NOTES ON

THE MANURING OF RUBBER,

BY

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Healthy Rubber Trees.

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There is probably no other subject connected with the agriculture of Ceylon upon which there is so much diversity of opinion as exists concerning the manuring of rubber. There is little doubt but that this diversity of opinion is chiefly due to the fact that there is probably no other crop in the world about which so little concerning the actual substance harvested, its purpose or its *raison d'etre*, is definitely known.

A vast amount of research work has been carried out both by individuals and by numerous societies. Botanists, chemists, biologists and other scientists of very considerable attainments and abilities have devoted years of study to rubber as a natural result of which many curious and valuable facts have been discovered and made known. But no one has yet thrown any real light upon the function performed by the latex, upon the purpose served by the latex in the natural economy of the tree, and there is every probablity that until this mystery is solved we shall be unable to exert any very direct influence upon the amount of latex manufactured by the tree and none whatever upon its composition.

Several theories have been put forward from time to time to explain the purpose served by latex, but none has been wholly satisfactory. It has been suggested that the latex cells serve as additional channels for the transport of food, a suggestion which merely begs the question. Apart from the fact that Hevea contains at least as many food-conducting channels as other trees, what purpose does the latex itself perform?

The same objection meets the suggestion that the latex cells serve as reservoirs for the storage of water or of food.

Another theory which has been suggested is that the latex serves to protect the tree from the attacks of pests and diseases, and solely for lack of a better this theory has met with a certain amount of acceptance, though it must be admitted even by its supporters that the evidence put forward in its favour is both meagre and extremely unconvincing. It has been pointed out that an area of Hevea bark which has been drained of its latex is frequently attacked by boring insects. This is perfectly true, but it is no more true of Hevea that it is of any other tree. The removal of the latex connotes the removal of considerable amounts of the vital nutritive principals also, in addition to which the local area of bark must necessarily be damaged in some way or other in order that the latex may be drained away. Now any tree subjected to this kind of treatment is liable to be attacked by poochies.

Moreover it is the largest yielding trees which are most subject to "brown bast." Those trees which give the most generous flow of latex, and therefore, according to this theory, ought to be most adequately protected, are just the very ones which are most liable to succumb.

Finally there is the unanswerable objection to this theory that the rubber tree is liable to be attacked by just as great a number of natural enemies of one sort or another as is any other kind of tree; a fact sufficiently evident upon a perusal of Petch's admirable work "Diseases and Pests of the Rubber Tree," a note extracted from the preface of which may not be out of place here :—

"That the future of plantation rubber is largely dependent upon the effective combating of disease has been repeatedly emphasised; and it is the duty of rubber planters, and those responsible for the management of rubber estates, to resist any attempt to minimise the importance of that aspect of rubber cultivation and research."

From all of which we may safely take it that the function of the latex is so far unknown.

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Quite a number of factors which influence the quantity and the quality of latex are already well known, and before endeavouring to increase the yield by artificial agency it is obviously necessary to ensure that every advantage is being taken of the benefits afforded by natural means.

One of the best known factor influencing the yield of latex is the actual tapping operation itself. An extraordinarily large amount of experimental work has been carried out to determine the optimum direction, angle and nature of the incision, its position on the stem of the tree, the number of the incisions, the frequency of tapping, and every other possible aspect of the problem together with the dependent questions concerning wound-response, resting periods, bark-renewal and so forth. And the voluminous reports upon all these trials contain the fullest possible particulars as to the variations in the flow and the composition of latex resulting from each modification in the system adopted. Indeed, so great is the amount of work carried out in this direction that it may reasonably be assumed that the matter has been fully thrashed out, and upon a subject on which so much has already been written it would appear needless to write more. It has been proved beyond question that in the old days the tapping was much too severe and the modern policy is all in favour of a far more moderate practice, generally consisting of alternate day tapping on a quarter of the girth with a resting period of one month in the year at the time when the tree is coming into new leaf.

The amount of latex present in, and obtainable from different individual trees varies enormously and this constitutes another most important factor governing the yield. This variability in the yield from different trees has long since indicated the necessity for the careful selection of the trees with the idea of eliminating bad yielders and of substituting those which were known to give a generous output. This is a problem which presents considerable difficulties in its practical application. One method frequently adopted was to plant the young rubber considerably closer than it was intended that they should remain, with the idea of subsequently removing those which were found to give poor yields. The objections to this method are that the close planting of the trees may retard their growth just about the time when they should be coming into bearing; a great deal of extra work is entailed in measuring and recording the yield of each tree separately, and when the bad yielders are thinned out the remaining trees are apt to be irregularly spaced. In spite of these objections however it is doubtful if any other practicable method will give better results.

