65.000)	86.000 „
Ledbury.	—	65.979 „

The exported rubber is almost exclusively obtained from Para rubber trees (*Hevea brasiliensis*). This variety was imported in 1876; in some places imported trees are still to be seen. In the Botanical Garden at Singapore, there is for instance a plantation, thirty-three years old, which has grown to really gigantic forest-trees. Originally various kinds of rubber were planted in the Malay States; experiments were made with *Ficus* (Rambong), *Castilloa*, *Funtumia* and *Manihot*. There still exist some regular Ficus Plantations, which are tapped systematically.

An error has been made by planting cuttings, which do not form a straight trunk, and in the plantation which I saw maintenance was neglected. On one estate I saw a Ficus plant, some few years old, being cut down and

FIG. 1. Area under rubber in the Federated Malay States.



The black columns show the area under rubber in the Federated Malay States only and do not, therefore include, Malacca, Johore, and the Province Wellesley; in the latter states, extension has taken place to almost the same extent.

Hevea planted instead. In Sumatra, Ficus is given more consideration. I saw there very favourably situated plantations, from which in the eighth year, two pounds of dry rubber per tree were obtained. They were planted as seedlings, carefully restricted to a single stem, and better kept than those which I saw in the F. M. S.

Ceará rubber is not being planted, I saw some experimental plantations of this variety in the grounds at Kuala Lumpur and also of the new Manihots (*M. piauhyensis* and *M. dichotoma*). The bark is considered to be too thin and the wood too frail; moreover the certainty that Hevea yields large returns, is sufficient reason for the neglect of other descriptions of rubber. In Ceylon I saw Ceará planted with good results at 1600 feet above the sea-level, at this height it is perhaps more suitable than Hevea.

A few Castilloa trees are found on some estates they are considered to be of little value.

Funtumia is very rarely planted at all; as was observed in Java, Sumatra and Ceylon, it suffers from insect fests to such an extent that there cannot be any question of culture.

In the following description Hevea alone will be considered and as true a report as possible will be given on the cultivation of the plantation and the preparation of the product in the Malay Peninsula.

A. PREPARATORY ARRANGEMENTS.

FIGURE 2.

Laterite ground. Soil with a layer of laterite, in which the planting hole has been made; near the hole there is a layer of laterite, which has not yet been weathered. In the background Hevea, $3^1/_2$ years old, kept perfectly clean.

CHAPTER I.

Clearing the Ground.

I. NATURE OF THE SOIL.

In clearing the ground, the following must necessarily be taken into consideration:

a. The composition and configuration of the ground.

b. The vegetation which may be found there and which must be removed before starting cultivation.

With regard to the configuration of the ground there are important variations on the Malay Peninsula. Near the coast and along the rivers, the ground is flat, but deeper in the country it is hilly; in Perak lime-stone is found and also lands consisting of gently sloping grounds, from which rise steep hills. These latter are but rarely planted with Hevea, although an exception is to be seen from the railway between Ipoh and Taiping, where tunnels are frequent.

The composition of the soil varies. In the lower flat valleys near the sea-coast and along the rivers, the ground consists of a clayish sort of earth, usually covered with a thick layer of 1 to 2 feet of black peat, which is found to be elastic when walked upon. According to an examination by KELWAY BAMBER,

this clayish sort of earth consists of very finely divided sand and insoluble silicates, the clayish nature existing on account of this fine division, and not by reason of the presence of kaolin, which only appears in small quantities. When this ground is wet, it looks like heavy greasy clay; in its dry state it forms a loose bottom through which the plant-roots can penetrate easily. Organic matter is generally obtained from it in rather large quantities (8—35 per cent); the nitrogen contents are high (0.4 –0.9 per cent), on account of the soil, which is dry from want of air. Other substances required for plant-food are present in such large quantities, potash particularly so. The growth of Hevea on these soils prove that they are extremely suitable for this culture.

In the hills, a red clayey ground also very rich in nitrogen is found; under this, which is very suitable for planting, there are frequent layers of laterite, sometimes at a lower depth than that to which the plant-roots penetrate, and sometimes quite near the surface. These laterite layers consist of a red, hard, granular iron-ore, through which the roots cannot grow. The upper layers must therefore be broken open when holing for planting. On estates where this is the case, the laterite shows like a heap of reddish-brown grains, which lie about near the hole and disappear slowly (see fig. 2). On soils which consist of pure laterite, the growth of rubber is but very slow.

The marshy, low lying lands near the sea coast give rise to other difficulties when they come to be cleared. The ground here is often hard, on account of the height of the subsoil water; when bringing a litmus paper in contact with this subsoil water, the colour

FIGURE 3.
A plantation on marshy soil. At × a tree with the characteristic appearance of this soil.

changes to red. Since a sour soil is not suitable for the growth of Hevea, it must be sweetened. This can be done by draining, as will be seen subsequently.

The usual practice is to apply lime to these soils, if the clay is not too thick; if the thickness exceeds two feet, the soil is not suitable for Hevea. The best thing to do is to mix the soil which is to be used for filling the holes with lime before planting. Where it is only recognised that lime is required after the trees have been planted, the plantations should be dealt with as follows: near each tree, three holes should be dug at a distance of one foot from the tree for each year of its age, (i. e. for a tree 3 years old, the holes should be 3 feet from the trunk) until the subsoil water is reached, and then a quantity of lime is thrown in. Trees which suffer from sour soil may be easily recognised by the drooping appearance of the crown. The top of the trunk and the upper and lower branches droop and exhibit a grey dried up appearance, and also the form of the root is characteristic (see fig. 3). From the point where the root has been cut from the stump, other parallel and horizontal roots are developed (see fig. 4).

These trees are not firm in the ground, and fall sideways after a time; straight trunks are essential for satisfactory tapping and sloping trunks are objectionable.

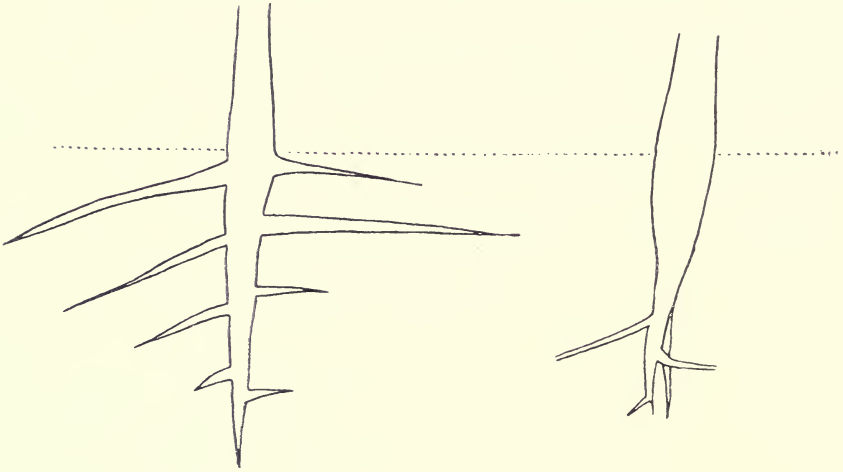
If an estate has to be planted up on clayey sour soil with the aid of lime, it must be carefully examined some months after the first liming. All trees which show the above mentioned characteristics must be continually dealt with until they show a healthy exterior.

The consequences of liming are surprising. I was shown over a plantation which looked so unhealthy

that its abandonment had been seriously considered, but by ample drainage and treatment with lime, the trees thoroughly recovered and compare favourably with neighbouring trees which stand on more hilly ground.

Lime is the only manure which is applied. Artificials or dung are never given and will not be required on virgin soil. Latex contains but small quantities of mineral

FIGURE 4.
Abnormal growth of the root in consequence of the marshy soil.



matter, seeds more. It would be interesting therefore to look for a type with a smaller seed production.

2. ORIGINAL COVERING OF THE SOIL.

The original covering is not without influence on the composition of the soil. Under heavy forest the humus is richer in plant food than it is under secondary jungle

FIGURE 4*a*.
Jungle Belt on an estate in the F. M. S. Between the Hevea fields, a belt of forest has been preserved.

or under lalang, although the latter is sometimes to be preferred for other reasons. These various types should be taken into consideration in settling questions of cultivation.

a. Virgin and secondary Jungle.

In the first place all the timber should be felled in the usual way and then burnt as completely as possible. The ground should be well cleared of dead wood, tree-trunks etc., in order to prevent attacks from fungus, a question that will be dealt with later on. This practice has only become general within the last year, since the reports of GALLAGHER on the spread of fungus have thrown more light on the matter. It seems to be not unusual for dead wood and old stumps to be left in the ground until the plantations are about three years old. It should be understood however that it is more to the purpose, more reliable in the result and cheaper to have the ground as clean as possible when the plantation is started. As a rule, this objective is aimed at. Screw-jacks are frequently employed to clear the ground of heavy tree-trunks, which would otherwise be difficult to clear away.

It is natural that the careful removal of dead wood, tree-trunks, etc., make the clearing much more expensive than a rough clearing only. For felling and burning, the usual calculation of expense is about $ 18 [1]) per acre, but for a complete clearance as much as $ 60 to $ 70 may have to be paid. Nevertheless this high expenditure will be profitable in the long run, as estates which are brought into cultivation at an unduly low figure must frequently be cleared up later on from dead wood

[1]) Straits dollar.

at an enhanced figure accompanied by loss of trees.

On a few estates in the F. M. S. and Sumatra I saw instances of the use of the original forest as "jungle belts" (see fig. 4*a*). These are strips of the jungle which had been left between various parts of an estate in order to prevent the spread of disease. The great objection to these is that they offer excellent shelter for wild animals, and later on they might harbour thieves. It would be better to fell the jungle entirely and plant other trees, such as Ficus, between the Hevea fields.

b. Lalang soil.

If rubber is to be planted on old lalang grounds, the method of procedure is quite different. These lalang grounds have not always been under that weed, they were firstly covered with heavy jungle, that had in most cases been cleared by the Chinese, in order to plant Cassava, but sometimes the Malays cleared it for the cultivation of paddy. Under the regulations, three crops only of rice may be taken off the land. When they have been harvested, the land is left to itself and then becomes overgrown with the destructive grass which is so prevalent in the Malay Archipelago. Lalang, or Alang-Alang (*Imperata Koenigii*) is prejudicial to nearly all cultivated crops, and yet this malign influence cannot be entirely explained. A proof of the strength of its growth is certainly given by the fact that the roots are capable of piercing the living roots of Hevea. In the Cassava plantations there is a considerable undergrowth of Lalang in harvest time. Cassava is said to exhaust the ground to a considerable degree,

FIGURE 5.
Old Liberia plantations, interplanted with young Hevea. (East Coast of Sumatra).

but I cannot obtain definite proofs of this anywhere. Still it seems certain that hilly land under Cassava is exposed to much loss by washing away and lalang and other growths are very rife among it when it is ripe. In these lalang grounds the small drains which were put in when the cassava is planted are still to be seen, just as in Deli, on old tobacco lands, the same condition is observable. I saw a notable example of the cultivation with rubber of old lalang grounds in Negri Sembilan. Australian ploughs had been used in the first place for the elimination of the weed, but this method was subsequently abandoned on account of the irregularities of the ground and the want of skill of the labourers. Hoeing was then adopted, but this had to be repeated every fortnight. The expense was relatively low, about $ 25—$ 30 an acre until ordinary maintenance — weeding every three weeks — could be adopted; this latter cost about 75 cents per month per acre. In wet weather weeding could be carried on quicker than in dry.

One advantage offered by lalang is that clean land, free from logs and other breeding places for fungus, is obtained. It is not yet certain, however, whether tapping results from Hevea on old lalang grounds will equal those on old jungle, and one objection is that there is a heavy loss of surface soil by wash, unless cover plants are made use of.

On the East Coast of Sumatra experiments have been made to ascertain this. It was concluded that the cultivation of lalang soils would cost about the same as that of jungle, and preference was given to the former on the ground of the non-liability to fungus, which is so destructive to Hevea.

It should be remembered that on the lalang grounds of Deli, only tobacco has been grown and consequently there has been no denudation from the rains, so that there is not an exact parallel between these and the old Cassava plantations of the Malay Peninsula.

c. Soils in which other crops are grown.

Finally there are some cases to be discussed where other vegetation than the foregoing has to give place to Hevea — usually this is coffee. On the East Coast of Sumatra this is still often the case, but in the Malay Peninsula it is not so common now (see fig. 5). Hevea is frequently interplanted with Liberian coffee. In such cases there should be no hesitation about cutting the coffee back vigorously where it encroaches on the Hevea (see fig. 6). Otherwise the rubber grows but slowly while it stands between the coffee, and only increases to any degree after its crown has overtopped the coffee. Experience has taught Straits planters that Hevea needs plenty of sun. I have seen several Hevea plantations in the native states interplanted with coffee. Although the girth of the rubber trees may be somewhat less than trees of the same age planted on jungle ground, the production of latex was quite as good. It must be taken into consideration that coffee crops are obtainable for some years during the growth of the rubber, although they are of course a decreasing quantity as the Hevea grows. Furthermore there is the advantage that the ground remains covered and maintenance accordingly is less, whilst there is an absence of fungus.

Sumatran experience is similar, I have seen several

FIGURE 6.

Hevea Stump. Six months old, planted between mature Liberian coffee. (Lampong District).

plantations there with Hevea planted in rows between Liberian coffee. During the first year the Hevea suffers somewhat from want of light, but once it has overtopped the coffee it grows as quickly as that on neighbouring plantations grown in virgin soil. After four or five years, according to the growth of the Hevea, the coffee must be taken out.

CHAPTER II.

Drainage by piping and as a protection against wash.

1. DRAINAGE OF THE GROUND BY PIPES.

For low, flat grounds, good efficient drainage is of the first importance, for Hevea will not tolerate stagnant water. It does not suffer much from occasional floods, but garden maintenance is thereby made difficult. The water level should be at least 3 feet below the surface. Plantations where the average level is higher are unsuitable for Hevea. Even with a 3 feet level, there are numerous difficulties to be contended with. Hevea does not form a very deep growing tap root and consequently it is apt to stand loosely in the ground or even to sink or fall, and although these trees may not die, they are nevertheless difficult to tap when they arrive at maturity.

Too much importance cannot be given to the necessity for good drainage. GALLAGHER has put this very expressively in the following words: "Above all things, *Hevea brasiliensis* must have good drainage".

On an estate in the low, flat valley of Province Wellesley, I saw the drainage carried out in a very

FIGURE 7.

Drainage of an estate situated in the lower part of Province Wellesley. At each fourth row (32 feet), there is a drain. Tapping has already commenced on the Heveas, which are just 3 years old. The plantation was originally topped.

thorough way. The planting distances were 8′ × 30′, and pipes were put in at every four rows, i. e. at intervals of 32 feet, these draining into other pipes at a lower level. In this way the upper 3 feet of ground were drained. The cost of it was estimated at $ 6—$ 8 per acre for laying and about $ 3 for the yearly maintenance (see fig. 7).

In some cases, on low, clayey grounds, other means besides piping have been employed. Between the Heveas, rows of bananas were planted, not as a catch crop, but with the view of absorbing the subsoil water. Everywhere on those estates where such "natural drainage" was employed, the results were extremely satisfactory. The plantation which I saw dealt with in this way made a very favourable impression on me.

The clay lands which require drainage are not only to be met with in the flat country near the sea-coast, but also on the hills where the clay is forming itself into pockets, something like the Dunes in Europe. In any case quick and well designed drainage is imperative.

2. SURFACE DRAINS.

In the hills, surface drains are generally made with another object; not so much to drain off the surplus of subsoil water, as to prevent the constant denudation of the surface soil by storm water. As a rule not much attention is paid to this matter in Java; on many estates nothing at all is done to prevent it, although Hevea seems to be just such a plant for which the surface soil should be carefully kept together. The side roots spread themselves very extensively in the surface

soil and the first results of a heavy wash are, as is frequently to be seen on an old plantation on hilly ground, that these side-roots become exposed (see fig. 8).

These are indications that such plantations do not produce latex throughout the year as in the case of Hevea planted on the level. Terracing, or the plantation of other trees in horizontal girdles around the hills is not practised anywhere (see fig. 9). I only saw one instance of the use of cover plants for the purpose of protecting the surface soil against erosion and will deal with the subject subsequently.

The attention paid to the preservation of the surface soil is therefore confined to the making of surface drains, called in Java "Vanggoten". Sometimes these drains are cut in semicircles, forming canals round each tree. In my opinion, however, a better method was one employed on an estate in Perak. The drains were laid at right angles to the direction of the slope in such a way that they were always in the same horizontal level. The vertical distance between them was always 25 feet, so that on the steeper slopes, the drains, measured along the surface, would lie much nearer to each other than on the flat. The expenditure on these "Contour Drains" would work out at about $ 10 an acre; and the annual maintenance was increased about $ 1 an acre. Exact figures are not obtainable, as the maintenance is reckoned in with the weeding.

Attention should be drawn to the danger of erosion if timely measures are not adopted. The opinion of such a very competent critic as Mr. KELWAY BAMBER, who has had much experience in tropical cultivation, is that everything possible should be done to keep the surface

FIGURE 8.
Washing away. An old Hevea tree on a slightly sloping declivity, with the roots considerably exposed.
An estate near Ipoh.

soil together. The amount of earth lost from erosion is larger than might be thought; it would cost some hundreds of dollars per acre simply to replace by manure the mineral matter washed away every year with the surface soil.

On the highland coffee plantations of Java this experience has been dearly paid for in early years of the industry. Although coffee is different from Hevea, it is still necessary with the latter to avoid from the beginning the loss of the most valuable part of the estate—the surface soil.

CHAPTER III.

Germination of the young plants.

I. CHOICE OF SEEDS.

As a matter of practice no great amount of trouble is taken over the choice of seeds, and I saw no estate in which selection was carried out. It would have been a matter of great difficulty to have done so for as the seeds ripen, the fruit is thrown off the tree.

When walking on a sunny day in a mature plantation, the fruit may be heard every moment bursting open with a short sharp report, the seeds dropping directly afterwards through the leaves. Generally it must be taken that a separate collection of the seeds of selected trees is practically impossible. Still some regard may be paid to the position of the plantations from which the seed is saved; preference would be given to well matured plantations and there the seeds may be gathered from the ground. The oldest trees are chosen if possible without any special reason being adduced. In many cases estates have been planted up so hurriedly that any seed obtainable was sown and sometimes the planter would be in complete ignorance of its source.

FIGURE 9.

Terracing. Plantations on an estate in Java, where the coffee has been carefully planted in terraces, (near Banjoewangi). The borders of the terraces are planted with a green manure, (Lamtoro, Leucaena glauca).

It need not be pointed out that with Hevea, a careful selection of seed is important. Brief attention may be drawn to the great variability of Hevea, for important differences are to be found between the trees. Variations are frequently found in the form of the leaves, in the manner of growth and also with regard to other important characteristics. With some trees, the latex flows all day, with the majority it ceases towards the afternoon. Again, the characteristics do not always remain constant throughout the whole life of the same tree; Mr. RIDLEY showed me, in the Botanical Garden at Singapore, a tree which for several years had given a bright yellow latex that had become modified to a cream colour at the time of my visit.

Besides such unusual irregularities, other deviations occur which are, to some degree, hereditary and similar to those which are to be found in other plants.

Fasciated trees form an example of this nature. In these trees the branches and upper part of the trunk show a twisted manner of growth, forming somewhat of a girdle round the tree. It appears to me that the yellow and variegated plants which are not infrequently to be met with in nurseries belong to the same category. This yellow colour is often attributed to another cause, lack of lime or iron (chlorosis) or of some plant food in the soil. These yellow leaved plants are however to be considered as hereditary variations which retain the characteristic of deviation from type in more or less strong proportion.

It is not difficult to discover one of these yellow leaved trees on a plantation; they do not grow as quickly as the normal plant, and they should be removed

immediately, and in no case used for planting out.

The colour of the bark varies in different trees from whitish-grey to dark brown. Trees with a whitish bark are less desirable than the brown ones, as the former are generally thinner.

Not infrequently, trees are found with a knotty bark, and the cause of this phenomenon need not be attributed to parasites, it may be based on variation (see fig. 10). Attention should also be drawn in passing to the small round wooden knobs which are found in great quantities on some trees and which have been formed by the excrescence and pruning off of adventitious buds. These are not caused by parasites nor can they be attributed to tapping too deeply, as they are found, although to a smaller extent, in trees that have never been touched by the tapping knife.

2. SEEDS AND NURSERIES.

The method of sowing the seed depends on the manner of planting that is to be adopted. This may be carried out in three different ways:

1. Seeds at stake.
2. Stumps.
3. Basket plants.

In the first of these the seeds are sown directly in the position which the trees are subsequently to occupy and no nurseries are required. Seedlings are usually however preferable.

When baskets are used, these are placed close together, so that they may support each other, and the neighbourhood of an older plant is chosen for the purpose, so

FIGURE 10.
Tree with knotty bark. Plantations 4 or 5 years old on an estate in the neighbourhood of Klang. Under the Hevea is Passiflora as a soil covering.

that the young plants may get some light shade. On the only estate where I saw this practice in operation, the non-germinated seeds were put into twisted baskets of bamboo, averaging about 4 to 6 inches in width and 6 inches in height, and costing about $ 1 1/2 to $ 2 1/2 per hundred. The seeds were kept in the baskets for 2 or 3 months. By that time the taproot will frequently have grown through the bottom of the basket and must be shortened for planting.

