REPLANTING*

BY

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Before describing the operation of replanting on rubber estates, it would be best to consider the principal reasons for doing it.

DETERIORATING OLD RUBBER

The first and most obvious reason is that much of the rubber in this country is getting old. Perhaps this is a premature old age due to bad tapping, the ravages of disease, neglect of soil conservation, and other such causes, but whatever it might be due to the fact remains that a very large part of our rubber yields under 400 lbs. per acre per annum and of this an alarming proportion is giving less than 250 lbs. Exact figures are difficult to obtain as, under restriction, estates are not in full tapping. The figures supplied for assessment purposes are derived from yields obtained during the slump years of heavy tapping following the resting of the previous restriction period and, of course, the rubber was younger then. They do not truly reflect the present situation and it is now generally agreed that such yields will never again be obtained from the old rubber trees we have now. Even with manuring and the cultivation of natural covers, yields are not likely to exceed those of the years 1929 to 1933, and in many cases the most that can be hoped for is the prevention of further deterioration. Besides, the older the rubber the slower its response to manuring. Improvement in foliage might take place rapidly but bark renewal, on which yields so largely depend, is a much slower process. It might be many years before yields have increased enough to pay for the manuring and by that time, on account of increasing age and losses due to disease, most old rubber areas would be uneconomic anyhow. With this unfavourable prospect in view for so much of our old rubber, replanting as a regular policy will soon commend itself more and more to planting companies and eventually, perhaps, to small-holders also.

IMPROVED PLANTING MATERIAL

The second great reason for replanting, more important even than the first, is the great improvement in planting material which

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has taken place in recent years. Budgrafting and seed selection have made such strides that no one who can afford it should refuse to consider the replacement of old low-yielding trees with modern high-yielding ones. As yet there are no large areas of budgrafted rubber which have been in bearing long, but the early results obtained so far indicate quite clearly that yields will be much greater than those obtained from mixed seedling rubber. Estimates of yield from budgrafted areas still vary considerably but 1,000 lbs. per acre per annum, which was once thought high, is now looked on as a very moderate expectation; 1,500 lbs. per acre is regarded as quite a reasonable possibility, and some enthusiasts optimistically hope for annual yields of as much as a *ton* of dry rubber per acre. There are many estates where, owing to loss of trees by disease and deterioration of those that remain, replanting even with mixed unbudded seedlings would be profitable. Now, with such high-yielding planting material available, even estates possessing comparatively good old rubber are beginning to realise that it is worth while to cut it out and replant.

Greater Profits

The third important reason for replanting is bound up with the second one and with the future price of rubber. When costs are discussed later in this lecture it will be shown that, if the price of rubber remains at about 20 cents per pound, replanting will pay for itself entirely in roughly a dozen years and leave the owner with a high-yielding property instead of a poor one. The question is, "What will happen if the price of rubber does not remain around 20 cents?" In that case, instead of regarding the cost of replanting as a charge on revenue it must be looked on as an addition to the capital value of the estate whose dividend-earning capacity has been greatly increased thereby. The argument is difficult to state in a few words but what it amounts to is that, if the price remains good, old rubber areas might do quite well but replanted ones will do even better and the outlay on replanting will soon be recovered. On the other hand, if we have another slump, the companies with high-yielding replanted areas, although perhaps more highly capitalised on this account, will have the best chance of surviving and of even paying dividends. Whichever way one looks at it, *and whatever the price of rubber*, high-yielding estates are bound to do better than low-yielding ones. In good times they make most profit and in bad times they make least loss. There may be occasional exceptions to this rule, as for example when, during a slump, circumstances are such that it is better for an old estate without reserves to go into liquid-

ation rather than try to raise funds for replanting, but in general it holds good so long as rubber is saleable.

Chance to improve Soil

The fourth great reason in favour of replanting is the opportunity which this provides of reconditioning the soil. Until the last ten years or so care of the soil was almost entirely neglected on rubber estates. On the flat coastal lands this has not been very serious but on undulating and hilly estates the loss of soil due to erosion has been nothing short of tragic. In addition to the wholesale transportation of soil by erosion, conditions under clean-weeding are such that humus formation is greatly retarded and cannot keep up with the consumption. The part which humus plays is not fully understood, but it is known to be a most important constituent of the soil. Without it beneficial bacterial activity almost ceases, and, moreover, recent research work in Europe seems to indicate that artificial manures do not have their full effect unless a good supply of humus is present. Replanting provides an opportunity of repairing some of the loss of humus and of improving the soil generally, by growing leguminous cover plants and later natural jungle covers in conjunction with such soil conservation methods as terracing and bunding.

Labour

These four reasons for replanting are the principal ones and apply to almost all estates possessing old rubber. There are other reasons, of less general application, of which the question of labour might be mentioned in passing. We all know how when the slump came and nearly all field works on estates were suspended, thousands of labourers, often of long service, were sent back to India or China. The result was that, when the price of rubber rose and money became available for much needed maintenance work, there was a serious shortage of labour. Labourers could not be brought back fast enough and there was an undignified scramble for those who had remained in the country. If those companies which could have afforded it had commenced replanting at the beginning of the slump, not only would they have done it much more cheaply but they would also have been able to keep their labour on the spot and avoided much of the trouble which came later. The slump has lifted, we hope for ever, and it is no use deploring having left undone the things which we ought to have done, but we must not overlook the fact that a similar situation with regard to labour still exists. Owing to restriction and the still rather low price of rubber, estate

labour forces generally are well below their full strength. If the price of rubber rose so as to permit some of the still neglected maintenance work to be done, or if the export allowance were to be increased unexpectedly, there would again be a shortage of labour. To be doing some replanting, even on a small scale, means having a reserve of labour on the estate which will be most useful in such emergencies.