A great deal of noise has recently been made about the method of selection by budding, but indications are not lacking that the claims made on behalf of this system have been grossly exaggerated.

Seed-selection and the creation of new strains in which the characteristic of high yield is fixed are methods which require expert control and which are obviously going to take very many years to carry out.

Other factors which are known to influence the yield of latex may be summarised briefly as follows :—

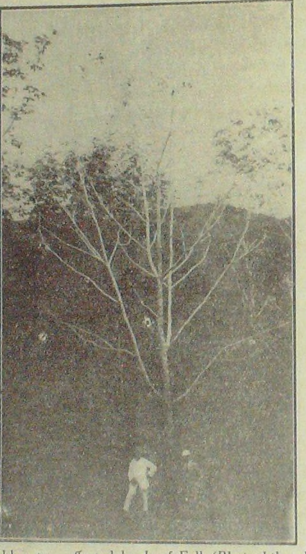
1. *The soil:*—Rich alluvial soils are the best for rubber; so are they the best for practically every other crop in the world. It is upon such soils that rubber makes its most rapid growth and gives its earliest and heaviest yields. Such soils are, however, few and far between and fortunately Hevea is such a stout-hearted tree that it will flourish upon a great variety of soils, even upon those which contain comparatively little inherent fertility.

2. *Elevation, rainfall and wind:*—These factors, all of which influence the yield of latex, are so intimately related to each other that they should be considered collectively. Generally speaking, the lower the elevation the better

yield, provided that marshes and swamps are avoided or else well drained. The higher the elevation the greater will be the influence exerted by strong winds, particularly if they prevail during the dry seasons, in which case the yield of latex will inevitably suffer. Rainfall is one of the most important, if not actually the most important of all known factors which influence yield. A fall in the neighbourhood of 70 inches per annum is generally considered to be the minimum from which the best results can be hoped for. The highest yield of rubber invariably follows shortly after the period of greatest rainfall, a fact which in itself indicates sufficiently strongly the importance of adequate rain, as also the importance of a good distribution of the rainfall throughout the year.

3. *Seasonal variations:*—The variation in the yield of latex at different seasons of the year is to a greater or less extent masked by the great variations in the seasons themselves, principally on account of the dominant influence exerted by the rainfall. However, generally speaking the highest yields are obtained in November, December and January, just before the period of leaf-fall. During the time the leaves are off the trees there is a fall in the yield of approximately twenty-five per cent. The fact that this reduction in yield occurs at the same time as the defoliation of the tree has led to the assumption that the leaves of Hevea have a direct influence upon the flow of the latex, but it should be observed that both the fall of the leaf and the reduction in yield are effects brought about by a common cause, the annual "slumber" of Hevea, when all parts of the tree, root-development, branch-growth, flow of latex, and all the other vital activities are similarly affected. In support of this theory it should be noted that when partial defoliation is brought about by attacks of Phytophthera the fall in the yield of latex is by no means commensurate with the extent of the defoliation. In many instances the flow of latex is not affected at all, and

generally speaking, it is only when the same trees have been attacked for several succesive years, and their general health thereby naturally debilitated, that the yield in terms of latex and of caoutchouc is seriously diminished.



Rubber tree affected by Leaf Fall *(Phytophthera)*.

4. *Age of tree:*—From the time a normal healthy tree is brought into tapping the yield gradually increases year by year until the tree is about twenty-five to thirty years old. By this time, provided the tree has been regularly tapped, the bark will have become exceedingly thin and thereafter it will be increasingly difficult to obtain any

profitable yield. By the time a field of Hevea has attained the age of thirty-five years it is very doubtful if any of the trees will shew a tappable thickness of bark.

5. *Closeness of planting:*—Trees planted too close together very naturally interfere with each other's development and therefore affect the yield of latex. The most profitable number of trees to be grown to the acre depends to a great extent upon the quality of the soil, the elevation of the estate and local climatic conditions. As in the case of tapping it is now generally recognised that a more moderate policy is the more profitable, and from eighty to ninety trees per acre is the number favoured by most planters.

6. *Level of soil water:*—Where the level of the soil water is comparatively close to the surface large yields of latex are obtained at an early age. In those districts where the soil water is at a considerable depth a correspondingly longer interval of time is required for the roots to reach down to it and during this time the yield of latex is dependent upon the seasonal rainfall.