It does not seem advisable to me to shade the plants.

On the larger proportion of estates in the Malay Peninsula, the stumps which have been grown in nurseries are planted out in the position they are finally to occupy.

Frequently wild seeds are used, but sometimes those from cultivated trees, and it seems to me that the latter should be recommended, especially in cases where the seeds have been sent from a considerable distance, and there is accordingly some risk of non-germination.

In order to germinate the seeds, they are put closely together in germinating beds and covered with lalang grass so as to keep the soil moist. In Java, the seeds are frequently laid between gunny bags which are kept moist in a dark corner of the godown or the nursery buildings. The seeds are then thoroughly examined. When a little knot — the radicle — appears, germination has commenced.

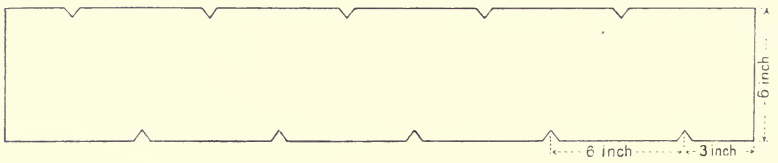
The seeds are then transferred to the germinating beds which are made as follows. The soil is dug up to the depth of 1 or 1 1/2 feet and cleaned from roots, stones and other rubbish; paths are dug 1 foot deep and a few feet in length, these serving also for drainage.

The width of the beds varies from 4 to 6 feet. The distance at which the seeds are planted is from 4 to 6 inches. Ungerminated seeds are carefully pressed into the soil with the hilum underneath so that they are just covered by the soil. The germinated seeds when planted out are put into the ground with the radicle downwards.

On one estate I saw a small "saw board" used for planting out the seeds (see figure 11). It was 6 inches in breadth, and notches were made on both edges at intervals of six inches so that the notches on opposite sides alternated. When the seeds were to be sown, they

FIGURE 11.

Implement for seeding.



would be pressed into the ground by the notches on one side, the board would then be turned round and the seeds laid out again for the alternate notches. They would therefore be planted out in quincunx fashion with six inches between the rows. A wide distance is recommended if stumps are used, the stem and leaves as well as the roots have then an opportunity to develop strongly. The beds are carefully watched and not shaded for the first week after sowing, but later on, especially if there is no rain, a light shade is given by putting the leaves of ferns (*Gleichenia dichotoma*) between the seeds

FIGURE 12.
Nurseries made between old plantations. Hevea 2 years old, planted 12 × 24 feet. Estate in the neighbourhood of Ipoh.

in the ground. I saw on one estate the leaves of *Albizzia Moluccana* employed with great success for this purpose; the advantage is, that when they are a little shaken in clearing them off the beds, the leaves fall off and in this way a mulch is given to the bed which is very beneficial to the young plants. The shade should be taken away as soon as possible in order to obtain strong compact plants; if there is too much shade given, fragile plants are obtained, which will not stand transplanting. The beds must be watered as little as possible, only for the first few days should be soil be kept moist.

Sometimes I saw seed beds planted under Hevea plantations of several years old. This system is not to be recommended. If a plantation is made on a old nursery it is visibly thinner than plantations on virgin ground; this at once condemns the making of seed beds in old plantations, equally with regard to the old plantation as for the young plants. The young plants get too much shade. If the planting is done in baskets there is the disadvantage of transplanting from the shade into the open. It is different, if in young plantations partitions are made between the rows for the cultivation of seed beds. On one estate I saw beds planted in this way, which had a very favourable appearance (see fig. 12). At the place where the beds were to be made, the soil had been dug up in the depth of $1^1/_2$ feet, and then bedded up with the surface soil from the immediate neighbourhood. The beds were about 6 feet in width; the Hevea planted 12×24, the beds laid between the rows, so that they were at a distance of 9 feet from the young trees. The latter were two years of age, the beds, at the time of my visit, were $2^1/_2$ months old. The position

of the beds as well as of the young plantation was extremely good. Planting out in this way, where no expenses of cultivation have to be included, as distinct from beds on virgin soil, it may be calculated that 1000 stumps, ready for planting will cost about $ 3; in this price the cost of cultivation, of the beds, seeding, maintenance, etc., are included.

3. Stumps.

It will always be best to make up the beds on virgin soil, on land specially chosen for this purpose; when the plants have been put out, the old beds must not be used immediately afterwards for planting out, they must first be laid down to timber, or be planted with a leguminous crop so that the distinctive influence of the nurseries is no longer effective.

In preparing the stumps, they must be cut down to 1 or 2 feet. Care must be taken to keep on the stem a pair of buds for the development of the growth, one of them forming the trunk. The cut with which the stem is shortened, must be slanting and smooth and must be tarred, so that it will not offer any attraction for fungus. Special care should be taken not to use too thick stumps; those the thickness of the little finger are the best for planting out. If they are thicker, then the bud does not grow so well into the lower part of the trunk, and in the trunk of the older tree, a bend will exist, which will make tapping difficult. (See fig. 13).

The tap root should also be shortened to $1\frac{1}{2}$ feet and the side roots to little stumps.

When pulling the stumps, attention should be paid

FIGURE 13.
Results of planting with too thick stumps. Tree $3^1/_2$ years old planted as a too thick stump, consequently the tree shows a curve.

to the tap root; plants where this has grown crooked, are not suitable for putting out. As mentioned before, all yellow leaved plants and stragglers must be destroyed.

In Java, where the plants are put out as stumps, cuttings are sometimes used, so that the upper part of the trunk can be utilised, doubling the number of available plants; this method of obtaining trees can only be applied to young plants; cuttings from older trees are no use. In the native states cuttings are never used; the abundance of seeds makes such a difficult method of obtaining more plants quite unnecessary.

The planting up of the nurseries can be arranged according to the following rules:

1. The seeds are put out to be germinated in gunny bags or on the soil, covered with hard grass.
2. As soon as the radicle has appeared, the germinated seeds should be pressed into the ground, so that they are just covered.
3. The beds should be made in virgin soil, dug up $1^1/_2$ feet in depth, and provided with paths of the same depth.
4. The beds are watered only when necessary, and only shaded at the beginning.
5. The stumps are suitable for planting out, when they are a finger's thickness; the stem should be shortened 1—2 ft. (two buds), the tap root to be of a similar length.

CHAPTER IV.

Planting.

I. METHODS OF PLANTING.

Before starting planting out, the question, to be taken into consideration is, what method and what distances are most suitable. In the first place, these factors depend upon the soil; the better the soil, the wider should be the planting; trees in less fertile soil do not mature so early and the dimension of the crown will be smaller, so that they should be planted closer together.

Furthermore, when choosing the planting method, it should be considered as to whether catch crops are to be planted.

If that course is decided upon, a wide planting distance is advisable; Hevea should be planted preferably in rows; so that in the rows, the trees are close to each other: whereas between the rows, broad paths of open soil may be made use of for catch crops in the first few years.

Planting in rows has also the advantage that later on, by thinning out, the plantation can easily be widened, without the regularity of the plantation being destroyed;

however, it is not safe to rely too much on thinning out. Experience teaches that there are many plantations which should be thinned as their age increases, whereas, when the right moment arrives, it could not be decided upon; there are very few where thinning has been properly carried out.

The setting out of the rows is done by means of the compass. When planting them the prevailing winds must be taken into consideration. Opinions are divided; on some estates, the rows are planted in an East and West direction, so that the soil gets plenty of sun. Others plant the rows North and South, so that the Hevea crown shades the soil in the morning and afternoon. If a catch crop is to be planted, the former system is to be recommended; otherwise the second.

With regard to thinning, opinions are divided as to the best way. On some estates, it is done regularly, for instance, at each alternate tree in the row, it being considered immaterial as to whether a large or small tree is taken away; other planters — I believe most of them — prefer to have the thinning out done so that only the weaker trees are taken away, to such an extent, that only the desired number of trees per acre may be left.

The first practice has this advantage, that a perfectly regular planting distance is maintained, which always, not only for upkeep, but also later on for tapping, considerably facilitates matters.

If planting is made in regular rows, this will allow an irregular thinning out, as the regularity will be sufficiently maintained to allow of satisfactory control of the plantation.

2. NUMBER OF TREES PER ACRE.

The following figures give an idea of the average distances for Hevea, which are usual in the Malay Peninsula.

Malay Peninsula.

(F. M. S. & S. S.)

	Planted surface in acres.	Number of Planted Trees.
1906.	123,463	12,325,904
1907.	179,227	27,558,440
1908.	241,138	37,440,200

In 1907, the average number of trees per acre was therefore, 153, which is equal to a distance of 17 × 17: in 1908, it was 163, or 16 × 16 feet. In 1906 $^1/_3$ of the total plantations in the Malay Peninsula exceeded 200 trees per acre, that is, less than 15 × 15 feet; whereas $^1/_7$ consisted of plantations, the distance of which amounted to 18 × 18 feet. The average for that year was 168 trees per acre, as a maximum.

Experience has taught us that we should not plant closer than 15 × 15 feet. If the planting distance is less, the plantations are backward and even after thinning, they are small in diameter, compared with plantations which had been originally made at a wider distance and they will never make up the difference. A wider planting distance than 15 × 15 feet will be advisable in cases where catch crops are cultivated.

As we have already seen, preference should be given to planting in rows instead of in squares or lozenges. The above mentioned figures can be taken as a basis for planting in rows. Generally the distance in the rows amounts to the half of the distance between the rows. The distance mostly adopted is 12 × 24 feet; on one Estate where the older fields were all planted 10 × 20 feet this distance was given up and all the new fields were planted 12 × 24 feet.

Wide distances have a considerable advantage over close planting and great preference should be given to them, even if any older Hevea-plantations were not to be seen. The advantages of wide planting may therefore be more closely particularised.

In the first place, as regards tapping, the crop can be calculated according to the total tapping surface of all the trees per acre. The tapping surface per tree is obtained by multiplying the height up to which the tapping can be made, by the girth of the trees. The height at different planting distances is, of course, the same; we need only therefore keep account of the girth of the trees. The best planting distance will accordingly be one in which the total girth of the trees per acre, is the largest in the long run.

The total girth is obtained by multiplying the average girth per tree by the number per acre; in this calculation, the wider the distance the greater the girth.

Increase of girth of trunk with different planting distances; for a plantation in Province Wellesley, planted January, 1906.

Planting distance.	20 × 20	10 × 30	12 × 24	8 × 30
No. of Trees per acre	109	145	150	181
Average girth of trunk				
on 30th Sept. 1907 .	9	3		6
„ 1st Jan. 1908 . . .	9 3/4	4		7 1/2
„ 30th Sept. 1908 .	12 1/2	6 3/4	7 1/4	10 1/2
„ 1st Jan. 1909 . . .	14	8 1/2	8 1/2	12
„ 30th Sept. 1909 .	17 3/4	12 1/2	12	15 3/4
Total girth per acre.	1934.75	1812.5	1800	2850.75

In the first line, the planting distance is given, secondly is the number of trees per acre, which accords with the planting distance. On the line beneath, the average girth of 20 measured trees is inserted. Under that is the figure for the total girth per acre, which is obtained by multiplying the average girth of the trunk by the number of trees per acre.

It appears from the figures that with a wide planting system the total girth per acre is greater, than with a narrow, with the exception of the last column. If, therefore, the tapping surface is to be taken into consideration, a wide planting method is best. Furthermore, the figures show that with a wide planting system the

average girth per tree is the greatest, i. e. that with wide planting the trees attain a tappable girth quickest. In order to bring the plantation into production in the speediest possible way, therefore, wide planting is advisable.

We have, however, to take other factors into consideration. With wide planting, the total bark-surface is divided over a small number of trees; less labour is accordingly required for tapping the bark surface, as the work for a large tree is about the same as for a small one, so that, if a double number of trees have to be tapped, in order to deal with the same bark surface, double the amount of labour must be done. We shall see later on that the returns for various planting systems differ less when they are calculated by the acre, than when comparing the productions per tree; it may therefore be taken that so far as the crop is concerned, a wide planting system is more profitable than a narrow one.

If, in view of tapping expenses, a wide planting system is advisable, on the other hand, having regard to maintenance, a narrow planting method may be recommended. The closer the planting is effected, the quicker the plantation will close up and close plantations do not, of course, cost as much for upkeep as fields where the soil is still lying open. This objection can, however, be overcome in another manner, with fields which are planted at wide distances, i. e. by planting a catch crop between the rubber. Nearly all cultivations suitable for catch-crops require light and therefore specially require wide planting distances in the Hevea. In planting in rows, there are, between the Hevea, roads of open soil which are well

exposed to sun and air for years and make the cultivation of another growth possible. (1)

These conclusions may be summarised as follows:

1. Cultivation in rows are preferable to squares or lozenges in view of the possibility of the cultivation of catch-crops and also of thinning out at a later period.
2. A wide planting distance gives large trees at an earlier date, a more lasting plant, makes the expenditure on the crop less, but the cost of upkeep is higher, if no catch-crop is planted.
3. More than 200 trees to the acre should never be planted.

3. HOLING.

The plant holes are made as usual in tropical cultivation. The dimensions are generally 1 1/2—2 feet square, with a depth of a good 2 feet. For filling two methods can be used; the holes may be made about three months before planting and the earth which has been dug up left in a heap exposed to the sun and air; or the hole may be made immediately before planting and filled with the surface-soil, which has been scraped together from the edge of the hole and from the walls, thereby enlarging it; as the surface sinks it is again filled up with the heap of earth from the bottom of the hole.

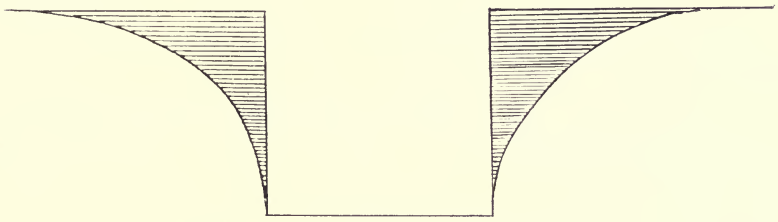
As the Hevea root develops itself especially in the

(1) A view of the development of a plantation with a planting distance of 12 × 24 is given in fig. 12, which also shows that during the earlier years large strips of ground are kept well open.

surface soil, the latter method of making the holes, is in my opinion to be recommended. (See fig. 14.)

On some estates, I saw that round plant-holes were made by Tamils with small spades, or "chokes". The holes were about 2 feet deep and 1 foot wide in average. This holing is done quickly and one man can make 60 daily. For the development of the tap-root, these deep holes are sufficient, the side roots cannot, however,

FIGURE 14.
Sketch showing the manner of filling plant holes.



The earth from the sides and the surface — indicated by shading — is used for filling; the loss of earth is replaced by that which has been taken out of the hole.

develop themselves as easily as in wider holes, only for soils where at a certain depth, a less penetrable layer is found, laterite, for instance, or a layer of gravel, or padas or iron-ore, and where, therefore, deep holes must be made, such small deep ones are advisable (see fig. 2).

4. PLANTING IN VARIOUS WAYS.

The plants may be put in the ground in three ways:

a. Seeds at stake.
b. Basket Plants.
c. Stumps.

a. Seeds at stake.

In this system frequently a few seeds are put in the soil. Several planters assured me that this method of planting would be preferred by them, if vermin, such as ants or rats did not feed upon the seeds, and therefore, destroy a great part of them. There are other objections to planting seeds at stake; it takes a longer time before a mature plant is obtained from the seeds and upkeep must be continued longer, whereas, if basket plants or stumps are used for planting, the reserve material contained in the young plant would carry it on, even although cutting the stump causes a temporary stand-still in the growth of the plant. Furthermore, a great objection against planting of seeds in the open ground is, that the seedlings cannot be selected as with planting in nurseries, where weakly plants may be eliminated. It is very desirable that the tree trunks should grow up quite straight. (see fig. 15).

b. Basket Plants.

Planting in baskets has the advantage that the young plants continue their growth immediately and grow up quite straight; still on the other hand, under this system younger and smaller plants are obtained than with stumps; the latter are generally about nine months old; whereas, basket plants are only a few months old when planted out. The baskets are planted entirely in the hole, which is then filled, it is not necessary to tear open the basket; in the roughly twisted bamboo there are enough openings for the side-roots to grow out. An advantage of basket

FIGURE 15.
Hevea plantation made from seeds at stake, in Serdang, $1\frac{1}{2}$ years old.

plants is that the root need not be shortened. The plants are therefore less subject to the depredations of white ants, which often attack the root of stumps where they have been shortened.

With the planting of baskets is included also the planting of dung pots. As far as I know this is not done anywhere in the Malay Peninsula.

c. Stumps.

The third most usual method is the planting of stumps. The seedlings are left about nine months on the beds, until the stem has become the thickness of the little finger. The stem and the root are then shortened, the former to about 2 feet, the tap-root to $1^1/_2$—2 feet, the side roots to stumps of a few centimeters.

The great advantage of stumps is that care can be taken that the plant is put in the ground exactly at the right spot and that it is certain that the plant has a sound healthy and straight tap-root; whereas with basket plants there is not this certainty.

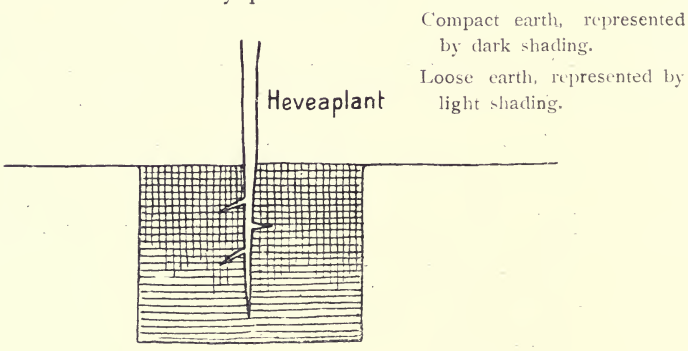
It is true that it takes some weeks before the stump pushes out, but on the other hand the growth is quicker than that of a basket plant, so that the damage is quickly repaired (see fig. 6).

5. THE PLANTING.

With the planting itself, two different methods are followed. In one, a marking stick is left in the hole, which is then filled, and a hole is made with a dibber in the loose earth and the plant is put in. The other way is that the hole is not filled until after the plant has been

put in. The best method to employ is the following; a strip of wood with a notch in it is put across the top of the hole with the notch against the marking stick, which is withdrawn and the plant kept in the notch till the hole is filled. This latter method of planting is advisable; the plant can then be put in the soil in the right place; with planting with a dibber the neck of the root often gets too low, because as the earth is rammed in, the plant goes down with it. Hevea is very sensitive to this; great care has to be taken that the stumps are

FIGURE 16.
Badly planted tree.



never planted deeper than they originally were in the beds. Furthermore the planting with this notched strip has the advantage that it is easier to see whether the tap-root is straight down in the soil.

One objection to the first method of planting is, that when the earth is filled in often only the surface soil is rammed down and that the subsoil remains loose, so that later on, when the dry weather comes, the soil round the plant becomes a separate clod and does not consolidate in one whole; this is called "Kawin" in Java. (see fig. 16).

Special attention should be drawn to the necessity of putting the plants in the ground in the exact place. If the collar of the plant, which should be above the soil, be covered, then either the Hevea dies or makes buds on the stem below the surface of the soil and an irregular or crooked growth is the result.

The method of planting to be followed may be summarised as follows:

1. Holes must be ample, for preference 2 cubic feet, and the earth used for the filling, must be well weathered.
2. Planting of seeds in open ground is not advisable.
3. When planting basket-plants or stumps, attention should be paid so that the collar of the plant is not sunk lower in the ground, than it was on the beds.

B. UPKEEP OF THE PLANTATIONS.

FIGURE 17.

Clearing. Plantation on an estate in Serdang. In the foreground, Hevea $1^1/_2$ years old, in the background $2^1/_2$ years old, which has been kept entirely clean from the beginning. The weeds have been raked up into rows.

CHAPTER V.

The upkeep of the Garden.

1. WEEDING.

With regard to the upkeep of the garden, different systems are adopted.

1. Clean Weeding.
2. Semi-clean Weeding.
3. "Dirty" Gardens.
4. Planting with Cover Plants.

a. Clean weeding is, when the plantation is once clean, the cheapest system. The difficulty is often, that, on account of lack of labour, during a short period of the year, pecuniary and other causes, the gardens are left unweeded and subsequently would not be entirely cleaned up, as the whole labour force would be otherwise employed in getting out lalang. It is therefore absolutely necessary, if the system of clean weeding be adopted at all, that it should be carried out systematically from the beginning of the work and no pains should be spared to this end (for examples of clean-weeding, see figs. 15 and 17). On a thoroughly clean weeded estate in Perak, where the plant was indeed "quite clean", I saw by the books that the gangs of labourers who weeded

the gardens covered the same ground every fortnight.

In such a case the weeds cannot seed and the expenditure on weeding per acre is very low, especially when the plant is well grown. This experience is comfirmed in Java with the so-called "djoetoel-system" which is employed on well cleared gardens.

It is essential, by careful management, to control the work in the plantations, in order to see that each field gets its turn every fortnight.

Working with absolutely clean gardens, has, therefore, the advantage that it is cheap; a second advantage is that the Hevea, with such upkeep, gets on splendidly.

A third advantage is, that it facilitates the control of the upkeep of the garden and noxious plants like lalang get no opportunity of getting a foot-hold in the plantation.

The advantages are not however, all on one side. On sloping lands where the soil is not under cover plants some amount of wash takes place, whereby, the best part of the soil is lost, as well as a part of the roots of the rubber trees (see fig. 8).

It is time something was done to prevent this, by means of surface drains, but this remedy is not wholly sufficient in hilly lands.

b. Partly cleaned gardens. On steep lands which are much exposed to wash, part of the weeds are sometimes left, only the lalang and other noxious weeds being taken away, plants like *Passiflora foetida*, *Mimosa pudica* and other harmless weeds are retained, and somtimes even cultivated. The gardens must be kept as systematically as the clean weeded ones. It is necessary to point out that under this system, full control of upkeep is not possible and there is always the danger that lalang

FIGURE 18.
Unweeded gardens. An unweeded garden of Hevea; round the trees, a circle has been cleaned.

may predominate over the benevolent weeds; the former must be taken out and this necessitates high expenditure. A second disadvantage is, that the rooting out of the noxious weeds from the benevolent ones is much more difficult than on a clean weeded estate and thereby weeding bills are very heavy.

I saw a plantation on an estate on hilly land, where grass and weeds were growing, but they were regularly cut down and a circle was left clear round the trees. Such a system is much more expensive than clean weeding. Moreover, the weeds seemed to be disastrous to the Hevea; the trees looked poor. (See fig. 18.)

2. COVER PLANTS.

A better method than working with half clean gardens, is the cultivation of special kinds of plants, to grow between the rubber instead of leaving it to Providence, as to which plants may grow up. The plants which may be chosen to help the Hevea are planted with several ends in view. (1)

a. Plants which assist in the drainage of the soil.

In a previous reference to marshy soil, it was mentioned that in order to dry out the land Bananas are sometimes planted between the Hevea.

(1) Full particulars concerning the application of green manure in rubber plantations are to be found in the report of the Congress of the Dutch Indian Syndicate of Agriculture, held at Bandoeng in August 1909. See "Publicaties van het Nederl. Ind. Landb. Syndicaat" 1909—1910.

b. Plants which improve the soil.

To this category belong the Leguminous plants, which are used for green manure; they give a great quantity of leaves which are rich in nitrogen. Sometimes *Crotalaria Striata* or *Tephrosia purpurea* are used on the Estates in the Malay Peninsula as green manures; most planters however are not in favour of such a system, thinking that these plants assist the distribution of fungus. Considering that the land already contains a large proportion of nitrogen and organic matter, green manure does not appear to be of great importance.

c. Plants which protect the soil against wash.

We have already seen that on the Malay Peninsula plants are very seldom used to bind the soil. Only once I saw this systematically carried out and in that case ferns were planted in rows between the Hevea. On a rubber estate in Sumatra, I saw Krokot, (*Sesuvium Portulacastrum*) used; the cultivation was attempted on the slopes, but without material success. In the mountains of Java not unfrequently "Bajem merah" (*Alternanthera amoena*) is planted out in horizontal rows, the stalks grow close to each other and form a sieve, so that the soil is kept together. Latterly also, *Leucena Glauca* is used for this purpose, and this has the advantage of improving the soil to a considerable degree; it must be cut down regularly, and the foliage must be left to rot on the soil, or must be dug in (see fig. 9).

FIGURE 19.
Passiflora Foetida, as applied as a soil covering in a Hevea plantation of 4 years old, on an estate near Klang.

d. Plants which destroy other weeds.

The usual idea in cultivating plants between the Hevea, is the destruction of noxious weeds. *Passiflora foetida* is used accordingly, a plant which is found everywhere at random. Especially on the flat low valleys, where the struggle with the lalang is severest, this plant is made much use of, but on no estate did I see it used to protect the slopes against wash. It forms a rather close cover over the soil, about 1 foot thick. The fall of the leaves is not important, neither does it protect the soil entirely against other weeds; when the *Passiflora* is taken away sometimes other weeds come up, amongst which grasses are found, but amongst those, I never saw Lalang. Although a climbing plant, it does not seem able to climb the small Hevea trunks (see figs. 10 and 19.)

Mimosa pudica (sensitive plant) is also used as a soil covering against lalang, but it is not sufficient for this purpose, it does not separate the soil sufficiently and raises further the objection that it is extremely thorny, which makes it very difficult for the coolies to walk in the grass.

If a climbing plant is wanted for the destruction of weeds, then "Kratok" (*Phaseolus Lunatus*), which is not unfrequently planted in Java, for this purpose, will perhaps give better results. As regards its growth and its capacity to destroy other plants, it is not inferior to *Passiflora*. Kratok, however, sheds fewer leaves and has the advantage of enriching the soil with nitrogen and breaks up with its deeply penetrating roots, the deeper layers of soil. I saw it applied with considerable success to a Hevea estate in Java, as a soil covering (see fig. 20.)

The disadvantages of all these weed destroyers are:

1. The upkeep of the gardens cannot be so well controlled with due regularity and it is difficult to ensure that all noxious weeds are really taken away.
2. It is much dearer than absolute clearance.
3. A Catch crop can only be planted between Hevea with difficulty or not at all; certainly not, when a climbing plant is used for a covering.

3. DIRTY GARDENS.

The system of working with dirty gardens now remains to be discussed. It is not to be understood thereby, that the Hevea is planted and then left to take its chance. In such a case lalang would quickly predominate and with lalang no Hevea can grow (see fig. 21).

The unhealthy looking yellowish stunted trees, which are here and there to be met with in the lalang soils of the Malay Peninsula give quickly the conviction that proper upkeep is the most important requirement and that it is better not to plant at all, if absolute certainty cannot be felt that it will be subsequently maintained. It is sometimes forgotten that it is easier to exploit and plant a large Estate than to keep it up for a few years. The maintenance should be started from the moment that the forest is cut off and burnt and when the soil is open, otherwise it costs ten times more money and brainwork to get clean gardens.

On some estates, I saw the method adopted of keeping only the rows of Hevea clean for a few feet in width, whereas, in rows between, lalang had grown high and only just round the tree, a space of a few feet was kept clean. This method is certainly not advisable. The under-

FIGURE 20.

Hevea with Kratok. On an estate in South Preanger (Java). The Hevea is about 3 years old. The Kratok forms a thick covering over the soil.

growth is continually working to destroy the pieces kept clean, and it needs continual attention and great expenditure to prevent this. The neighbourhood of lalang near the Hevea-roots, which extend far in the soil, cannot have a favourable influence.

In an estate in Java, where formerly the gardens were kept in this manner, the weeds were eventually cleaned out by giving a few more feet of diameter to the clean spaces each weeding time, so that the spaces ultimately joined and the whole surface was clean. I visited this estate before and after this improvement and it was interesting to notice how the trees increased after the clearance. The upkeep of a Hevea plantation is not very expensive.

If the trees are planted at an average distance, in about 4 to 5 years, the plantation will have closed up, and a few years later, it will be a dark forest, where no weeds can penetrate. There will only be found some quantity of young plants, sprung from the seeds which have fallen from the older trees. It is advisable to weed out these small plants regularly, as they rob the soil unnecessarily, and increase the danger of fungus.

CHAPTER VI.

Catch crops.

1. REQUIREMENTS FROM CATCH CROPS.

One of the points upon which opinions are mostly divided, is the question whether it is advantageous or not, to plant between the young rubber, other plants which will give a profit before the rubber comes into production, and cover, at least, part of the upkeep, expenses and maintenance during the earlier years. On some old estates, where tapping is already being done on a large scale, these are not necessary. The profits which are readily obtainable from Catch crops, are not required and it is preferable to concentrate as much energy upon the rubber plantation as possible; the crop from the older trees is sufficient to cover all expenses, to provide money for extension and to distribute, moreover, high dividends. For younger and smaller estates, it is different; here we are anxious to find a cultivation which gives sufficient profit as soon as possible, in order to strengthen the capital account and cover the high expenditure for the upkeep of the young plantation.

When the Hevea is about to mature and come into production — i.e. after about 4 to 5 years, or with a

FIGURE 21.
Hevea Plantation in Province Wellesley, overrun with Lalang.
The Hevea is here and there only slightly visible.

wider system of planting perhaps 6 years, — the catch crop must be taken out, the shade of the old Hevea is too close to have another cultivation beneath it; perhaps too, from the point of view of management there would be objections against proceeding with tapping while at the same time taking care of the catch crop. It is advisable to plant the Hevea out fairly close together in the rows, but with wider distances between the rows; a sufficient number of trees can be planted per acre and will still leave a space for roads where the catch crops can find a place.

It is advisable not to approach the rubber too closely with the catch crop; a suitable distance is, for instance, 6 to 7 feet on either side of the Hevea rows. There is then no danger of the Hevea suffering from the catch crop or that the latter may be too much overshadowed by the Hevea and moreover, a large open space on both sides of the Hevea facilitates the control of the maintenance.

For a plant to be suitable for a catch crop, it must answer the following requirements;

1. It must not prejudice the development of the Hevea.
2. It must come into production as soon as possible.
3. Its cultivation must not present special difficulties requiring a exceptionally trained labour force; the production must not require a special installation of expensive machinery.

2. CATCH CROPS IN THE MALAY PENINSULA.

The catch crops which I saw made use of in the Malay Peninsula were the following:

a. Cassava (Tapioca).

Cassava has been planted for several years in the Malay States, usually by the Chinese; it was, therefore quite natural for it to be tried as a catch crop. It answers partly to the requirements enumerated above, but there are some objections; although nearly always it is considered suitable for the purpose. When cassava is planted in this way in rubber, it should not be too close to it; when rubber is planted in an old cassava plantation, obviously it must suffer and therefore the cassava is planted in rows between the Hevea.

For the following reasons, cassava is considered unsuitable as a catch crop:

1. *Cassava tends to exhaust the soil.*

It has already been mentioned that there are no proofs of this, but it is certain that with repeated cultivation of cassava on the same place, its production decreases, although it does not follow from this that the soil would be less suitable for other plants. If cassava is only planted far enough from the Hevea on raised beds, then soil exhaustion, so far as Hevea is concerned, will not be important.

2. *Cassava is not a profitable crop.*

The decrease in the price of cassava meal of late years makes its preparation so little profitable that the tubers are almost unsaleable to the Chinese meal manufacturers. A case was mentioned to me where the cassava was

FIGURE 22.
Hevea Plantation 3 years old, between which sugar cane is cultivated as a Catch Crop; here and there reeds are still to be seen.

planted between the rubber and output was firstly sold at $ 6 per acre, the price could not be maintained and finally, it was offered to anybody who would only clear it out of the ground and take it away under contract to clear the ground completely. It is rather difficult to clean up the land, as the growth is very persistent, even after a thorough eradication.

3. *After the cassava, lalang comes up.*

In most cases it is not possible to weed an estate with cassava as clean as one without a catch crop. The stalks and weeds hinder the weeding and make it difficult to carry it out effectively. Once the cassava has been cleaned up, the lalang which seems to be always underneath, grows out. In lower Perak and Province Wellesley, I not unfrequently saw Hevea gardens, where old cassava beds were still faintly visible, covered with lalang and where the rubber had obviously to suffer from the lalang.

b. Sugar cane as catch crop.

In the low districts of Province Wellesley, with a very fertile soil, sugar cane is planted as a catch crop. The Hevea is planted out in rows, 12 × 24, or 8 × 24 feet. The cane is planted between and earthed up. During the first year the production per acre is not quite so good as cane planted by itself and in subsequent years, the cane production considerably decreases and still more so the sugar contents. It is usual to grow cane therefore for three years only and figures of production were given

to me showing for the first year 69 piculs per acre and for the third year only 25 piculs. The examples which I saw of this cultivation gave the impression that the Hevea did not suffer at all from the cane; one-half of the trees which were three years old were already being tapped. The favourable growth was partly attributed to the thorough cultivation of the soil, which was always under a crop; the soil was therefore cultivated down to $1^1/_2$ feet and the dead cane leaves were dug in.

Of course cane can only be planted as catch crop where there is a sugar factory in the neighbourhood, capable of dealing with the crop. In the above mentioned example, this was so and transport charges were low; as the whole country is intersected with drainage canals, so that water transport is easy (see fig. 22).

As was the case with cassava, after sugar cane, lalang comes up quickly and as soon as the last cane crop is out of the field, the garden must be cleaned.

c. Vegetables and other cultivations.

In the same districts where sugar cane is planted as a catch crop, vegetables are often to be seen planted in the rubber. After being planted with Hevea, the land is given to Chinese market gardeners, who plant different vegetables under the Hevea, such as Yams (Sweet Potatoes), ginger, several sorts of Solanum, Patchouli and others and being good agriculturists, the gardens are kept carefully. The results are favourable and the growth of the Hevea is excellent.

Mention should here be made separately of the use of Indigo as a catch crop; this is planted in the same

FIGURE 23.

Liberian Coffee as a Catch Crop. Hevea on an estate in Serdang, on the left with Coffee on the right, without. Age of Liberian Coffee, $2^1/_2$ years old, of the Hevea with Coffee, 1 year and 7 months, of the Hevea without Coffee 2 years.

districts. The leaves are cut off and used for the preparation of the well known dye; the whole industry is in the hands of the Chinese. The catch crop of Indigo appears to do more good than harm to the rubber. In Java I saw it used sometimes as a green manure in Hevea plantations, in this case the leaves are cut off and dug in.

Several other plants have been experimented upon by the European planters for catch crops, but not on a large scale and with one exception quite unsuccessfully; as an example may be quoted the *Sansevieria*, a fibre plant; it was not even cut and during my visit, it was being pulled up out of the Hevea. On the same estate, there was planted with more success, a relatively rare medicinal plant, which is often found in the neighbourhood. I refrain from giving its name here, as the one estate fully meets the requirements of the market and more plantations would speedily result in an over-production.

On one estate in Java, I saw Citronella and Lemon grass planted as a catch crop. At the present prices, these cultures are hardly profitable; they require a rather expensive installation and the transport of the leaves from the plant to the stills involves much labour.

3. SHRUBBY PLANTS AS A CATCH CROP.

On some old coffee estates in the Malay Peninsula Liberian coffee has been planted as catch crop between the rubber; but I only saw young estates planted up in this way. In Sumatra, I saw an example of Hevea planted out between young Liberia; during my visit the Hevea was about two years old, the Liberian coffee

a year older (see fig. 23). Both plantations looked well and the measurements of the trees appeared to be in no way inferior to those on a neighbouring estate which were not planted between young coffee.

In Java and Sumatra and at present also in the Malay States Robusta coffee is used more and more as a catch crop between rubber. Of all varieties of coffee, Robusta is certainly the most suitable for use as a catch crop. In many respects it is preferable to Liberia; for the latter only comes into full production after four or five years. This is so much the more important as in the ordinary way coffee must be cleared out after about five years for the shade of the Hevea grows too heavy and the coffee becomes unproductive (see fig. 24). From the Robusta therefore, two or three full crops can be taken, from the Liberia only one. (1)

The crop is much larger and the gathering and preparation come out cheaper; the principal advantage of Robusta as a catch crop is, that it comes early into production, after two years it gives a small crop, and after three years it is in full production. There are therefore the two advantages that the Robusta comes into production earlier and matures better than Liberia.

In this respect we may refer to the planting of young rubber in old coffee gardens, a practice which is to be met with in the Malay States and frequently in Java and Sumatra. In these cases the old coffee is still kept as a catch

(1) For further particulars, the reader is referred to an article in *Teysmannia* 1909: "Robusta as a catch crop for Hevea".

FIGURE 24.

Topped Hevea Plantations in Serdang. The trees are about 5 years old, planted in an old Liberian Coffee plantation. In consequence of the topping, the trees have formed a heavy crown. The neighbourhood of the Hevea has a deadly influence on the Coffee.

crop. This is also the case with rubber between tea, or in old cocoa plantations in Ceylon, but these crops are not entirely suitable for the purpose; tea requires a too expensive installation and comes too late into production, and the same is the case with cocoa, moreover the latter only gives much of a return when the Hevea shade becomes so heavy that it has to be cut out.

CHAPTER VII.

Methods of growth, topping and pruning.

I. THE GROWTH.

Within a few weeks from the stumps having been planted, shoots should be developed from the superior buds. (See fig. 6). The strongest of them are left and the others removed. From the beginning care should be taken that the tree grows straight upwards with a single trunk; trees with two or more trunks are not easily tapped on a systematic method; it is difficult to tap the inside with a knife. Moreover, the fork is a place in the tree which tears easily and where rotten leaves and rubbish accumulate so that it becomes a brooding nest for fungus.

During the first year of growth, the tree is branchless, and grows into a long pillar of green, upwards, and the growth of the diameter is inconsiderable, compared with the increase in height of the tree. At the beginning of the second year, the first side-branches appear, usually always after the first fall of the leaves.

After the side-branches have appeared, the diameter of the tree commences to increase.

2. PINCHING OUT.

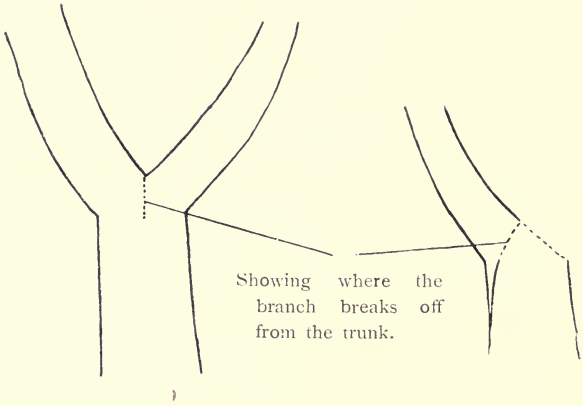
It is remarkable that trees which branch out earliest also increase in diameter soonest. It is easy to see in a young plant, by the thickness of the trunk, if a tree has branched out or no. This observation has prompted experimenting with topping. Topping with a knife is not advisable; the buds which appear after the cutting off of the upper part of the trunk, on the old wood, are not attached strongly enough to the trunk, and often tear off. Therefore, "nail-pruning", or "thumb-nailing", is applied; the point of growth of the trunk is pinched away, with the fingers; generally the trunk is left to grow 15 feet high, and then the top is pinched out; the stem being is sufficiently thin and flexible to be bent downwards. This pinching out has as a result that branches grow out from the upper buds, extending themselves as though to continue the trunk; in this manner, a fuller and broader crown is obtained than with trees which are not topped (see fig. 24).

There is no doubt that such trees increase in girth more rapidly than trees which are not topped; the difference is remarkable. When by some accidental cause, a tree in a plantation is topped, or some rows are pinched out, as an experiment, the trees show up at once remarkably, by their greater girth.

Nevertheless, this topping sytem has been abandoned, and I did not see it practised on any of the estates which I visited. The reason of abstention is, that these topped trees produce an excessive number of branches from the trunk and the crown becomes too heavy for the it. During the first three or four years, after the

topping, the trunk can still bear the crown, but when it is five or six years old, the burden of the branches becomes too heavy. The trunk tears at the fork and one or more branches fall. The remaining part is weakened by the breakage of the wood and later on it cracks (see fig. 25). Even if this should not be the case, there will, nevertheless, exist a big crack on the upper part of the trunk, which closes but slowly and often threatens to rot. The only manner of preventing this rotting is

FIGURE 25.
Results of topping.



the thinning of the branches from the beginning, when they appear after the pinching out. Three or four branches only are preserved, and from these, the side branches are cut away, if too many should develop. This however, is not sufficient; even such thin crowns often tear. The practice has therefore, been generally abandoned. When a tree is somewhat late in forming its branches, the superior leaves of the trunk may be taken away. From the buds of the leaves also, branches grow out;

the point of growth at the end of the trunk, is then, however, safe, so that the trunk can continue growing.

3. PRUNING.

Of late years, the pruning system generally applied is that all branches on the lower 10 feet of the trunk are taken away. The best way is to cut them off with a saw. If the whole branch is sawn off in one operation it will break off from its own weight before the saw has gone entirely through. It is therefore necessary to cut off first the heavier part of the branch, so that only a small stump remains to be sawn off. These small stumps should not be left but must be sawn off the trunk as smoothly as possible, and the wound should be trimmed with a sharp knife, in order to assist in healing the wound and to avoid projections and uneven parts remaining on the trunk afterwards. The idea of this pruning system is, to obtain straight trunks of 10 feet high; it is possible that the trunk will be regularly tapped up to this height in future. The wounds should be always dressed with boiling tar, which is more fluid and therefore much easier to use than cold tar. Great care should be taken in older plantations that with trees which have lost their branches through wind, or from which sickly branches or the extremity of the trunk have to be cut off, the wounds are made as smooth as possible. If a trunk has to be sawn off, then this must be done with an oblique cutting surface, so that the rain water can flow away easily. Chopping off with a few strokes from top to bottom, which the natives are inclined to do because it is easiest, causes a hole in

which rain water, dead leaves, etc., gather, and which becomes a breeding nest for parasites. The question may be summarised as follows:

1. On the stump, the strongest bud should be kept, the others are cut out.
2. Although topping increases the diameter of the trees, it is dangerous from their greater tendency to split from becoming too heavy. If topping is practised, it must be done by pinching out the point of growth and later on the crown must be thinned out.
3. Generally, all the branches are pruned away from the lower 10 feet of the trunk, so that a bark suitable for tapping is left.
4. All wounds must be cut over as smooth as possible and be covered with boiling tar, so as to permit the rain water to flow away.