7. *Cultivation:*—An estate which has been properly and continuously cultivated from the time it was planted up invariably yields more latex per acre and per tree than another similar estate which has not been cultivated, which is only what one would naturally expect. Disturbance of the soil by tillage results in the aeration of the soil by which plant-food is converted into a soluble form, in a greater freedon of movement of soil-water, in the conservation of moisture, and in the admittance of air to the roots, with the natural consequence that the trees grown upon soils treated in this manner will become bigger, stronger and healthier, and hence will yield more latex that those grown upon uncultivated soil. But it cannot be too strongly insisted upon that if the cultivation is carried out in such manner that the root systems of the trees are damaged and the roots themselves exposed by the subsequent washing away of the loosened soil then

the results are wholly harmful, and nothing by way of benefit will reward the labour and expense incurred. Weeds or other crops interplanted with the rubber are detrimental to the yield of latex, with the possible exception of small legiminous plants grown between the rows for the purpose of enriching the soil in nitrogen and, to some extent, preventing the wash-away of the surface soil.

8. *Health of the tree:*—Good health is as essential to a good yield in the case of rubber as it is in the case of all other crops. It is a curious fact that a diseased or dying tree will very frequently be found to give a largely increased yield for a short period, but unless remedial measures are taken this state of affairs will rapidly change and the death of the tree will follow. Those trees which are excessively large yielders are by far the most liable to develop brownbast, and it would appear that the continual emptying of large and well-developed lacticiferous tissue in the ordinary course of tapping ultimately results in the collapse of the cell walls and the subsequent appearance of brownbast.

9. *Manuring:*—Up to a comparatively few years ago the diversity of opinion relating to the manuring of rubber was concerned not so much with the kinds of manures to be used as to whether or not rubber should be manured at all! Since then, however, the alarming increase in secondary leaf-fall, the larger number of dry trees and the slower renewal of bark have combined to manifest the necessity for artificial aid in order to enable Hevea to maintain its vitality and to ensure satisfactory renewal of bark.

So much for the principal factors which influence the yield obtainable from Hevea. A moment's consideration will reveal the fact that while some of them are entirely beyond our control others can be modified to a greater or less extent at will.

The soil, for instance, may be good, bad or indifferent for the purpose of growing Hevea. But whatever it is we have to make the best of it. Within certain very narrow limits we can modify its mechanical condition by cultivation and we can make good a deficiency of plant-food by judicious manuring, but that is about as far as we can go. The elevation, rainfall and wind are obviously entirely beyond human control. Something can at times be done to ameliorate local conditions by way of protecting the trees from excessive winds and some useful work can be done to conserve soil moisture by adequate cultivation, but for the rest we have here again to make the best of things as they exist. And of course the same applies to seasonal variations, the level of the water in the subsoil, and so forth.

The factors which are within our control, to a greater or less extent are closeness of planting, cultivation, the health of the trees and manuring, and it is through the proper manipulation of these factors that we can most readily exert an influence upon the yield of latex. Reference has already been made to closenes of planting and to cultivation. The health of the trees will always depend upon the efforts put forth by the planter to spot the first trace of disease, diagnose its nature and to adopt remedial and preventive measures. And now at length we come to consider the question of manuring rubber.

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It is unfortunate that the trials and experiments carried out with different types of manure on rubber have been nothing like so numerous nor so comprehensive as those dealing with the tapping of the trees and other allied questions.

The information gained from the manuring experiments can be all too briefly summed up as follows :—

1. No single manure nor any mixture or manures has yet been discovered which can be relied upon *in all cases and upon all soils* to increase directly the flow of latex or the proportion of caoutchouc.
2. One series of trials carried out for three consecutive years under expert supervision gave the following data :—

   Neither line, potash nor phosphoric acid gave any improvement in yield.

Nitrogen has a distinctly beneficial effect which made itself apparent in the fuller crowns and darker foliage of the trees. By actual measurement it was shewn that the renewal of bark was hastened and that growth was more vigorous. In all cases the effect of the fertiliser (Nitrate of Soda) was apparent at the end of the third year though by that time the yields were diminishing.

Nitrogen had also a specially valuable effect on the lacticiferous system; the latex cylinders became more numerous and the yield of rubber was increased.

The same series of trials carried our on other types of soil, however, gave conflicting results, showing that even nitrogen cannot be relied upon to increase the yield upon *all* types of soil.