CHAPTER VIII.

Diseases and Pests.

I. FUNGUS.

In the Malay Peninsula, two serious diseases have specially to be struggled with, fungus and white ants. Root-fungus (*Fomes Semitostus*), is triumphant throughout the whole country, as well as in Sumatra. It has been studied by Mr. GALLAGHER from an agricultural point of view ("*Root diseases of Hevea Brasiliensis*") and I quote the following particulars from this important study.

The fungus lives on tree roots in the jungle; after felling, the Mycelium extends itself from the rotting stumps along the dead roots of rotten wood through the soil; without the help of such conductive materials it cannot grow. It is almost certain that Hevea must come into actual contact with the Mycelium and is not susceptible to spores. The infection starts with the side roots, the Mycelium extends then to the tap root, only when the latter is affected, will the tree bear exterior marks of the disease, and then the leaves wither and the tree soon falls down. Rubber trees of 15 months to four or five years old, are specially exposed to this, not because they are less susceptible, beyond

these limits of age, but because the fungus requires the first few months to obtain a foothold, whereas when the plantation has remained free the first four or five years, it is evident that fungus is not present.

Palliatives and local treatment of the disease do not help; the only method of combating exists in clearing up as cleanly as possible; dead wood *must* be dug up, stumps *must* be taken away as much as possible and burnt, so that there are no sources of infection present, nor means whereby the fungus can extend itself into the soil. During my visits to estates in the lower districts near Klang, I had often occasion to notice how energetically the fight was carried on by the planter. Even in plantations which were two or three years old, all dead wood that remained in the soil and the stumps of heavy trees, were carefully gathered and burnt. In order to protect the Hevea against the heat of the fire, corrugated iron sheets were put into the ground, but not touching the trunk, as this would easily cause damage to the bark, (see fig. 26). The roots of all the trees were examined. Around the infected ones, trenches were dug, the soil was cleared a few feet deep from all wood and the infected tree was pulled up, and then lime was put into the soil to disinfect it. In the sides of the trenches, the fruiting parts of the fungus were usually to be seen their colour being a brown or orange yellow; the root bark is thin and easily broken.

Fungus is certainly, at present, the most dangerous enemy to rubber in the Malay Peninsula. On the other hand, thanks to the information disseminated by the Agricultural Department, we know how to meet it. Aided by the researches and counsels of expert Mycolo-

FIGURE 26.

Destroying Fungus on an estate near Klang. A Hevea plantation 3 years old. The dead Hevea has been dug up, piled and burnt.

gists like Mr. GALLAGHER, this struggle has been so energetically persevered with that fungus no longer menaces the susceptibility to life of the culture.

2. OTHER PESTS.

A second and important pest is White ants. Not by all kinds, but by one special variety, (*termes Gestroi*), is the rubber infected. In young plantations the trees are examined regularly; if they appear infected, then it is necessary to search for the nest, and the latter must be destroyed. It is not only necessary to search for the queen, the whole nest must be destroyed. In older plantations, (of more than six years old), these pests are destroyed by means of an apparatus called the "White Ant Killer", which consists of two parts, a pump connected by a hose with an oven, in which a mixture of sulphur and arsenic is burnt, the fumes from the oven are pumped into the holes which are occupied by the white ants through a second hose with a nozzle, which, with the aid of some clay, is fastened hermetically to the opening of the ant holes.

As a third less important disease, should be mentioned the stem disease, identical with the "Djamoer Oepas", which is to be met with on various plants in Java; the cause of this disease is not known with certainty.

Finally, mention should be made of rats, which gnaw the bark from the young trees; this pest is to be dealt with by liming the lower part of the plants.

C. TAPPING.

CHAPTER IX.

General considerations.

I. PRINCIPAL RULES.

Before starting to describe tapping, we may enumerate here the principal rules to be observed.

1. The production obtainable is proportionate to the number of latex tubes.

The latex is contained in the tree in tubes, which run more or less parallel to each other and allow it to flow when they are cut; it is, therefore, essential, to cut as great a number as possibe of these vessels. It is found that an angular cut is best; with parallel horizontal cuts, the greatest number of tubes would be opened per centimeter of cut, but the latex would not flow, and therefore, the cut is made obliquely. Further, the tapping system should be made use of in such a way that sooner or later all the latex tubes will have been reached; if a part of them are omitted, the latex will not be obtained, representing thereby a loss.

2. Before starting to tap, a definite system must be settled upon, in accordance with which operations will be effected; this system should be so arranged that it will not be necessary to tap the same part of the bark again within a period of four years, unless with young trees.

The general experience of planters in the Malay Peninsula is that the bark should be left alone for four years, in order to form a new cortex with latex vessels; for very young trees a shorter interval is sufficient. After this period has elapsed the same place can be tapped again, possibly however, it will be necessary to make the cut in a different direction the second time. Therefore the following rule is necessary.

3. The tapping system must be arranged in such a way that the wounds may recover easily and that the new bark which forms itself on the place which has been tapped, shall have a regular and smooth surface, so that it can be tapped again in a rational way later on. The prejudicial influence which arises from unsystematic tapping is best seen in old trees, in which from a want of experience in technical matters, different tappings, i. e. different cutting and notching systems have been made use of, so that everywhere on the area that had been tapped, wounds, notches and badly healed scars are to be seen, and it becomes almost impossible to apply a regular tapping system subsequently on the tree.

The tapping system must be so arranged on the estate that all the bark shall be cut away successively and that there shall not be areas of untapped trees here and

there between the places which have been systematically worked. If the tapping lines are not set out exactly and if care is not taken that the tapping is not done accurately along the lines which have been set out, then, between the places which have been tapped, here and there some patches of bark will remain uncut. Firstly, this means a loss in production — the latex vessels on these places are not open and cannot therefore, add their quota to the crop, and secondly, when in due course a return is made to the renewed bark, there will be no smooth surface on which to apply the knife, the places which have not been cut at the previous tapping will form projections and knots.

5. The tapping system should be so chosen that it does not unduly disturb the internal economy of the plant, necessitating thereby an alternation of resting periods for the tree.

Various tapping systems which resulted in interference with the circulation of the plant have been tried on estates in the Malay Peninsula and quickly dropped. The spiral cut is an example. With the application of this tapping system, the tree is practically girdled and dwindles away; after a few months the production of latex falls off, and tapping, must therefore, be stopped, in order to allow the tree to recover from the damage done. Common sense tells us at once that such a system is to be condemned and that a method whereby the crops may be obtained regularly throughout the whole year, without damaging the tree so seriously that it suffers under it, deserves a much greater preference.

6. By the application of a rational tapping system, a tree can be tapped consistently, and climate or labour troubles permitting, it is not necessary to rest the tree.

The experience gained by the tapping of an old tree has shown that Heveas do not unduly suffer where part of the bark is tapped each alternate day, or even daily. This was proved by figures, which were shown to me concerning an old Hevea tree in the neighbourhood of Seremban.

Everywhere in the Malay Peninsula, the plantations which are in the producing stage are tapped daily or on alternate days.

It should, however, not be forgotten that in the Malay Peninsula, climate is no obstacle, as is the case in other districts, for instance, tapping is not possible in Ceylon on days when there are heavy rainfalls; the streams of water, pouring down the trunk, wash out the latex from the cuts. Neither is it possible to continue tapping during the long, dry monsoon; the trees have then no sap to lose and latex will not flow from the opened vessels. Latex flows best when tapping is performed in the morning after a night's rain; it is then, however, the thinnest. Now the climate in the Malay Peninsula is characterised by rainfalls which are regularly divided over the whole year.

7. Tapping must take place as early in the morning as possible and must be finished by midday.

If tapping is performed in the afternoon, the trees then require water for damping out, and the latex does not flow as easily. In the Botanical Garden at Singapore

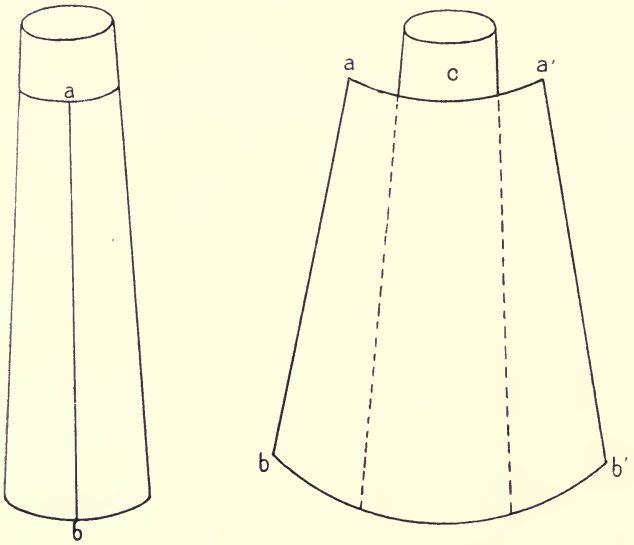
I saw experiments made by Mr. RIDLEY with the tapping of trees during the afternoon; the provisional result of these experiments confirm the experience that tapping during the afternoon does not pay.

8. The cut must be made in such a way, that as little bark as possible is taken away, allowing at the same time for the maximum number of latex vessels to be opened. As most of the latex vessels are near the cambium, the cut must be made as near to it as possible, but so as not to injure it. The cambium is the tissue from where the healing of the wound must take place; when the tapping knife touches the cambium cells, they die, and consequently the healing of the wound must take place after the renewal of these injured cells. When the cambium dies the inner wood is exposed, and there is a danger that fungus or borers may penetrate the trunk. Therefore, the cutting should be done only to a determined depth in the trunk; if it is not deep enough, an insufficient quantity of latex will flow out; if on the other hand it is too deep, a wound is made, which recovers very slowly and introduces an element of risk with regard to parasites. We shall see later on that there is an easy method of ascertaining whether the tapping is done deeply enough. Again the tapper must take care not to take away too much of the bark. The cutting serves only to reopen the wound, the quantity of the latex does not depend upon the thickness of the strip of bark which is taken away. The latter should be made as thin as possible and as much latex will be obtained from the cut, as though thicker strips were taken off the cut surface.

The thinner the strip of bark shaved off, the longer time any given area of bark will last and the longer it takes before coming round again to the same place. We will refer again to these general rules when con-

FIGURE 27.

Sketch showing the rolled out bark.



a—b represents the line where the bark has been opened; in the second figure, the bark is rolled out; the lines *a—b* and *a'—b'* are therefore the same line of section.

sidering the manner in which the tapping takes place in practice.

2. TAPPING SYSTEMS.

In order to elucidate the different tapping systems, it is essential to show in detail by means of diagrams

the steps to be adopted. We can, as it were, roll out the bark of the tree, as in fig. 27. The line *a*—*b* represents the line at which the bark has been cut open; in the second figure is shown the bark which has been rolled out; the lines *a*—*b* and *a'*—*b'* were, therefore, originally joined together; *c* is the heart wood of the tree.

Tapping systems can be divided into two main groups:

1. One in which the bark is cut open over the whole surface of the trunk.

2. Another in which the surface bark is divided into vertical strips, one or more of which are not immediately tapped. The cut then ends in a vertical cut, which we may call the "conductive canal".

In this group we can distinguish the following types:

a. Those in which the cuts run in two different directions, lying on both sides of the conductive canal, and terminating in it.

b. Those in which the cuts run in two different directions and all lie on the same side of the canal in question.

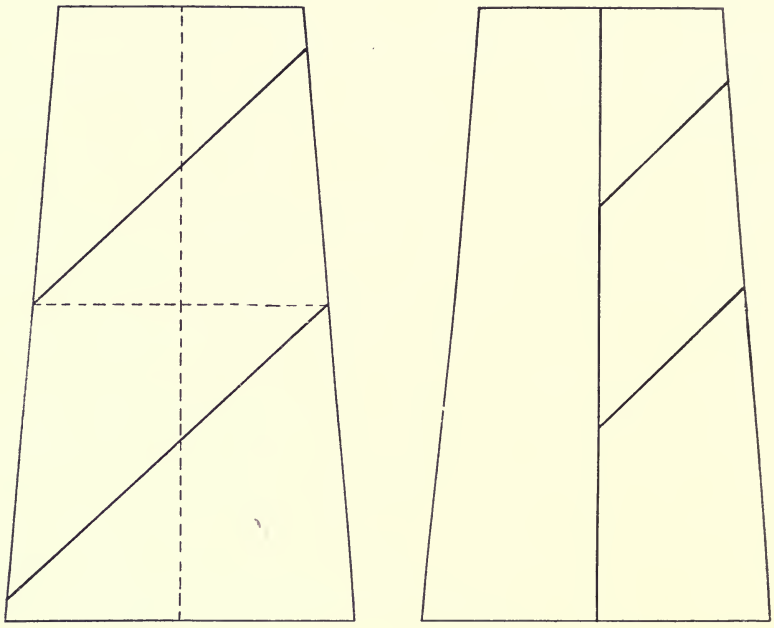
To the first group, belong the spiral type; to the second, the V-cut, and the herringbone; to a third, the half V-cut, the half spiral, and the half herringbone.

1. Full spiral cut.

In this case, a continuous cut is made, sloping gently downwards as it goes round the tree. The bark is

FIGURE 28.

Sketch showing tapping systems.



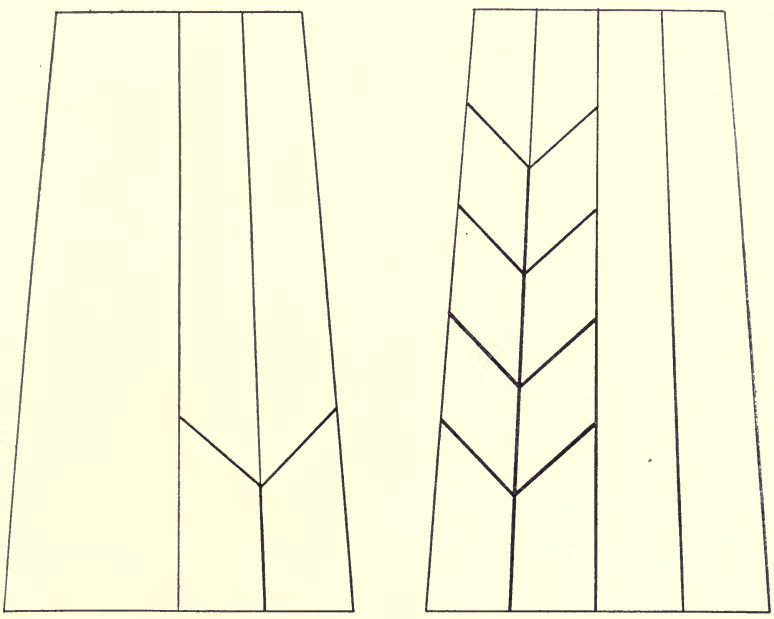
a. Whole Spiral. *b*. Half Spiral.

accordingly cut open over the whole surface and the incision girdles the tree. The consequence is, that the production of latex ceases sooner or later, and the tree becomes stripped. The full spiral system has conse-

quently been practically abandoned in the Malay Peninsula. The only case where this method is of value is when it is intended to kill trees in a plantation by tapping in order to thin them out. (See fig. 28*a*).

FIGURE 28.

Sketch showing tapping systems.



c. V cut. *d*. Full Herringbone.

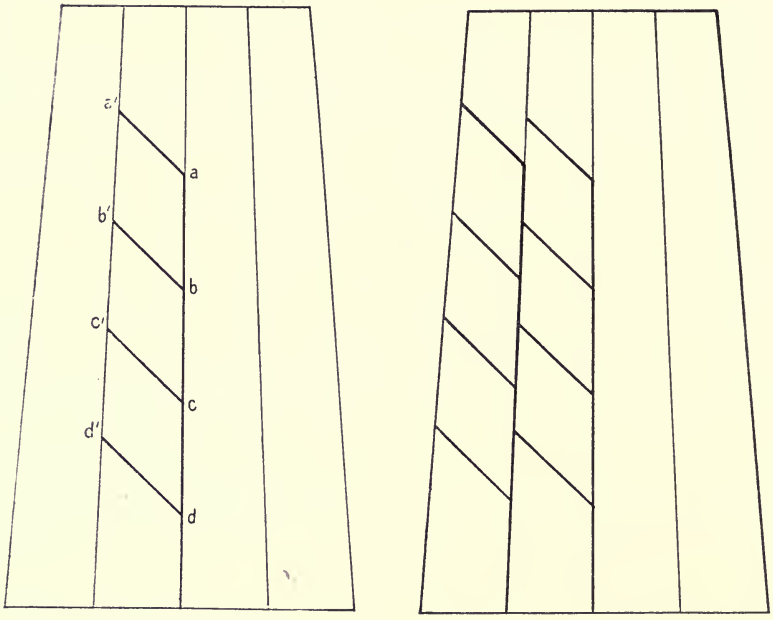
2. Half spiral.

With this system the tapping surface is divided into two halves only one of which is tapped. Accordingly

the cut covers half the surface, and leaves the other half to maintain the connection of the crown with the root. Often several cuts are made, one above the other,

FIGURE 28.

Sketch showing tapping systems.



e. Herringbone. *f.* Two Half Herringbones.

and along the lower ends of the cut, a groove is made, ending in a drip-tin.

One advantage of the half spiral is, that the cut runs to one side, and that therefore the tapper does not need to change the position of his knife, hand or arm. If

there are thicker trees to be tapped, then the cut will become too long, and the regular shaving down of the cutting surface along a straight line will become too difficult. I saw this system applied only occasionally (see fig. 28*b*).

3. The single V-cut.

A method of tapping, which is applied generally, and is specially suitable for young trees. At the bottom of the tree, a V-cut is made, which takes in the whole surface, terminating in a groove at the base of the V. The cut, therefore, consists of two halves, having a different direction. For young trees, the tapping of half of the trunk surface does not present any objection; but for older trees, preference should be given to a system under which not more than a quarter of the surface is tapped (see fig. 28*c*).

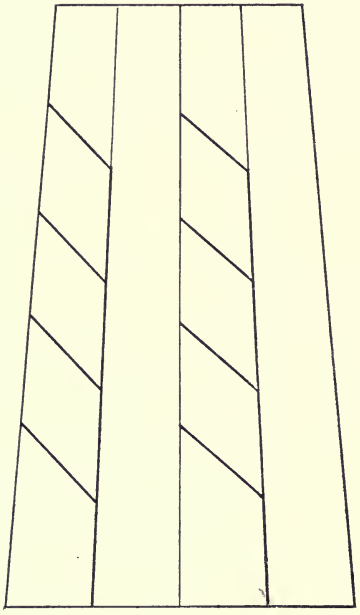
4. The full herringbone.

This is only made use of on old thick trees, quarter surfaces of which are too large for the half herringbone cut (see fig. 29). On both sides of the groove, cuts are made running in different directions, each covering one-eighth of the whole trunk surface, the whole herringbone therefore, covers a quarter of the surface. The herringbone is to be considered as a groove with a series of V-cuts; sometimes also the terminal parts of the side canals alternate so that those

of the left side end between those of the right side in the central canal (see fig. 28*d*).

5. Half herringbone (see fig. 30).

FIGURE 28.
Sketch showing tapping systems.



g Two Half Herringbones, opposite quarter sections.

By far the most common method in the Malay Peninsula; exclusively used on the plantations which are from six to eight years old. The cuts cover only one quarter of the trunk surface and all lie on the same side of the central canal (see fig. 28*e*).

If it is desired to tap the half surface of the tree, two quarter surfaces can be tapped, each with a half herringbone cut, and therefore, quarter surfaces can be used which are adjacent to each other (see figs. 28*f* & 28*g*). As a rule the latter sytsem is given the preference, as it will have less effect on the internal economy of the plant, than the tapping of adjacent quarter surfaces.

3. THE CALCULATION OF DISTANCES BETWEEN THE TAPPING LINES.

One of the above mentioned tapping systems will have to be chosen according to the ends in view and bearing in

FIGURE 29.

Herringbone over half the surface of the tree.

mind the girth of the trees which have to be tapped. As a rule, for young thin trees, the single V, or half spiral is chosen; for trees of middle age and average surface, the half herringbone; for older trees the full herringbone which is, however, not applied on a half surface, but on a quarter; and for trees which must be tapped to death the full spiral. When the tapping system has once been chosen, before it is set out on the trees, the distances between the tapping lines must be calculated so as to work round the surface of each tree in a given period which in the case of young trees will be not less than two years, and in old trees four years.

The speed with which any part of the bark will be tapped off, depends upon the intervals between tapping and upon the dexterity of the tapper. Trees may be tapped daily or on alternate days. An inexperienced labourer will take away more of the bark with each cut, than an experienced one. A tapper can make on an average 15 cuts per inch, at least; very dexterous tappers know how to shave the bark down in such a way, that 30 or even a few more cuts, will go to the inch; this measurement indicating the tapped distance along the vertical groove. Such tappers, are however, rare; in a group of 100 men, there were only 7 who could make 30 cuts per inch. On an estate where the tapping has been going along for a considerable period, experienced tappers are available and an average of 20 to 25 cuts can be taken; it may be expected that this figure will increase up to a limit of 30 cuts per inch.

A single example will suffice to show how distances between the tapping lines are calculated.

If a V-cut be made and alternate day tapping practised and if the tapper make 20 cuts per inch, then the cutting surface will be moved one inch in $20 \times 2 = 40$ days; in one year therefore, we get $360 \div 40 = 9$ inches of advance (1). If therefore the terminal point is desired to be 6 inches above the soil, the first cut should be made at 6 plus 9 = 15 inches above the soil.

When applying the single herringbone, the distance between the parallel side cuts must be calculated in the same manner (see fig. 28*e*). If the tapper make 25 cuts per inch, and the tree is tapped every day, 25 days should be taken for one inch of the bark. In one year, $365 \div 25$ or about $14\frac{1}{2}$ inches of the bark will be taken away. If therefore the distance from *a*—*b* is taken at $14\frac{1}{2}$ inches, after one year the cutting surface *aa'* will be moved to the line *bb'*, and *bb'* to *cc'* and so on; in a year, within a distance of $14\frac{1}{2}$ inches between the tapping lines, the whole quarter surface will be tapped off.

If the tapping of renewed bark is desired to be commenced in four years, each quarter surface should be treated consecutively in this manner, so that at the end of the fourth year the whole tree will have been done. If tapping has only been done every alternate day, and other circumstances remain the same, then for one quarter of the surface double the time would be taken, i. e. two years and in that case two quarter surfaces can be tapped together, for instance, first two opposite surfaces, which will take two years, then the two remaining

(1) In this and the following examples, the numbers of days per year are certainly too high; there are always some to be deducted for feasts, rainy days etc. Although sometimes 365, 360 or 350 are taken; in reality 350 is the highest attainable figure.

FIGURE 30.

Half Herringbone over a quarter of the surface of the tree.

which will also require two years; this method will mean a four years rotation.

The great influence which the taking away of as thin a strip of bark as possible has in the long run, is shown by the above mentioned examples and may be separately elucidated.

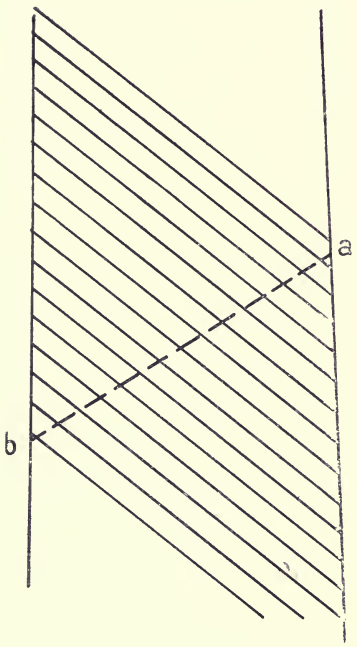
Supposing that on two trees a half herringbone is applied, on two adjacent quarter-surfaces; one tree is tapped by a workman (A), who makes 15 cuts per inch. The other tree is worked by a more experienced tapper (B), who makes 30 cuts per inch. With both trees the distance between the side cuts is 12 inches, when the tapping takes place each alternate day. Tapper A, with 15 cuts per inch gets over 1 inch in $15 \times 2 = 30$ days; he, therefore, taps off 12 inches yearly, and after a period of one year, he has tapped both quarter surfaces. B, with 30 cuts per inch works over 1 inch in $30 \times 2 = 60$ days; after one year, B has thus tapped only half of each quarter surface, whereas he has obtained as much rubber as A. While A in order to work four years, can only tap one quarter surface, B can tap during the same period two quarter surfaces and can, therefore obtain from the same tree twice as much as A.

4. REMARKS ABOUT THE SUITABILITY OF THE TREE FOR TAPPING.

In order to ascertain whether a tree is suitable for tapping, the girth is measured; the reason of this dimension being considered decisive for the suitability is obviously that with very thin trees, the side cuts would not be

long enough. It is, however, open to question, whether this point of view is entirely exact; a single instance, which tends to show that the age of the tree has some influence in the matter may be mentioned here. On one estate, I saw Hevea which was originally planted between coffee, near to another Hevea plantation on virgin soil; the former trees were much inferior in girth to the trees on virgin soil, but according to the manager, their production of rubber was in no way behindhand. On the same estate, in a row of old Hevea trees, there was one among them which was remarkably thicker than the rest; its production of rubber, however did not exceed that of the others. Generally the age is also taken into consideration and trees which are younger than four or five years are not touched, even when the girth is sufficient; the reason for this, however, lying more in the fact that in a plantation of this age the amount of the trees suitable for tapping is too small.

FIGURE 30*a*.
Sketch showing tapping of renewed bark.



If at the second tapping, the cut is made in the direction of the dotted line, the older bark will be found at *a*.

In such cases, of course, not only the manager's views are decisive, but also the financial position of the estate

comes into consideration. The market price of the rubber also has some influence; during a period of very high rubber prices, such as the middle of 1909, there was a tendency to tap as much as possible; during a period of low prices, there is more of a disposition to wait.

Especially when the estate, besides rubber, also produces a catch crop, the owners are less dependent upon the general state of the rubber market and therefore, not so quickly compelled to undertake the tapping, and this is, certainly, no small advantage. The general opinion among planters is that it is better not to tap any trees under five years old, even when their girth is sufficient. Not seldom, the assurance is given: "if it were my own estate, I would not yet tap the trees". On an estate in the Province Wellesley, I saw on a three year old plantation, that the bigger trees were tapped, and I must confess that the trees evidently did not suffer from this.

If the size of the trunk only be taken as a criterion, then, of course, the lower part of the more or less conical trunk is more suitable for tapping than the upper part.

Generally, the trunk is considered to be suitable for tapping, when the girth amounts to 18 inches, and as soon as the tree at a distance of $1^1/_2$ feet above the soil has this girth, a V-cut can be put on it. If, one or two years later, at 3 feet above the soil, the tree is 18 inches in girth, then the tapping can take place at this height, and a half herringbone cut can be made.

Of course, all trees on a plantation do not obtain a tappable girth at the same time. The percentage of the trees in a plantation which are suitable for tapping must

influence the decision as to whether the tapping is to take place. Mr. GALLAGHER said to me: "if 60 % of the trees are 17 inches at three feet above the soil, I should tap all trees of 16 inches and more above the soil; this would be about 75 % of the full amount. After a year, I would add to them, those which would be 16 inches or more at a height of 3 feet, and so on every year".

CHAPTER X.

The practical work of Tapping.

1. SETTING OUT THE TAPPING LINES.

In the first place, a definite working scheme has to be made up, having regard to the age, the sections of surface, and the special system on which the trees are to be tapped. As soon as a garden has attained the stipulated age, a competent man will have to measure the trees and mark all of them which possess the required girth.

The tapping lines will then have to be set out on these trees. It is of much importance to do this very carefully. The aim will be to tap off as regularly as possible the whole surface of the bark and this is only feasible if it is clearly laid down beforehand which sections of the trunk are going to be tapped, in which direction the cuts are to be run and in what terminals they are to end.

When previously tapped trees are to be tapped again, the new tapping cuts should be drawn as much as possible in the same direction as the old ones; if this is not done, then the new tapping cuts intersect the old ones, i. e. bark of different age and different thickness.

Before the tapping lines are set out the tree is cleaned up with a piece of cocoanut husk so that dead bits of bark, dirt, moss etc., are rubbed off from the trunk.

For the cutting of the tapping lines a marker is generally used, also the "Jebong knife", both tools are described in the following chapter.

When setting out, there should be clearly indicated:

a. The limits of the sections.

b. The directions of the tapping lines.

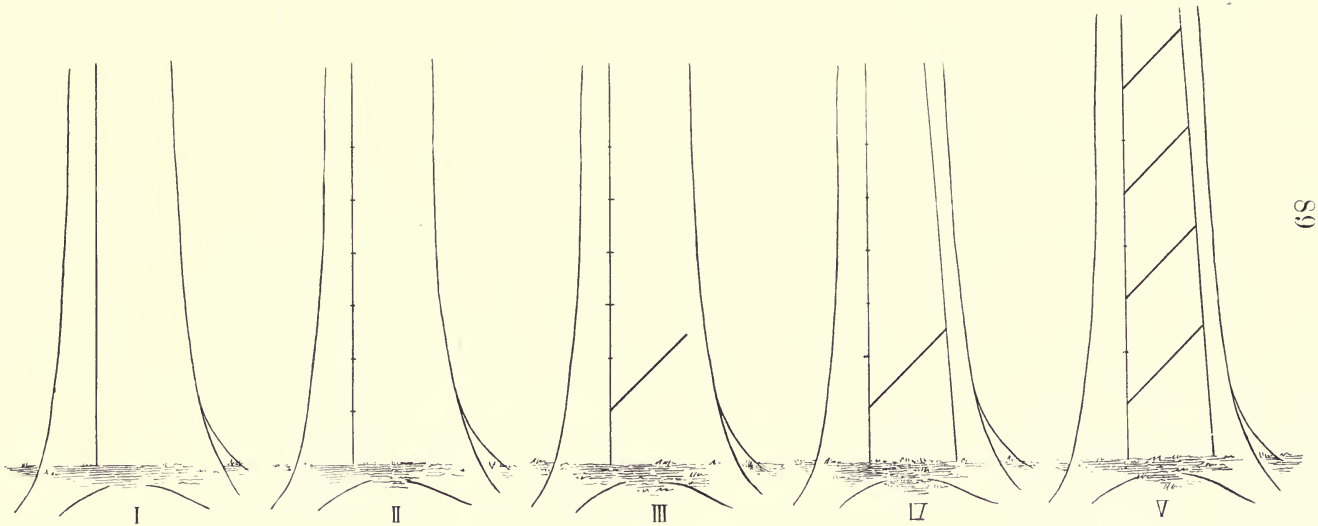
If a half herringbone is used, care should be taken that the side canals run strictly parallel. Different methods may be used, and two which I saw applied on one estate will be described here. It is essential for both, that in the first place, the tapping surface of the tree should be so selected that when the vertical canal is cut it shall not end just above a root; this would make it difficult to place the latex cups properly and as in subsequent years, new quarter surfaces have to get their turn and at a distance of 90° a new vertical canal must be cut again, it is also essential when cutting the first canal to take into consideration the location of these latter. Therefore, the place for the first canal should be so chosen that those others which have to be cut at intervals of 90° will be well placed between the roots. According to the first system, the work is carried out as follows:

1. When a suitable place is found, the conductive canal is cut, with the aid of a wooden straight edge, which is held vertically against the tree; the bark is then lightly cut away (see fig. 31 I.)
2. Notches are cut on the straight edge at intervals

FIGURE 31.

Sketch showing the setting out of the tapping lines, with a tin template.

For explanation see text.



of 6″ and these are marked off on the tree, starting from 6″ above the soil (see fig. 31 II).

3. Then, at 6″ above the ground, with a tin template cut to an angle of 45°, another line is made 19″ in length (see fig. 31 III).
4. Through the extreme point of this oblique line, a vertical line is made, parallel to the first, up and down the tree, with the straight edge (see fig. 31 IV).
5. With the tin template, parallel side lines are also drawn from the other measured points to meet the second vertical line at 12″ distances (see fig. 31 V).

With the tapping system followed on another estate, the side lines are not set out with templates, but at equal distances on the second vertical line (see fig. 32). First one vertical line is set out (see fig. 32 I), then at one quarter of the way round the bark, a second one (see fig. 32, II). Then, on the first line, starting from the soil, points are marked off at distances of 16″ (see fig. 32. III). On the second line, similar points are marked off, the first one at 6″ above the level of the corresponding point on the first line, and subsequently at intervals of 16″ (see fig. 32. IV). These points are joined (see fig. 32. V). The incised lines do not make exactly the same angle with the vertical canal, but the difference is so small that it may be neglected.

The tapping of young trees was carried out in the following way. As soon as the trees, 22″ above the ground, have a girth of 16″, the first cut is made, a V, covering half the surface of the tree, each leg of the V having a length of about $7\frac{1}{2}$″. The length of surface suitable for tapping is about 16″, and this will be sufficient for daily tapping for about a year. It must not be forgotten that several days will

have to be deducted from a calendar year — rainy days, feast days, etc. for the native workmen. The number of cuts to the inch for an average workman is calculated at about 20. When half the tree has been tapped, another V may be put on the other side, but in the ordinary course of nature the trees will have increased in girth during the first year of tapping, and should, in the second year, be large enough for a half herring bone to be put on a quarter section. Having regard to the girth of the trees, two side cuts may then be made; the tapping area will be about 38″, or a little more than three feet above the soil. A year later another cut may be put on.

When the third half herring bone is made, the tapper will have got back again to the lower part of the tree which was tapped with the V, and then another side cut is made. The tapping area will then reach to 70″ above the soil, or nearly six feet. At a greater height than this, tapping can only be effected with the aid of a ladder. (see fig. 33).

On a third estate which had only young plantations, the following system was adopted. As soon as a tree, at 18″ above the soil, had a girth of 18″, a V was made over half the surface. The tapping lines were set out with a tin template at an angle of 45° with the vertical groove. The vertical depth of the V was therefore about $6^1/_2$″. (see fig. 34). In this case, the trees, as they increased in girth, were intended to be divided in quarter sections for tapping. Experiences teaches us that while the trees are young, they will not suffer from a second tapping being made on renewed bark in less than four years.

The following simple system (see fig. 34) suitable for

FIGURE 32.

Sketch showing the setting out of the tapping lines with a straight edge.

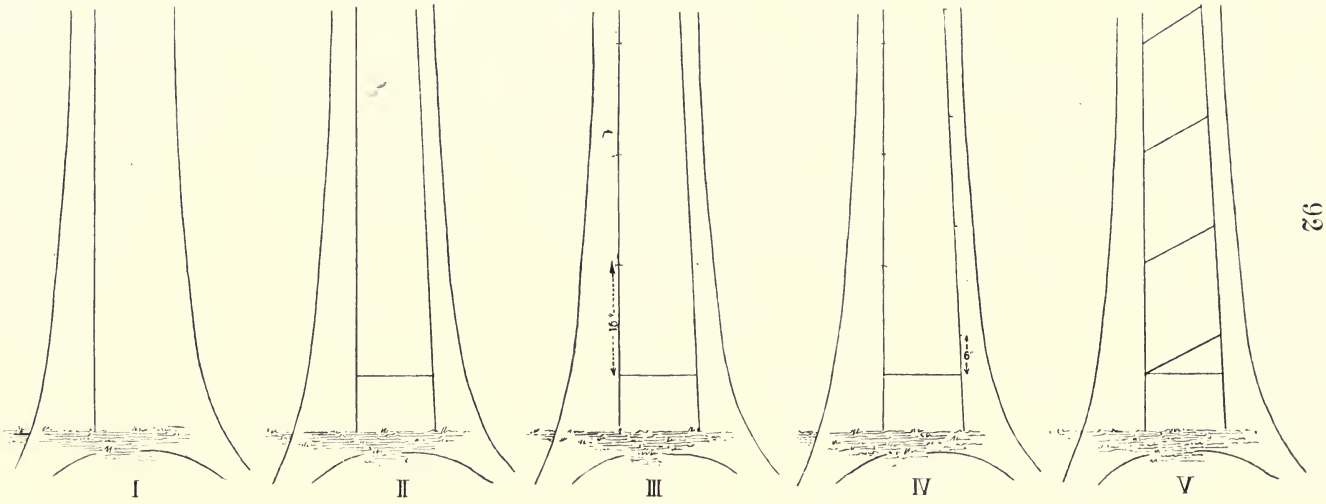
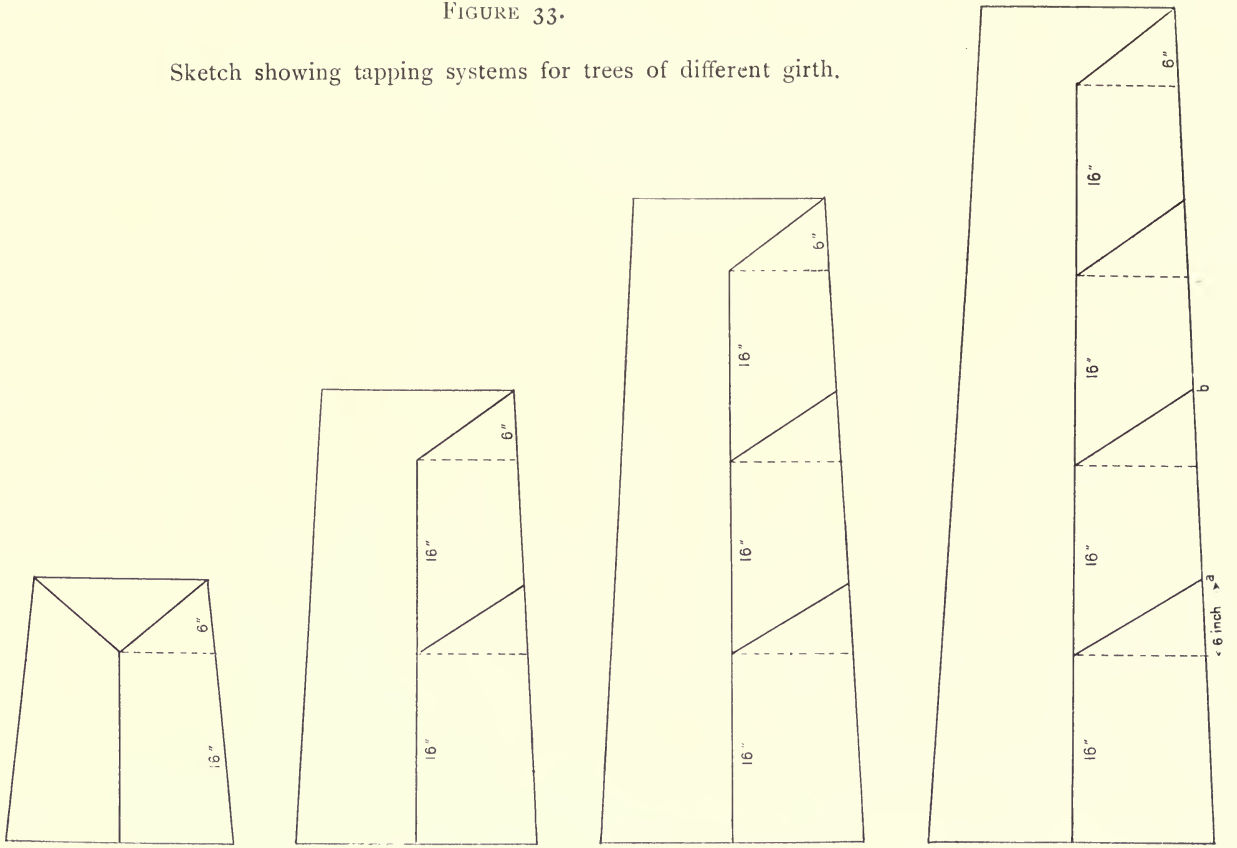


FIGURE 33.

Sketch showing tapping systems for trees of different girth.



I.
If the circumference at 22 inches above the soil is 16 inches, the Basal V cut is made.

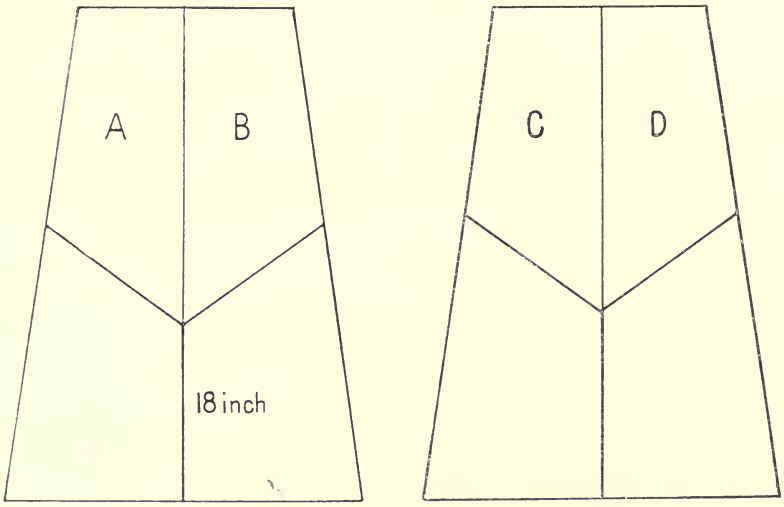
II.
If the circumference at 3 feet above the soil is 16 inches, two cuts are made. (Half Herringbone).