3. When manured with nitrogen Hevea tends to "winter" later than when manured with phosphoric acid.
4. Nitrogen, when applied in a soluble and readily available form, has a distinct effect in combating attacks of secondary leaf-fall and pod disease.
5. The effect of manure upon mature rubber has been clearly demonstrated as conductive to a vigorous and generally healthy condition of the trees. This has of course an indirect beneficial effect upon yield.
6. It has also been clearly demonstrated that rubber requires to be manured to maintain its vitality and to ensure satisfactory renewal of bark. This has been evidenced by the increase in secondary leaf-fall, the proportion of dry trees and the slower renewal of bark upon unmanured estates.
7. Young trees which have been manured can be tapped several years earlier than others which have not been manured.

Now the above seven points cover all the information which can be relied upon as being accurate, so far obtained from the trials carried out in Ceylon and in other rubber growing countries. In many ways this information is meagre and unsatisfactory, but in view of the fact that it is all there is we have to make the best of it. Certain general principles are clearly revealed and of these we must of course take the fullest advantage if we hope to obtain the most profitable results.

The general principles may be stated in the following form :—

Manure mixtures for rubber should be such as are calculated to induce the vigorous growth and sturdy development of the tree. This naturally implies that it is the vegetative portion of the tree that the manure is required to benefit.

From this it follows that nitrogen must enter largely into the composition of the mixture, since the development of roots, stem, branches, leaves and bark is directly controlled by the quantity of nitrogen available.

But the mixture should be "complete," i.e., it should contain both phosphoric acid and potash in addition to the nitrogen, in view of the necessity for taking every possible precaution to safeguard the health of the trees by ensuring even and natural development.

The bulk of the manure mixture should be readily available for absorption by the tree for two very important reasons, first because large quantities of organic matter are added to the soil annually by the wintering of the trees, thus obviating *to some extent* the necessity for applying expensive organic manures, and secondly because to get the best effects the fertilisers should be applied during the wintering season so that they can influence the bark tissues that are formed after the new leaves appear. If the manures are applied after these tissues are formed the best opportunity of increasing the number of latex vessels will be lost.

Now let us try to devise a manure mixture which will be in accordance with the experience gained from the trials so far carried out and which will comply with the general principles deduced therefrom.

In the first place where nitrogenous crops are well established between the lines of trees it will be quite unnecessary to include any form of organic matter whatever in our mixture, since the leaves from the Hevea and from the leguminous plants will be ample to meet all requirements. But for those estates which do not grow any nitrogenous crops it would be advisable for our mixture to contain a relatively small proportion of some organic fertilising material, and for this particular purpose it would be difficult to choose anything better than Fish Guano. To quote the words of Sir A. D. Hall, the greatest living authority upon soils and fertilisers, "Fish Guano shares with the true guanos the property of continuing to yield nitrogen to the plant throughout the whole growing season."

This most useful property is due to the fact that the nitrogen in fish guano exists in several different forms which become available after different intervals of time. In addition to which it contains a good proportion of phosphoric acid which gradually becomes available to the plant as the decomposition of the guano proceeds.

To guide us in the choice of our available nitrogen we have only to turn to the classic trial carried out year after year, for twenty consecutive years, by Dr. J. G. Lipman and A. W. Blair, who report as follows :—

"Twenty years continuous investigation shew that Nitrate of Soda is the most effective in crop production, that is, the crop is able to utilise or win back a larger percentage of nitrogen in this form than in any other form. The average amount of nitrogen recovered in the crop, over twenty years, was :—

Nitrate of Soda	62.42 per cent
Sulphate of Ammonia	47.48 ,, ,,
Dried Blood	36.89 ,, ,,
Farm Yard Manure	32.69 ,, ,,

In so far as available phosphoric acid is concerned our choice is practically limited to superphosphate in view of the fact that we require a substance of well-established efficacy which can be absolutely relied upon to supply the plant with this important food material in such a form that it can be immediately drawn upon.

For potash we turn to the muriate as being the cheapest and at least as good as any other form of potassic fertiliser, if not actually better.

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Turning now to the question as to the proportions of these ingredients to be included in our mixtures it should be observed that for several years past it has been the practice in Ceylon to prescribe mixtures containing approximately 6 per cent. of nitrogen, 8 per cent. of phosphoric acid and 4 per cent. of potash. This is one of the very few aspects of the question of the manuring of rubber upon which there has been a fairly general agreement. It is sound in theory and it has been found to answer well in practice so that there would appear to be little object in effecting any alteration except, possibly, in the direction of increasing the amount of potash.

The exact effect of potash upon the crop to which it is applied is by no means clearly understood. It is known to take an esential part in the process of carbon-assimilation, and by some means or other it assists in transferring starch from one part of the plant to another. It has also been found to assist in the production of leaves and in the elaboration of the acid juices of fruits.