III.
If the circumference at 3 feet above the soil is 29 inches, three cuts are made.

IV.
If the circumference at 3 feet above the soil is 24 inches, then the tapping is done with half herring-bone of 4 cuts.

trees of varying girth, has been recommended to me by Mr. GALLAGHER. If the trees, at 3′ above the ground, have a girth of 18″, tapping is commenced. The trunk is divided into two half sections. On one of these a basal V is made, with the point 18″ above the soil, and that is tapped daily for a year, and the first half section (*a* plus *b*) is tapped dry. The next year, on the other half

FIGURE 34.
Sketch showing tapping of young trees.

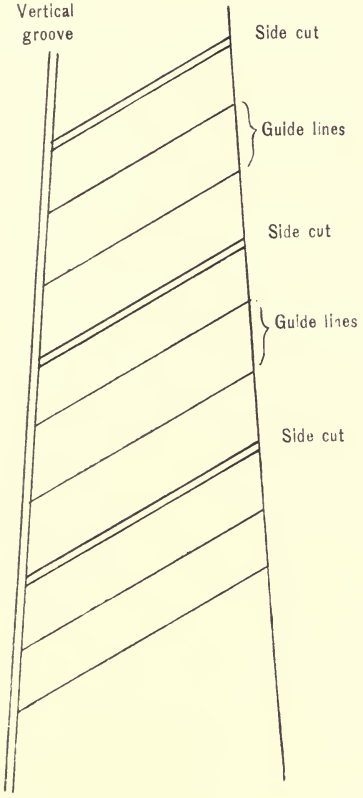


section, another basal V is made (*c* plus *d*), and tapped off. The third year, the quarter section *a* is tapped with a half herring bone, which goes as high as the girth of the trees will allow — generally three side cuts can be put on. Then a four year system is applied, *c* is tapped in the fourth year, *b* in the fifth, *d* in the sixth, and so on, always with a half herring bone on each quarter section.

2. Points which should be taken into consideration during tapping.

1. *The layer of bark which is to be shaved off should be as thin as possible.*

Fig. 35.
Sketch showing guide lines.



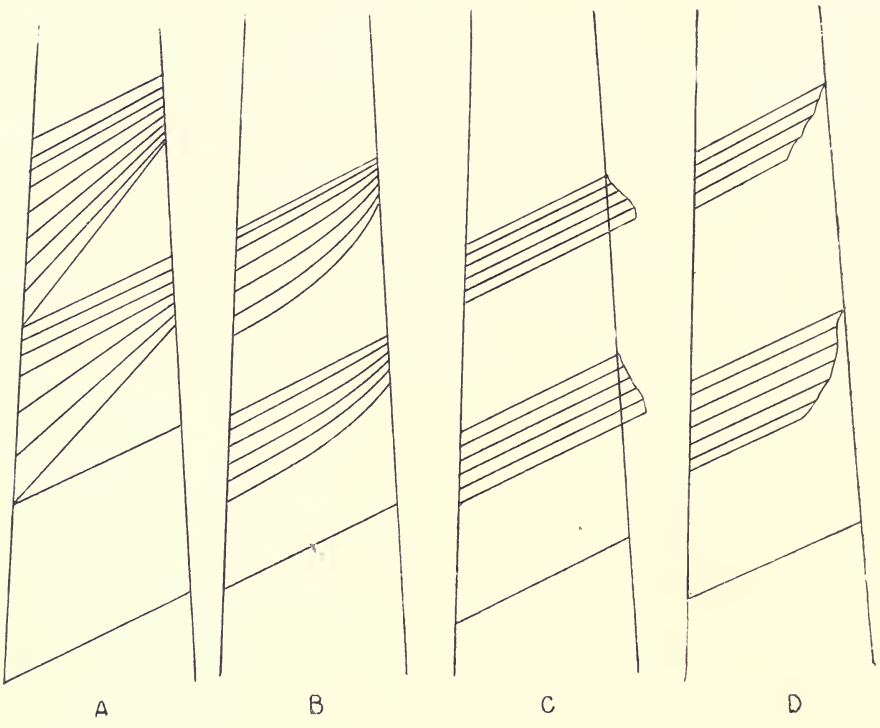
The importance of making this shaving as thin as possible has already been pointed out; the thinner the strip which is taken off, the longer the tapper can make a given tapping area last out. A good method of keeping this well in the mind of the native workman is to draw a guide line, one or two inches below the first tapping line. (see fig. 35). He knows then that he has to so arrange his work that he may reach that line within a given number of days, and he will do his best to approach the line as slowly as possible.

2. *The cuts must be made exactly parallel to the first side cut.*

As we have already seen, the whole bark surface, within a given area, must be worked off. If the direction of the tapping line is slightly changed, by the time the greater part of the surface to

be tapped has been worked off, there will remain a triangular patch of back. This means in the first place, a loss of the latex remaining in this patch, moreover, the presence of these patches interferes with the clean renewal of bark. (see fig. 36*a*.)

FIGURE 36.
Examples of bad tapping.



3. *The cuts must be made perfectly straight.*

Inexperienced tappers show a tendency to make crooked cuts (see fig. 36*b*.) Here again, portions of the bark will remain untapped with the same results as explained before.

4. *The side cuts must terminate at the proper margin, not exceed them nor fall too short* (see figs. 36*c* & *d*.)

A mistake which is often made on estates beginning to tap is that the cuts are made longer and longer, so that they exceed the marginal lines and consequently encroach on the area that should belong to a subsequent year's tapping. The renewed bark will accordingly have to be re-tapped before a four years' interval has elapsed. And again, the growth will become irregular, a fault of some importance here, as the marginal lines of the tapping surface first under operation, have to be used as the conductive canals of the next years' operations. If, on the other hand, the cuts are made too short, the consequences will be as already enumerated under heads 2 and 3.

5. *When tapping, the bark must be carefully cut down until reasonably near the cambium.*

The fear of tapping too deeply sometimes leads the workman into the opposite fault, i.e., not cutting deeply enough into the bark, and thereby leaving untouched the inner layers which are richest in latex. A good test of the correct depth of the cut is to be found in the colour of the exposed bark, it should show a faint greenish shade. The depth may also be estimated by putting the point of a sharp knife into the bottom of the cut which has just been made; if any quantity of latex exudes, it may be taken that the tapper has not cut deeply enough, if, on the other hand, little or no latex appears, it shows that the latex bearing vessels have been exhausted and that the workman has gone quite as deep as is desirable.

6. *When tapping, care must be taken not to injure the cambium.*

The alternative to the last mentioned error is, of course that the workman may make too deep a cut. This happens when the cambium is removed and its cells die off, exposing the heart wood.

As soon as this is discovered, the tapper must leave a small strip of bark, under the wound, so that the cambium is protected and closes the wound. If care is not taken to do this, the workman will unconsciously extend the wound with successive cuts. It is readily noticeable in old wounds that they have commenced with a small place; they become broader and broader at the bottom, but if a small strip of bark is left as directed, the would will not appreciably increase in size. A slight amount of damage in this way is almost unavoidable, and the wounds recover relatively quickly. It is different when frequent patches of exposed heartwood are met with, such carelessness is evidence of rough and negligent tapping.

7. *The vertical canal.*

On most estates, the vertical canal for gathering the latex from the several side cuts and conducting it to the collecting vessel is fairly broad, but need not be cut too deep. It is not necessary that it should be cut as deeply as the side canals, as it is not used for latex production. On some estates the central vertical canal is not made at all, a strip of bark is cleaned and serves to allow the latex to flow along its smooth surface.

At the end of this canal, whether incised or not, a small tube is fixed into the tree, this should have sufficient fall to allow the latex to run down easily into the cup.

3. TAPPING WITH A PRICKER.

Besides the methods of working already indicated, tapping may be effected by means of a pricker. Instead of making incisions down to the cambium, but without touching it, the pricker is run along each of the side lines. The point of the pricker should touch the cambium. This method has some advantage in that the cells around the spots which have been tapped are to some extent protected, and the whole is less exposed to drying out, as it is covered with a thicker layer of bark than when tapping by incision. The pricker can be used without cutting the bark away, or a light incision may be made in the bark, and then the pricker run over it, so as to enable the tool to get at the latex vessels easier.

I am told, however, that the pricking system is not used on Estates in the Malay Peninsula. The wounds do not heal well, the bark forms many stony cells, and the production of latex is inferior to that obtained with a knife.

CHAPTER XI.

Tapping tools.

1. The requisites of a tapping tool.

Many descriptions of tapping tools are in use on estates in the Malay Peninsula. We shall see that they may be reduced to a few simple forms. Too much importance should not be attached to the form of the tapping tool. The chief thing in carrying out the tapping is careful management and the dexterity and experience of the workman. The perfection of his tools is a secondary matter. It is an old tale that "bad workmen complain of their tools", and this saying is very applicable in this case.

The essential requirements of a good tapping knife are the following.

1. The knife must be simple, containing as few nails and screws as possible and no fragile or very light or breakable parts. The native workman is not competent to manipulate difficult tools. He always wants to take them to pieces, much as a schoolboy shows the same anxiety with his first watch. Repairing is always a more or less difficult matter and is generally left undone.

2. The knife must be light and easy to handle.

3. The cutting edge must be easily sharpened. For practical work it is essential to keep the knife always sharp. Fine cuts cannot be made with a blunt knife, and the wounds made by it do not readily recover.

4. The knife should not be expensive.

We may divide tapping tools into two main groups.

Firstly, those which have a round edge, and secondly those the edges of which consist of two straight surfaces, giving thereby an angular cut.

2. TAPPING TOOLS WITH A ROUND EDGE.

The two primitive tools from which tapping knives under this head have developed are the gouge and the farrier's knife. Both are used on many estates in the Malay Peninsula. With regard to the latter it is difficult to explain why it should be used, as there are certainly knives which possess all the advantages of the farrier's knife and are more easy to handle.

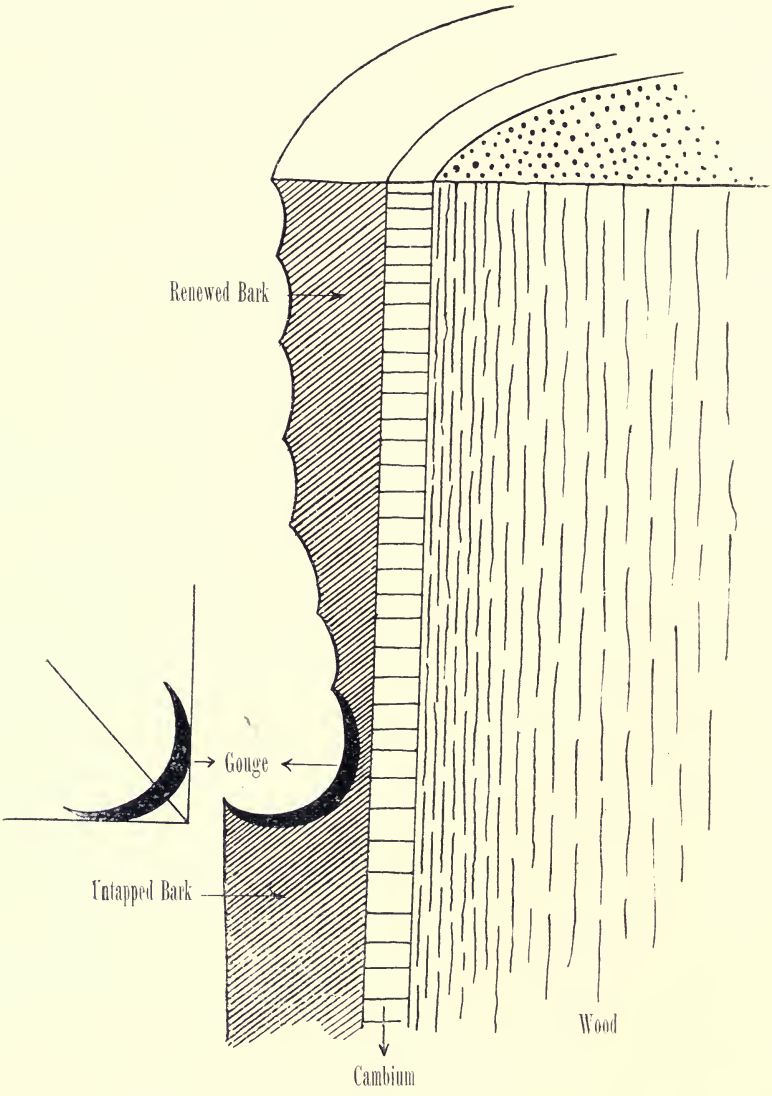
1. The gouge.

Thus is an ordinary hollow chisel, varying in width from $^5/_{16}''$ to $^3/_8''$. For older trees with a thick bark, the broader chisels are used, the smaller ones for young trees. In the hands of experienced tappers, the gouge seems to give very satisfactory results. On estates which showed the best system in their work, getting thirty or more cuts to the inch, the gouge was invariably used. The use of this tool left also nothing to be desired as regards the depth of the cuts.

The gouge may easily be used to cut in either

FIGURE 37.

Use of the Gouge.



direction. The handle is held with one hand which pushes it along, and the shank of the blade is steadied with the other hand which also serves to give the proper direction and inclination to the tool, and regulates the depth of the cut. The gouge should be so held that the centre of the back of the hollow blade lies just on the marked out line. To put it geometrically, a line drawn perpendicular to the axis of the gouge should make an angle of 45° with the cambium. Figure 37 illustrates the position of the tool. The handle is held as near as possible to the tree so that the long axis of the chisel approaches the cambium as nearly as possible.

With trees of a good girth this is not difficult, but with young trees, the cooly's fingers are somewhat in his way. When thin trees have therefore to be tapped a bent gouge is used which facilitates matters. The gouge can be easily sharpened, is very cheap, costing only about 50 cents retail, and is the most simple tool which can be used.

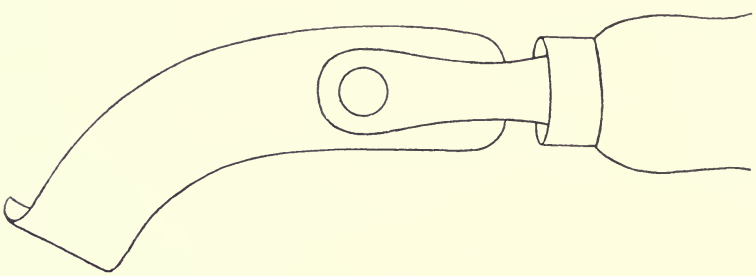
2. The Farrier's Knife.

In its most simple form this knife consists of a broad blade, a little thinner at the extremity, the point of which is curved. Both edges of the blade are sharp at the curved part; this therefore allows cuts to be made in both directions, making a small channel of the width of the cut. The knife is cheap and very simple, so that any native blacksmith can make it, although as a rule he will rarely follow his pattern with exactitude. Care should be taken that the curved portion is not made

too narrow, otherwise the canal which is to be cut with it will be too small. In using it, the cutting surface is put against the bark in the same way as with the gouge.

The principal point of difference between the knife in question and the gouge is that the cutting edge is more or less drawn along the bark, and thereby, the necessary direction is given with the hand which holds the handle. The farrier's knife has been in use from the early days of the industry and still does good work, although the tool next to be mentioned is now receiving some amount of preference owing to its easy manipulation.

FIGURE 37*a*.



Improved Jebong Knife.

Somewhat of a drawback is that it is not so easy to sharpen as the gouge, and it wears out quicker.

3. The Jebong Knife (fig. 37*a*).

This tool is made on the same principle as the farrier's knife, but the blade is bent. Its action is essentially a drawing one, much more so than with the farrier's knife. When using it on the upper series of tapping lines, those at breast height and upwards, the knife is drawn from

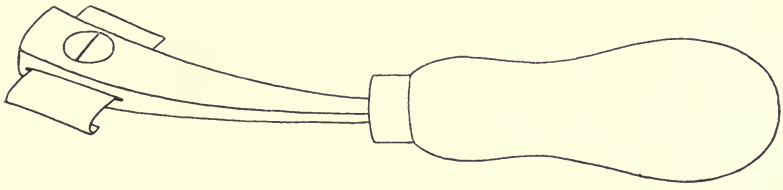
FIGURE 38.

Use of the Push and Pull Knife.

top to bottom, but on the lower series, the action is reversed, and is drawn from bottom to top. Generally speaking it works as a farrier's knife and possesses the same advantages as regards simplicity.

A slight improvement in the Jebong knife consists in making the blade in two parts, the cutting portion being in a separate piece which is attached to the remaining portion with rivets or screws, so that when the former is worn out or broken, it can be renewed without taking out the shank.

FIGURE 38*a*.



Push and Pull Knife.

Another improvement was shown to me consisting of a double knife made to be used on both sides. It looked to me very practical, but I am unable as yet to give a full description until the patent rights have been secured.

4. Push and Pull Knife (see fig. 38*a*).

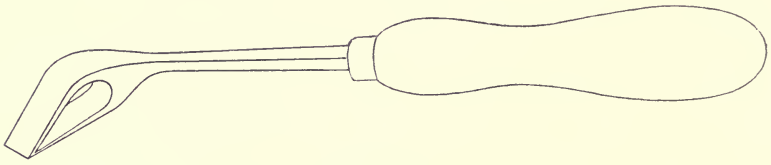
This is a kind of Jebong knife, but somewhat more complicated. There are two separate parts — the shank, and the cutting portion which is fastened to the shank with a set screw.

The cutting portion is somewhat like the extremity of the farrier's knife as is shown in the sketch. The

principal point to be noticed is that it is rather heavy at the end and therefore lies easily in the hand. By reason of this heavy construction, it is more suitable for pushing than for drawing than is the Jebong knife. On one estate which I visited, inexperienced workmen were given the push and pull knife to practise tapping with, the experienced coolies received the gouge.

There still remains to be described the marker (fig. 38*b*) which was originally made for tapping purposes, but is now exclusively in use for setting out the tapping lines. It consists of a handle in which is set a bar, bent and terminating in a wedge shaped head with an opening

FIGURE 38*b*.



Marker.

made through it. The edges of the opening are sharpened so that the head can easily be drawn through the bark. The cutting edges rip open the bark, and the strip which is cut away falls through the opening in the head.

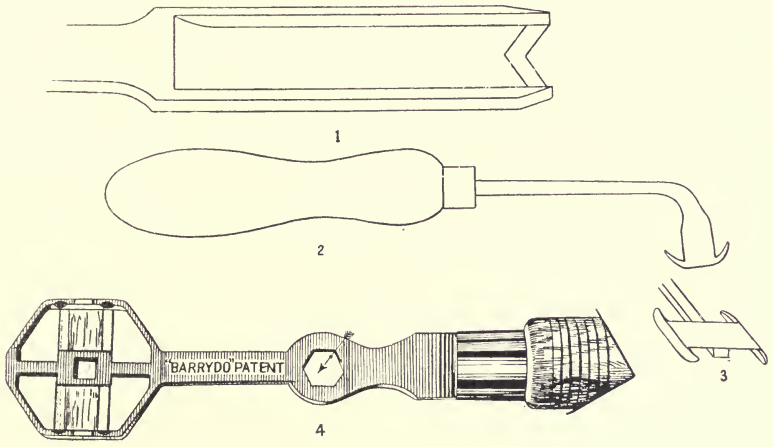
There are other types of tapping tools which only differ in a slight degree from those mentioned above, such as those, for instance, in which the cutting edge and shank are in one piece, and again those in which the whole tool is of a lighter construction than the ordinary push and pull knife. These, however, need not be more fully described here, they are fully described in the catalogues of dealers in such articles.

3. TAPPING TOOLS WITH A SQUARE OR STRAIGHT EDGE.

Many of the knives already described also exist in a somewhat different form with angular edges. Of the marker there are types with square shaped cutting edges. The tool most like the gouge is the Michie-Golledge

FIGURE 38*c*.

Tapping Knives with square or straight cut.



1. Michie-Golledge Tapping Tool.
2. Miller's Tapping Knife.
3. Sculfer's Tapping Knife.
4. Barrydo Tapping Knife.

tapping chisel. It will be seen on reference to the diagram (fig. 38*c* I) that the shape of the cutting edges permit the tool to be handled with great facility in several directions.

Various kinds of tapping knives with square cutting

edges may be met with. There is for instance a marker with a square opening in the head instead of a three sided one. There is an improved Jebong knife with a square cutting edge, and a bar shaped blade instead of a flat one. Other knives with a square cutting edge are more complicated. Miller's tapping knife (fig. 38c. No. 2) is a kind of marker with a square opening, and in front of and behind this opening there is a projecting part which allows the tool to glide easily and prevents cutting too deeply.

Sculfer's knife (fig. 38c. No. 3) has a bar to which a blade is attached. Both of its edges are sharp, and the sides are furnished with bent strips which have the same use as those in Miller's knife.

The Barrydo Tapping knife (fig. 38c. No. 4) is made on the same principle as Sculfers's, only the blade is changeable, and the strips continue so that the blade is, as it were, attached to a hexagon. The main objection to the three last mentioned knives is that the cutting edges are straight. In the process of tapping it is necessary that not only the underlip of the wound should be shaved down, but also the bark itself. This is possible with the Michie-Golledge tool, because there are two cutting edges, placed at an angle, but this is not so with the other three tools mentioned, and these knives have to be worked twice over the cuts, once around the underlip of the wound and once in order to shave down the bark.

There are many more complicated knives in use in the industry, and for details reference should be made to the catalogues of such firms as Messrs Walker, Sons and Co., of Colombo, Ceylon, or The Planters' Stores and Agency Co., of Kuala Lumpur in the Straits.

The tools that I saw most often in use on the Estates I visited were the gouge, the farrier's knife, the Jebong knife and the Michie-Golledge chisel. On one estate only did I see one of the more complicated tools, the Sculfer knife.

CHAPTER XII.

Harvesting the crop.

1. COLLECTING CUPS.

It has already been noted that at the foot of the vertical channel a small collecting cup must be attached so that the latex may flow into it. These cups must comply with the following requirements:

1. The inner surface must be perfectly smooth, so that no latex may adhere to the sides.

2. The material of which they are made must be such that will have no deleterious effect upon the colour of the product.

3. The cups must not be such as are suitable for any household use, otherwise they may be appropriated by the coolies for use in their houses.

4. They should have no sharp edges inside, to which the latex may adhere. In some cups the bottom forms an angle with the sides, and there is a resultant loss of latex.

5. They must be capable of being easily cleaned. It is necessary to clean them out frequently. With cups made of glass or white porcelain, it is easy to see if this has been done, but grey earthenware cups conceal the dirt rather.

6. They must not be fragile.

7. They must be moderate in price.

I have seen the following cups in use.

1. Cocoanut shells.

These do not answer the requirements of 1, 3 & 5, and their use should be strongly disapproved.

2. Tin bowls.

Sometimes, soldered tin bowls are used. They do not answer the requirements of 2, 3, 4 & 5.

3. Pressed Steel cups.

These are so made that the sides do not make a sharp angle with the bottom, however they do not answer to requirements 2 & 5. They have some advantage in that a handle can easily be attached, and they can be fixed on the tree above the level of the soil.

4. Earthenware cups.

The chief objection to these is that they do not generally answer to condition 1 and never to 5.

5. White porcelain cups.

These are in every respect better than earthenware cups and if the name of the estate is baked in when they are made, theft may be discovered, if not wholly prevented. They answer less to the last two conditions.

6. Pressed Glass cups.

These are of the same shape as the last mentioned. The sides make a sharp angle with the bottom. The name of the estate is impressed in the bottom. A great objection to their use is that they break after a short time, without any apparent reason.

7. Cast Glass cups.

These are manufactured in a shape which makes them unsuitable for household use; the bottom ends in a point, so that the cup can be pressed into the soil, but cannot be left on a table. The inside bottom is round and shapes upwards to the edge. The glass of which they are manufactured is colourless, so that they are easily cleaned. They do not often break,

although a certain percentage will usually arrive in a broken condition. The only objection is that the name of the estate cannot be put on indelibly so that theft is comparatively easy.

2. GATHERING OF VARIOUS FORMS OF THE PRODUCT.

1. Collection of the latex.

The ways in which the process of tapping is to be carried out, have now been clearly shown, and it has been pointed out how essential it is to start tapping as early as possible in the morning. Each tapper should receive a given area, all the trees in which he is to tap daily — if daily tapping is to be the system — or if alternate days' tapping be adopted, he must tap half of his trees one day and the other half the next.

Tapping cannot be carried out on rainy days. If it were attempted the water streaming down the trunks of the trees would wash the latex away.

The practice should be for the coolies to go into the fields as early as possible in the morning. Each workman should be armed with a tapping tool, a piece of tin (a piece cut out of a petroleum tin) a basket and a pail of water. Having arrived at the tree to be tapped the first places the latex cup in the proper place to catch the drip and puts a little water in the cup. Then he puts the piece of tin over the latter so that no dirt may get in the latex. His next step is to clear out from the cuts any scrap that has coagulated from previous operations, and then he must make fresh cuts. When the latex

is flowing, he dips a small roll of fresh leaves or a brush into the water and squeezes a few drops at the top of the cut, so as to rinse it, in order to assist the flow of the latex. Next he is to see that the latex flows properly along the cuts and down the vertical channel and that it is not impeded by rough patches of bark which might give a wrong direction to the flow. The scrapings of bark which have fallen on the ground are to be carefully collected and put in the basket. They will be subsequently dealt with in the factory.

When all his trees have been tapped, the labourer will collect the latex from the cups in a pail. On large plantations, these pails are again emptied into a vat on wheels which is sent down to the latex house.

Part of the latex in the cups will already have coagulated. This is called Lump Rubber. It is taken in to the latex house together with the rest. In order to prevent premature coagulation, the latex cups are sometimes covered with a green leaf.

After the cups have been emptied, they should be cleaned, and hung up to dry, generally on a stick which is put in the ground by the side of the tree. In one case I noticed that they were hung up on nails driven into the trees, which were apparently none the worse for the treatment.

2. If the scrap rubber is not gathered by the tapper, a separate gang of workmen should go round in the afternoon after the tapping has been done for the day (or on the afternoon of the following day when alternate days' tapping is practised) to collect it from the trees.

Women and children may be employed on this job. It should be noted that the operation of collecting the scrap is performed easiest when it is pulled from the tree from top to bottom.

On one estate I visited, the system in use was that of tapping every two days, and the scrap was gathered twice; the first time by an independent gang of coolies, and the second time by the tappers themselves immediately previous to making their fresh cuts. It is found that plucking the scrap from the trees causes the wounds to open afresh, so that a small quantity of latex is thereby obtainable. If this scrap is not collected on the second round, it is left on the bark and collected with the shavings. By gathering the scrap twice and paying the tappers separately for the amount gathered, the proportion of bark rubber obtained on the estate I have just referred to was reduced from seven or eight per cent to three per cent.

It will be found that a certain amount of latex will be wasted by spilling on the soil. This cannot be helped altogether and it is left to coagulate there and should be gathered by another gang which goes regularly through the fields for the purpose.

3. LABOUR FORCE REQUIRED FOR TAPPING.

In the Malay Peninsula, Tamils, and sometimes Javanese, are employed on tapping, men as well as women; occasionally also Chinese are to be found. The latter can only be employed on task work, and it is stated to be difficult to so arrange their work as to receive

a proper return without the trees suffering from over rough and too deep tapping.

Generally the extreme height to which tapping is limited is about six feet above the soil; if women are used on the work, it will be lower than this, or the two highest cuts would have to be put on by men. If tapping at a greater height than six feet is practised, ladders must be made use of, and men alone are competent for this work.

A tapper can make about a thousand cuts a day, good men can make 1,400 daily. The number of cuts depends to a great extent on the system of tapping adopted — when there are only two cuts per tree to be made, the coolies must walk a greater distance than if three or four cuts are to be made.

On one estate I visited, the coolies did 110 trees per day on an average, with 6 to 8 cuts per tree; the gathering of the scrap was done by the same workpeople and was included in the daily labour.

If two quarter sections per tree are to be tapped with a half herring bone of 4 cuts, daily, a conservative estimate would allow one workman per 100 trees. Calculating 100 trees per acre, which is wide planting, the tapping force required would be one man per acre. If closer planting has been made, the labour force would have to be proportionately increased, but this does not necessarily imply a greater output of rubber. In districts where the price of labour is low, a wide planting distance is advisable so far as the cost of production is concerned.

The following example has been selected from an estate in full production:

Trees tapped with four cuts, half herring bone on two quarter sections of each tree on each alternate day.

13 women each with 200 trees (100 trees daily).
4 reserve women in case of illness of regular hands or to take the place of any absent for other reasons.
1 woman to clean the cups.
1 Female Mandoer.

18 women (excluding the Mandoer) for 2,600 trees.

The planting distance gave about 150 trees to the acre, so that these 18 women tapped 16 acres.

4. MANAGEMENT.

It is not clear that the best system for dealing with the management if the labour force has yet been settled on. Generally speaking it would appear to be best that payment to coolies should be on the basis of results, as in other industries.

A few cases may be mentioned as examples of different systems.

On one estate the plantations suitable for tapping were divided into fields each of 240 trees. Each female tapper was allocated one field which she had to work over in two days. Her afternoon's work was to get in the scrap from the trees which she had tapped in the morning. Each woman received a number and this number was painted on her trees, the one day's trees, that is, half her total number, having a circle painted round the number, and the remaining half being left plain. By

this means she was enabled to distinguish easily each day's work.

A list is kept hung up in the factory with the respective fields indicated, and it is written up each day with the amount of latex obtained by each woman in the morning and the scrap in the evening. Owing to the necessity for adding some amount of water to the latex in the cups, it is not possible to reckon up the exact amount of amount of latex gathered, but if any great excess is added, the falsification would be apparent. Possibly a simple instrument like an areometer might be of good use in this direction. On the estate in question the latex collected by the women is bulked together and it is only after coagulation and further manipulation that the average return from each labourer can be ascertained. It was intended as soon as a larger area was ready for tapping, to allocate a special gang to each section of the estate and separate establishments would be maintained for coagulation and a monthly account would be taken so that premiums might be allowed to each gang based on the quantity of coagulated latex obtained.

On other estate, I saw also, the gang system was also adopted. Special arrangements were made to ascertain effectively the quantities of the different grades of rubber collected. Here again, each gang had its own field. The gathered rubber was collected and carefully weighed daily. Labels of which were provided to affix to the different descriptions of the prepared rubber.

Specimens are shown on page 117.

Date	
No. of Field	
No. 1	
No. of Lengths	
Weight	

Date	
No. of Field	
Lump	
No. of Lengths	
Weight	

Date	
No. of Field	
Skimmings	
No. of Lengths	
Weight	

Date	
No. of Field	
Scrap	
No. of Lengths	
Weight	

Date	
No. of Field	
Shavings	
No. of Lengths	
Weight	

Date	
Earth rubber	
No. of Lengths	
Weight	

WET RUBBER.

Rubber Account of ESTATE: for the

Date.	No. of Tappers.	Trees Tapped.	No. 1.	Cup washing.	Bark.	Scrap.	Total.	Weekly Total.	Remarks.
Total.									

DRY RUBBER.

Month of...19..........

Date Tapped.	Date Rolled.	No. 1.	Cup washing.	Bark.	Scrap.	Total.	Estimated Dry.	Weekly Total.	Cost per lb.	Remarks.

On the first line, the date of the crop is filled in; on the second, the number of the field showing at the same time, the gang responsible for the rubber. The third line specifies the quality of the rubber. "No. 1". means first-class rubber prepared from latex. "Lump" is the rubber, which coagulated in the cups, strained out before the fluid latex is dealt with. "Skimmings" means the rubber obtained from the scum taken off the pails, strainers etc. These three qualities produce a rubber of about the same market value. "Scrap" was gathered by the tappers daily; separate gangs of women and children being employed on the alternate day system. The shavings are always gathered by women; the earth rubber by a separate gang going through the whole estate, and therefore not allocated to specified fields. "Number of lengths" means the number of the strips of crêpe obtained from the different qualities, and, on the last line, the weight is filled in. All these figures are again entered in the Ledger, and on each parcel, the percentage which the different qualities bear to the bulk is calculated.

With such a complex system, it is often possible to discover mistakes which otherwise would not be observed. An example of this is the following; It was remarked that with gangs which worked every day and collected their own scrap, the percentage of this was lower and that of the bark rubber was higher than with gangs where the collection of scrap and latex was made by different labourers. On close investigation, it appeared that the former gathered their scrap with less care and left a great part on the trees, which was therefore brought in with the shavings.

The following figures deal with the composition of the crop.

	Old trees.	Young trees.
No. 1.	74.64 per cent.	74.77 per cent.
lump	8 52 „ „	5.83 „ „
scrap	10.58 „ „	11.73 „ „
bark.	6.26 „ „	7.67 „ „

When the crop returns are entered up, the dry rubber figures must also be carefully made out. The following report shows how account is taken of the different quantities which have to be dealt with.

5. FIGURES OF OUTPUT.

The production can be expressed in two ways: production per acre and production per tree. If an average number of trees is planted per acre, then the production per acre at different planting distances is generally about the same; the production per tree however, shows important differences, at least as far as the older plantations are concerned. In younger plantations where some of the trees may not yet be suitable for tapping and where the number of trees of tappable age increases year by year, the production per tree is practically the same, as the trees have still space enough during their earlier years, whereas the production per acre will vary considerably. The practice in the Malay Peninsula is generally to reckon out the production at per tree, these figures, however, are deceptive, especially for older plantations. Production figures per tree should not be passed by without mentioning another system. In the Malay Peninsula the tendency is growing to value the production in the

first place per acre followed by a statement of average figures at per tree. The following estimates are by Mr. GALLAGHER, and different competent planters, made independently of each other.

Age of trees	Crop (1)	Crop (2)	Crop (3)
4 1/2—5 1/2 years	200 lbs.	200 lbs.	150—200 lbs.
5 1/2—6 1/2 „	250 „	280 „	225—290 „
6 1/2—7 1/2 „	390 „	390 „	375—390 „
7 1/2—8 1/2 „	500 „	480 „	475—490 „
8 1/2—9 1/2 „	500—640 „	590 „	500 — „
9 1/2—10 1/2 „	500—700 „	700 „	500 — „

These figures are the average based on a low estimate. I have been able to compare them with crop figures from estate accounts and I found that they were not too high but rather under estimated.

(1) Mr. GALLAGHER's estimate.
(2) & (3) Estimate of other planters.

CHAPTER XIII.

The Preparation.

1. COAGULATION OF THE LATEX.

The rubber must be obtained from the fluid latex by coagulation. This coagulation can be effected in different ways; generally it is effected by the addition of an acid, usually acetic. Before starting the operation, the latex is strained through a sieve of fine copper gauze in order to separate the impurities which are sometimes contained in it and also the lump rubber which has already been coagulated.

Opinions differ with regard to the manner in which the coagulation is best effected and about the quantity of acetic acid to be added. Different processes may be described.

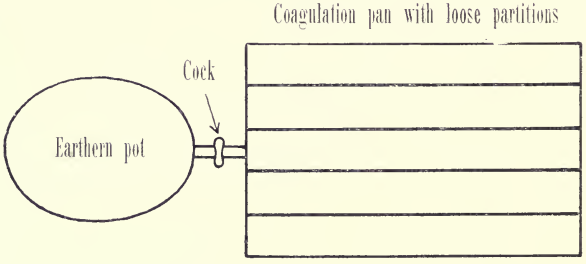
The following method was adopted on an estate in Negri Sembilan.

The latex was strained through a sieve into an earthenware pot, fitted with a tap through which it can pass into a wooden trough; in this pan it was mixed with acetic acid which was sprinkled as a solution of 1 : 12.5 over the latex, that is 1 oz to 1 gallon of latex which is the equivalent of 1 part solution of acetic acid to 160 parts latex.

At the time of my visit to the plantations, the coagulation trough was divided up by strong partitions, each section being filled with latex. It was intended to make an improvement in the system by replacing the fixed partitions by movable ones, so that they could first fill the pan, then sprinkle the latex with acetic acid, and then divide the mixture by means of the partitions in this way, effecting with certainty a thorough admixture of latex and acid and obtaining thereby a completely homogeneous product (see figure 39).

FIGURE 39.

Pan for coagulation.



The latex is left for a few hours; during which perfect coagulation is effected. The block of freshly coagulated latex is then loosened from the edges of the trough but still remains floating in the liquor. A frame is laid on it which keeps the white mass under water. The water is changed as often as possible.

On another estate, I saw coagulation taking place in pots.

In this case a cup full of 8 % solution of acetic acid was added to 25 gallons of latex; the cup would contain about half a pint which is the equivalent of 1 part of

FIGURE 40.

Pots for coagulation.
Showing the rubber coagulated, floating on the surface.

acetic acid solution to 400 parts of latex. The Manager informed me that as little acetic acid should be added as possible; an excess of acid makes the colour of the prepared product too dark.

On a third estate, coagulation was effected with a solution of 12 % acetic acid, in the proportion of 1 part of acetic acid to 300 parts of latex. Here the Manager thought that the chief thing was to coagulate as quickly as possible, and the operation was done in about ten minutes. The quick coagulation would turn out crêpe of a clear yellow (melon yellow); with slow coagulation dark colour is obtained.

Besides acetic acid I saw as an experiment, coagulating with smoke. On a subsequent page I will refer again to this.

In the above mentioned cases, the latex was made into crêpe. Another form in which the rubber comes on to the market is sheet. These are practically the only two descriptions which are manufactured in the Straits.

2. FINISHING THE COAGULATED RUBBER.

a. Sheet.

Thin homogeneous sheets of rubber are so described.

The preparation takes place as follows:

The latex is coagulated in square enamelled dishes, such as are used for the development of photographic plates. Then the soft block of freshly coagulated rubber is taken out; in the thick creamy white mass nearly all the water is still present. This is taken out by rolling.

The block is put on a wooden table with a sloping leaf, so that the water flows off; it is rolled out by hand with a wooden roller; the greater part of the water is thus eliminated and the block changes its shape. This piece is again passed two or three times through a couple of rollers. When small quantities only have to be dealt with, an ordinary wooden mangling roll may be used, but a rolling machine is necessary for handling large quantities. The distance between the rolls is continually reduced so that the sheet becomes gradually thinner and thinner. Machines are used with engraved rollers so that the pattern is transferred to the rubber sheet; in this way diamond sheet is obtained.

The sheets are then dried and smoked, the latter process being adopted in order to protect them against fungus with which they are often covered. The smoking establishment consists of a drying house of one story; in the top room, the sheets are hung up, and below is a fire-place with a smouldering fire of cocoanut shells, dead wood, etc. No damp material must be used for this fire; otherwise, moisture would be deposited on the rubber to its detriment. Square openings are made in the floor of the top room under the places where the rubber is hung so that the smoke can enter freely.

In the Botanic Gardens at Singapore, I saw small furnaces in use, for the smoking process. On the floor of the drying house, round holes are made, which are covered with fire-proof stone fitted with a funnel-shaped pipe; the tapering part of the pipe finishes in an enlargement, in which holes are left open in order to allow the smoke to pass. In the lower part there is a hole in the pipe to feed the fire.

The smoking of the sheets only requires a few days; then they are dried for about three weeks.

The price of sheet is a few pence per pound higher than that of crêpe.

b. Crêpe.

Crêpe is made by the roller machine. The two cylinders of the same are provided with screws; they turn with irregular speed, whereas, with the use of the roller-machine for the manufacture of sheet, the cylinders turn with regular speed and slower; also for sheet the distance between the rolls must be made wider.

The coagulated latex is fed through the crêpe machine, and is sprinkled with water; if the lumps of freshly coagulated latex are too large, they are first cut with a wet knife. By the screwed cylinders turning with irregular speed the mass is kneaded and stretched; after having passed the roller a few times, it has the form of a sheet with an uneven surface. In this form the crêpe is hung in the drying house; sometimes only the edges are cut off; the long ribbons are generally cut to a uniform length.

The drying as a rule is effected without artificial heat; on one estate, I saw a vacuum dryer, which was heated by steam by which the air was dried. Otherwise, the drying takes place in a drying-house, built of wood, with corrugated iron roof. A floor divides the drying house into an upper and lower story; the upper story serves for a drying room, the lower for the packing room. This floor consists of beams which are laid at wide intervals on the transverse beams, so that the air

can circulate freely. The strips of crêpe are hung close to each other. The rubber must be kept about three weeks in the drying house, and can then be sent to market.

c. Inferior qualities.

The scrap is always made into crêpe rubber. This takes place in the same manner as already described, in the crêpe machine; by means of a pipe with holes made above the opening between the cylinders; plenty of water is added, so that, by stretching out the scraps, the dirt which is there, is washed away. The crêpe thus obtained shows a darker and not so even a colour as the crêpe made direct from latex; the scrap consists of lighter or darker brown lumps of rubber, and these shades of colour are found again in the crêpe.

d. Scrap.

The shavings still contain a small percentage of rubber, not in the tissue but outside, because, after pulling off the scrap, these wounds bleed again, and produce a small quantity of rubber, coagulating on the bark, and sticking to the small strip cut away in the process of tapping. The shavings are worked in the same manner as the scrap; water should be supplied amply. In this way, a blackish brown crêpe is obtained with, here and there, lighter points, which are grains of bark tissue.

Earth rubber is worked exactly like shavings; the crêpe obtained from it is black.

c. Smoking.

Para rubber gathered in the wilds of Brazil brings higher prices on the market than plantation rubber, that is, having regard to the proportion of pure water-proof rubber. That the quality is better, may result from several causes. The trees in the forests of Brazil are older; the manner of tapping is different, and there exists quite a series of other differences. One of these, which can be avoided, without any great difficulty is the manner of preparation.