But although the means by which these results are brought about are little understood the results themselves are clearly of great importance to the plant, more especially in the case of rubber, since potash has frequently been found to have a hardening effect upon the wood.

With the idea therefore of benefitting the wood and endeavouring to render the tree more immune to the attacks of fungoid diseases it is considered that it would be advisable to increase the proportion of potash in our mixture from 4 per cent. to 6 per cent.

We therefore arrive at the following composition for our manure mixture :—

	Nitrogen.	Phosphoric Acid.	Potash.
200 lbs Fish Guano containing	15 lbs.	17 lbs.	0 lbs.
200 ,, Nitrate of Soda ,,	31 ,,	0 ,,	0 ,,
250 ,, Superphosphate ,,	0 ,,	45 ,,	0 ,,
100 ,, Muriate of Potash ,,	0 ,,	0 ,,	50 ,,
	46 lbs.	62 lbs.	50 lbs.

Percentage of plant-food	—Nitrogen ...	6.1	per cent.
	Phosphoric Acid	8.2	,, ,,
	Potash ...	6.6	,, ,,

This mixture contains the ingredients selected for the special and particular reasons previously mentioned and it contains them in the proportions which not only would appear to be the best from a theoretical consideration of the whole question of the manuring of rubber but which have also proved themselves to be the best in actual practice.

It is not designed for the special purpose of inducing an immediate and lavish increase in the flow of latex; it is designed expressly with the object of producing a healthy, vigorous tree which will resist disease and on which the bark renewal will be speedy and the bark itself will be healthy, thick and composed of an increased proportion of lacticiferous tissue.

It is not suggested that there is anything new in this mixture, indeed it actually contains no novel feature whatever. The ingredients themselves and the proportions in which they are prescribed have been used with great frequency in Ceylon, and in other rubber growing countries also, and the results obtained have invariably justified the selection made.

In the case of soils which shew some special and peculiar characteristic it is possible that some modification in either the nature or the proportions of the ingredients may be desirable, and where such conditions exist they must of course receive due consideration, but in the great majority of cases it is exceedingly doubtful if any such modifications would be either necessary or desirable.

The amount of this mixture to be applied per acre will of course depend upon the frequency with which manuring is carried out. On those estates where manure is applied annually the soil should be dressed with 350 lbs. per acre, whereas if manuring is done only once in two years the quantity should be increased to 700 lbs. In this connection it might be observed that the annual dressings invariably give the better results.

The time at which manure should be applied to rubber is a question which is open to great controversy but the general concensus of opinion favours the wintering period as the most suitable. This would appear to be sound from every point of view. It is at that time that root development is at a stand-still and the roots themselves therefore receive less damage by the forking than at any other time. Moreover the tree will thus be supplied with a quantity of soluble and available plant-food just when it most requires it, when it is putting forth its fresh leaves and when new tissues, including those of the lacticiferous system, are being developed.

In a country like Ceylon, where the climate varies to enormously in different districts, exceptions will of course have to be made in those parts where climatic conditions are unfavourable at the time the trees are wintering. If at that time the ground is dry and hard, forking will be very difficult and ineffective and as the drought will in all probability be followed by torrential rains at the burst of the monsoon there will be considerable danger of loss through washaway.

The ideal conditions under which manure can be applied to rubber are during, or just after, a period of light showers with the monsoon a month or six weeks ahead, and where these conditions prevail at the time when the trees are wintering there can be no question about it that this is the best possible time to apply the mixture.

Under such conditions as these the manure can best be applied by broadcasting it over the surface of the soil and lightly forking it in. Here again, however, exceptions have to be made in the case of estates where forking has been neglected during the earlier growth of the trees as there is in these cases a danger of inducing excessive exposure of the roots, which should be strenuously avoided.

Where the roots are already exposed and there is a danger of exposing them still further there is no help for it but to resort to the trench method of applying the manure.

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In view of the great diversity of opinion already existing upon the question of the manuring of rubber it would of course be hopeless to expect that this modest contribution to the subject will receive unanimous support. The writer is fortified by the knowledge that many prominent rubber planters are in agreement with the principles herein laid down and this must be his justification for submitting it to all.

A large number of Ceylon planters will recognise the mixture recommended as one with which they are already familiar, and being satisfied with the results obtained in the past they will doubtless continue to use it in the future. But to those to whom it may come as something new the writer presumes to offer one tiny piece of advice.—Try it upon a small scale and see what results it gives.