In the forests the latex is coagulated by smoking over a fire. In the Botanic Gardens at Singapore. I saw some experiments made by Mr. RIDLEY, who imitated the smoking process in a very simple way. In order to obtain the smoke, a small furnace is used entirely open at the top. A stick on which the latex is smoked, hangs with one end in a loop and the other part rests on a horizontal beam. Firstly, the stick is gently warmed above the fire, and care is taken that it is not caught by the flame; a slinging movement is given to the stick and it is always turned a little so that the stick is well warmed. Then taking it off the fire, a little latex is is poured over it. A pan is placed beneath so that none of the latex is wasted. The end of the stick having been well covered with latex, it is held in the smoke and turned gently round until coagulation is effected. Then more latex is poured on and the smoking process repeated.

There is a little difficulty in starting the operation — the wood must not be too smooth and the latex must be rubbed on it. Once, however, the first layer has been obtained, the rest is easy. In this way a ball of hard,

brown and very elastic rubber is obtained, — by shaking, it can easily be detached from the stick.

3. Packing.

In the Malay Peninsula I saw nothing but Venesta Chests used for packing. These are patent cases which are sent out from Europe and have to be put together by hand. The sides consist of three ply wood, the grain of which cross each other, and are perfectly smooth. This is a most important consideration for rubber packages. If the sides are dirty or if splinters or sawdust are present, these stick to the rubber and decrease the price enormously, and for the same reason, paper linings must not be used. The sides of the Venesta cases are fastened together by metal strips which are sold with the wood.

VENESTA, Ltd., 20, Eastcheap, London, E.C.

Venesta Rubber Cases at Cotton's Wharf, London.

MR. KELWAY BAMBER, the leading authority, says—

Do not ship your RUBBER in rough-sawn Cases.

We say, therefore—

Ship your Rubber in VENESTA CASES.

They are as smooth as planed wood, cost less, and are much stronger.

Being practically, if not actually, air-tight, Venesta Cases turn out the Rubber with the minimum of oxidation. This means **2d. to 6d. lb. better price by using VENESTA CASES.** Shippers of Castilloa, which oxidizes so quickly, should specially note this. Planters, however, who prefer to ventilate the contents of the Cases can have them supplied with small ventilation holes, which do not impair the strength of the Cases.

VENESTA CASES of the same Internal Capacity as Wooden Cases, measure **from 10 per cent. to 20 per cent. less for Ocean Freight,** and Weigh from **40 per cent. to 60 per cent. less for land Carriage,** than Wooden Cases of the same strength and internal measurement. The gain over Rubber shipped in bales or other packages is still larger.

Cases for TEA, BUTTER, PROVISIONS, RUBBER, SHELLAC, TOBACCO, CHEMICALS, FRUIT, and all kinds of Colonial Produce.

Shipped in parts at C.I.F. Prices to any part of the World.

Mark your Home Indents: **"To be packed in Venesta Cases"**, and save Freight and Charges.

COTTON & JUTE MILL SKIPS, COP BOXES & SLIVER CANS, MINE SKIPS, TRAYS FOR FACTORIES, PARTITIONED BOTTLE CASES.

FOR FULL PARTICULARS WRITE, STATING REQUIREMENTS, TO

VENESTA, Limited, 20, Eastcheap, London, E.C.

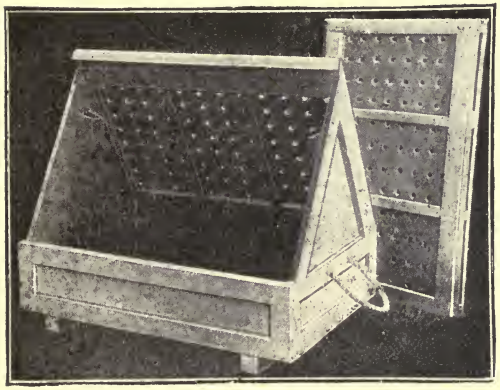
WARDIAN CASES

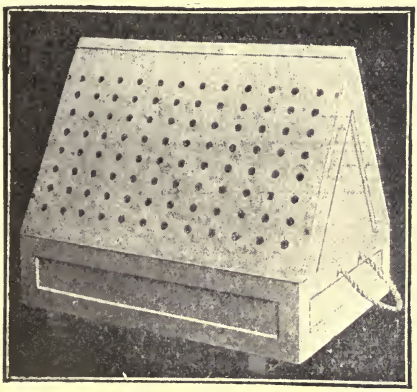
MADE OF

Waterproof "Venesta" 3-ply Boards

ARE THE

Lightest and Strongest form of this package on the market.





Extract from "Tropical Life",

May, 1910.

VENESTA WARDIAN CASES.

SINCE we, or those who were then at the head of our affairs, first sent the seeds from Trinidad (W.I.) to Ceylon, to plant up the Palli Estate, the first cacao estate on a large scale to be laid down in Ceylon, we have been interested in Wardian cases. We have worked with many firms to turn these cases out, light, but strong, and able to stand rough usage; until lately we had been unable to obtain what we considered to be a satisfactory article, but now have much pleasure in showing here illustrations of Venesta Wardian cases which that firm has placed upon the market at our suggestion. In a future issue we hope to give further particulars.

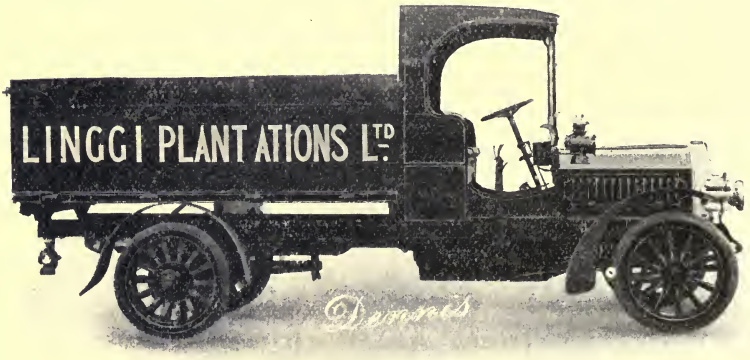
Price 45/- each made up.
„ 40/- each in parts ready to put together.

Weight 80-lbs. each complete with glass under covers.

Measurement Length, 33-ins. Width, 26¾-ins. Height, 33-ins.

VENESTA, Ltd., 20 Eastcheap, London, E.C.

DENNIS BROTHERS Ltd.
GUILDFORD,
England.



Motor Cars of every description for private use and General Estate Work.

The above Commercial Car was specially designed for the Conveyance of Latex.

Catalogues from

STUART R. COPE, Export-Agent.

6, Old Queen Street,

LONDON, S. W.

Telegrams: Teaminster, London.

Telephone: Westminster 5929.

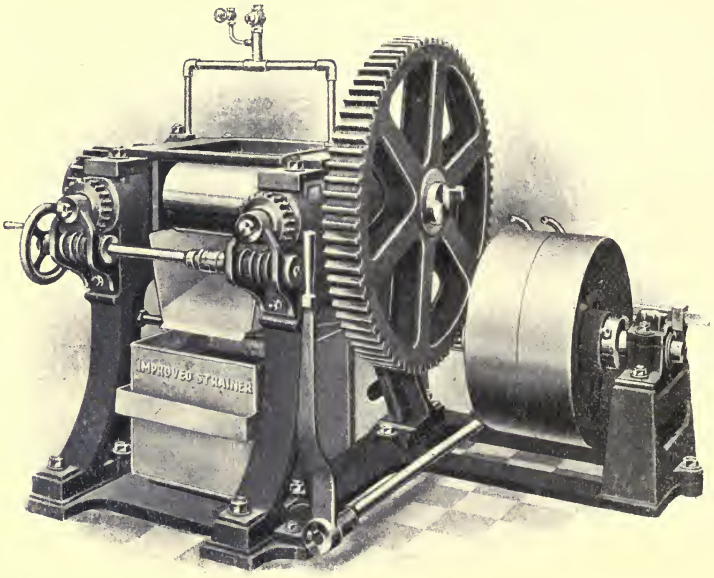
BRIDGE'S IMPROVED
RUBBER MACHINERY
FOR PLANTATION AND WILD RUBBERS
ALSO FOR FACTORIES.

PLEASE SPECIFY OUR MACHINERY
AND YOU WILL GET THE

BEST.

COMPLETE PLANTS SUPPLIED

WE HAVE FIFTY YEARS EXPERIENCE WHICH IS AT YOUR SERVICE.



CATALOGUES, SPECIFICATIONS, AND ESTIMATES FREE ON APPLICATION.

THE ILLUSTRATION SHOWS ONE OF OUR WASHING-SHEETING MACHINES, SELF CONTAINED.

AWARDS:

GOLD MEDAL, Mexican Exhibition Crystal Palace, London 1908
FIRST PRIZE MEDAL, Coomassie Exhibition, 1908.
TWO GRANDS PRIX, at the International Exhibition, Brussels, Colonial Section, Parc de Tervueren.

SOLE MAKERS:
DAVID BRIDGE & Co. LTD., YEW IRON WORKS.
CASTLETON NEAR MANCHESTER.
LONDON OFFICE: 35, QUEEN VICTORIA STREET, E.C.

THE DA COSTA PATENT "RAPID"

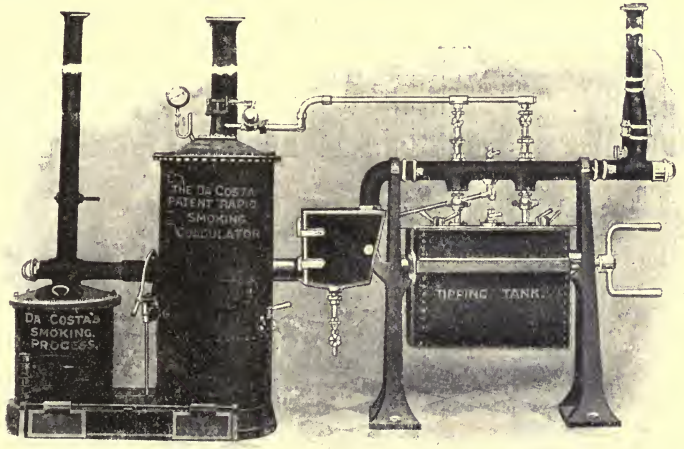
SPECIFY

RUBBER LATEX COAGULATOR

FOR THE PERFECT COAGULATION OF ALL KINDS OF LATICES
BY A SYSTEM OF SMOKING.

Rubber is now being exported from the Far East, etc., the Latex of which has been completely coagulated by the **DA COSTA PATENT "RAPID" SMOKING SYSTEM** and prepared by **BRIDGE'S IMPROVED AND PATENTED MACHINERY.** This is known as the **"DA COSTA" SMOKED RUBBER,** and is commanding the highest market prices as far as Plantation Rubber is concerned. It must be clearly understood that, by this system, raw manufactured Acetic Acid is not used in any shape or form but, on the other hand, Smoke is injected by Steam directly into the Latex with the result that every molecule is thoroughly coagulated and made antiseptic. The Secret of the Preparation of Rubber lies in the proper coagulation of the Latex. The best Rubber in the World is undoubtedly "Para" (Brazilian Wild Rubber), that is, Hevea brasiliensis from the Amazons. Why? **BECAUSE IT IS SMOKED DURING THE PROCESS OF COAGULATION.**

Acetic Acid Coagulation is Doomed. Why? Because it is not the natural way.



Adopt and specify the Da Costa Coagulator and BRIDGE's Preparation Machinery.

TYPE "B".

Made in various sizes for dealing with 50 to 2000 Gallons per hour.

We are supplying these Plants to
CEYLON, MALAY STATES, DUTCH EAST INDIES, EAST AFRICA, WEST AFRICA, MEXICO, BRAZIL, Etc. Etc.

Awarded Two Grands Prix at the International Exhibition, Brussels, Colonial Section, Parc de Tervueren

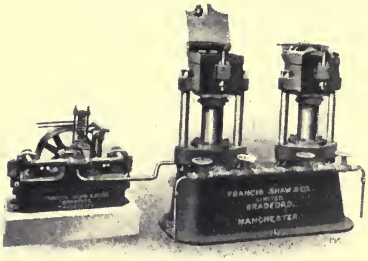
SEND FOR CATALOGUES & ESTIMATES.

SOLE MAKERS:

DAVID BRIDGE & C°. LTD., YEW IRON WORKS.

CASTLETON NEAR MANCHESTER.

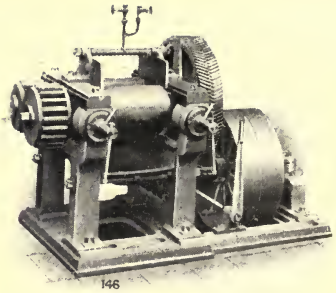
LONDON OFFICE: 35, QUEEN VICTORIA STREET, E.C.



BLOCKING PRESS.

SHAWS SMOKER COAGULATOR

coagulates latex by the smoking process to command the highest market :: prices. ::



18″ × 12″ WASHING MACHINE,

FRANCIS SHAW & Co. LTD.

CORBETT STREET IRONWORKS, BRADFORD,
MANCHESTER, ENGLAND.

Largest makers in the world of -:- -:-

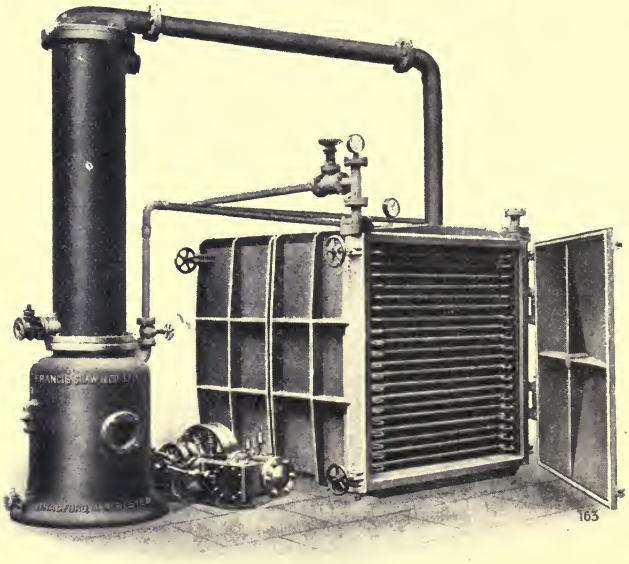
RUBBER PLANTATION MACHINERY

SEND FOR OUR 1911 ILLUSTRATED CATALOGUE POST FREE.

SPECIAL MACHINERY FOR TREATING VINE RUBBER BARK ETC.

VACUUM DRYING ∴ ∴ STOVES FOR ALL PURPOSES.

BUNGALOWS DRYING SHEDS COAGULATING SHEDS FACTORIES.



FOR PROOF OF THE QUALITY OF OUR MACHINES REFER TO LINGGI, LABU, CICELY, KAMUNING, PANDAN, SEKONG, MALACCA, SANDYCROFT, SENDAYAN, GLEN BERVIE, BANTENG, SUNGEI-BUAYA, BUKITKAJANG, F. M. S. ESTATES, ETC. ETC. ETC.

THE SHAW VACUUM DRYING STOVE.

We supply & erect complete Rubber Factories in all parts of the world including machinery, engines, buildings, drying houses, coagulators etc. etc. Plans, prices & full particulars of the most modern designs post free.

SOLE AGENTS:

GUTHRIE & Co. LTD. SINGAPORE, PENANG & KWALA LUMPUR.	LINTNER & Co. LTD. SOURABAYA & MEDAN.	WALKER SONS & Co. LTD. COLOMBO & KANDY.	LONDON OFFICE 139 CANNON ST. LONDON E. C.

The Netherlands Gutta-Percha Cy., Limited.

95, Anna Paulownastraat
The Hague
(Holland).

High Grade Gutta-Percha

Works in
Singapore
(Straits Settlements).

PLANTATIONS
on
Java (Preanger).

THE NETHERLANDS GUTTA-PERCHA Cy. LTD.

Gutta-Percha
Palaquium oblongifolium (left).

Rubber
Hevea Brasiliensis (right)

Mr. J. C. HARVEY offers his services in technical examinations of virgin forest lands in Mexico, Central or South America, containing Castilloa or Hevea rubber or valuable timber trees.

Expert investigations of physical conditions essential to the planting of Rubber, Cacao, Coffee or other cultures, in any part of the tropics- of either hemisphere.

Practical tapping demonstrations with improved tools upon Castilloa Rubber Trees, preparation of product in marketable forms, and statements of cost and yield.

Confidential reports upon going Estates.

Valuations and estimates. Also acts as visiting Agent for Estates.

Correspondence solicited and references exchanged.

J. C. HARVEY,
SANBORN.
ESTADO DE VERA CRUZ,
MEXICO.

Herm. J. van Koolbergen

Broker

Especially for Rubber, Balata and Drugs

Amsterdam

Telegraphic Address
:: "Koolbergen" ::

Telephone interc.
:: No. 5310 ::

Issued by J. H. DE BUSSY, *Amsterdam:*

MERCURY-CODE

3rd EDITION ENGLISH AND DUTCH
with Supplement.

An indispensable work for every one interested in telegraphic communication with the Netherland East- & West-Indies.

This Edition has been largely augmented and contains the telegraphic Code Words carefully selected from the Official Vocabulary published by the "Bureau international des administrations télégraphiques" of Bern.

Price of the "MERCURY-CODE":

TWO VOLUMES WITH SUPPLEMENT £ 6.6.-
not including carriage.

The employment of this Code has many advantages which are not to be obtained with other codes, not specially designed for communication with the Dutch Colonies.

Specimen page and further particulars may be had on application.

Published by J. H. DE BUSSY, *Amsterdam:*

ALPHABETICAL LIST,

arranged in the order of the terminations, of the words contained in the

"Official Vocabulary"

for reducing Telegrams to Code Language, compiled in accordance with the decisions of the International Telegraphic Conference of Paris by the International Bureau for the administration of telegraphs at Berne.

Price 40/— net.

This ALPHABETICAL LIST is an *indispensable supplement* to the various Telegraph Codes composed of words selected from the "Official Vocabulary of Berne". It contains all the words to be found in it arranged according to their terminations, so that not only all users of the "Mercury Code" third Edition, but also of all other telegraph codes on the market whose words have been selected from the said Official Vocabulary (such as the A. B. C. 5th Edition, Lieber's Code, Western Union Code, Atlantic Code, Broomhall's Code and others) and especially the possessors of private codes who have taken their code words from the same source, will find this book exceedingly useful.

Ed.

...HOP,

...ew-York.

...S IMPORTER

OF

...BE RUBBER

...a Percha and Pontianak.

Correspondence sollicited.

Valuations and any other information gladly furnished.

LINDETEVES - STOKVIS.

SEMARANG. - SOERABAIA. - BATAVIA. - AMSTERDAM.

Rubber Machinery and Rubber Utensils.

SOLE-AGENTS
FOR
The Dutch-East-Indies.
OF:

CLARKE's
Improved Washing,
Crêpeing and
Sheeting Mills.
Block Presses.

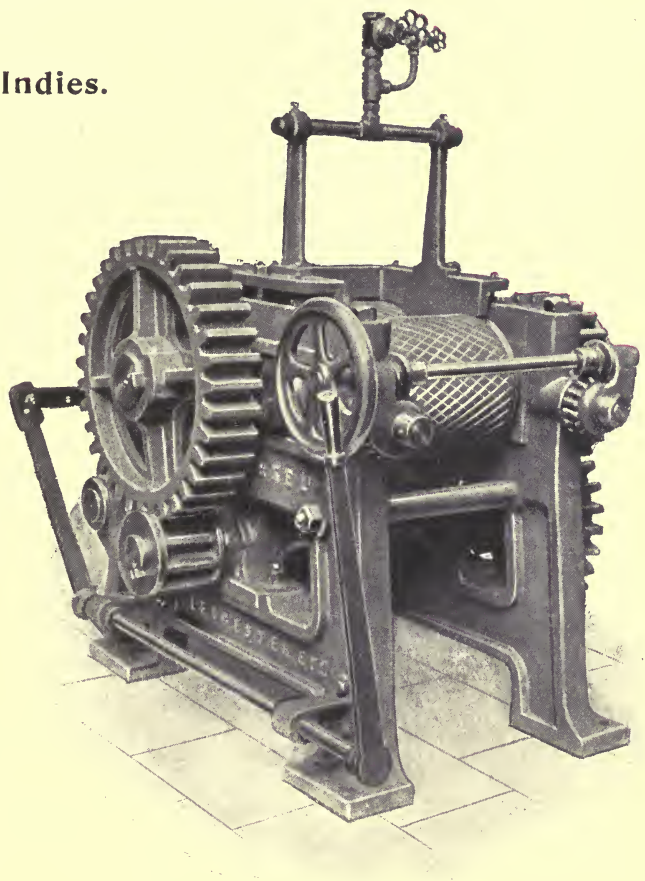
EMIL PASSBURG's
Vacuum
Drying Chambers.

ELIAS.
Preserventine.
Antiseptic Coagulant.

PURE MURAC.

BRONS CRUDE-OIL ENGINES.

RUSTON PROCTOR & Co.
Steam Boilers.
Portable Engines.
Power Transmissions
etc.



We furnish **all** kinds of tapping-knives, collecting-cups, coagulating-apparatus, chemicals, etc. etc.
We solicit the favour of enquiries or orders for complete rubber-factories

Ask for our ILLUSTRATED CATALOGUE.