Now we can go on to the description of the operation of replanting. It is not proposed to describe in detail the various field works, as you are all familiar with them, but emphasis will be given to the points requiring special attention.

Selection of Area to replant

To begin with, there is the selection of the area to replant. The natural impulse is to replant the worst part of the estate first, so as to make the loss of revenue due to cutting out as small as possible, but this is not always the wisest thing to do. On some estates, of which there are many unfortunate examples here in Malacca, the worst parts are so bad that only very lavish expenditure on manures would make replanting possible. Even then the results might be disappointing and would discourage further replanting. Every case must, of course, be judged on its own merits but in general the most suitable areas to select for replanting are those where the soil is still good but where the yield has been reduced through old age or loss of trees by disease. In this way there is no great loss of revenue through cutting out and yet, the soil being still fairly good, the replanted rubber can be expected to do well. Very poor land should be replanted last, and, pending replanting, efforts should be made to improve the soil by the growth of suitable natural covers.

It might be emphasized here that a progressive replanting programme should be planned as long beforehand as possible. The reason is that one usually has to decide whether to manure the existing old trees or to cut them out and replant. For financial reasons, or because the old trees still have a few more years of useful life, it might be decided to defer replanting. If this is the case an estimate should be made of the date when replanting will be carried out to enable one to decide whether it is worth while to manure now. With old rubber, it takes a long time for manuring to cause an increased yield and thus by spending money on manuring one is practically committed to keeping the old trees for many more years. So, if replanting is not possible at once but is intended within say 5 years, it is a waste of money to manure the old trees since they will be cut out before they have paid back the cost.

Tapping to Death

Having selected the area for replanting, the next step is to tap it so as to get the largest possible yield in a short time and thus help to counter-balance the loss of crop during the period before the replanted rubber comes into bearing. The system to be used in this "tapping to death" depends on the length of time available, and should be such that the trees become exhausted just about the date it is intended to cut them out. If the decision to replant is made suddenly, so that there are only 2 or 3 months left before felling, a very drastic system such as the daily tapping of two cuts can be employed. The cuts would each be half the circumference of the tree, as wide apart as possible on opposite sides, and tapped down to the wood with virtually unlimited bark consumption. If replanting has been foreseen a year or so ahead, a more moderate tapping system planned to last that time, such as two half-cuts tapped alternate-daily, will be more profitable.

Recently a method of tapping to death during the actual process of replanting has been suggested. The proposal is to cut off the branches of the old trees and tap the stumps whilst the work of replanting and establishing cover plants is going on. Even if the yield from the pollarded stumps is poor it will not matter a great deal in these days of restriction, as the exportable allowance can, or should be, easily obtained from the other parts of the estate. When the stumps are no longer worth tapping they will be sawn off at ground level and laid along the contours to help in preventing soil erosion. This method has not yet been tried but we hope to be able to experiment with it on a large scale soon. It is, of course, only applicable to areas where there is no root disease, that is to say where it is not necessary to do any digging and root extraction after felling the old trees. Most rubber estates originally planted on virgin jungle land contain a great deal of root disease, necessitating much digging over before replanting can be done with safety. On the other hand estates where the land was used for growing other crops such as pineapples, sugar, dry padi, and so on, before planting with rubber, are often almost free from root disease, and if this suggested method of pollarding the old trees and tapping the stumps, whilst replanting is going on, proves successful, it might be practised with much saving of time and money. However, although promising, it has yet to be proved. Too much faith must not be placed in it at this stage but any estate with suitable land should find it worth a trial.

Elimination of Root Disease

In the ordinary way, after tapping to death, the old trees are felled and the roots examined for disease. Where disease is

found the soil should be dug over to a depth of 18 inches and all diseased roots extracted and burned. The roots of healthy trees can be left to rot in the ground and on heavy land will help to improve water percolation and drainage. The lighter branches of the felled trees can be burned together with the diseased roots, but this should be done carefully to avoid extensive scorching of the soil and destruction of humus. The heavy branches and trunks should be placed along the contours to act as stopwashes unless, of course, they can be used or sold as firewood.

No accurate estimate of the cost of the digging to eliminate root disease can be made, since it varies so widely. On light sandy soil with little disease it is negligible. On heavy clay land with much disease it might reach $30/- per acre, or even more, but the work is much too important to be neglected. One of the few advantages which replanting has over planting from virgin jungle is that it provides an opportunity of starting with disease-free ground, and this opportunity should be fully exploited, as failure to do so can result in serious and unnecessary loss. There have already been cases of replanted areas where the old trees were merely sawn off at ground level and within two years some 45% of the young rubber trees, and most of the bush covers, were infected with root disease. The cost of checking the disease now will be greater than that of proper digging before replanting, and the areas are permanently damaged.

Planting

After the disease work has been done, terracing or lining, holing and planting are carried out in the usual way, and need not be described to you. Normally, about 200 holes per acre are to be recommended. As regards planting material, where replanting has been foreseen long enough beforehand, nurseries should be established early for the multiplication of budwood and to provide sufficient budded stumps and/or stumped buddings for planting up the whole area. This saves much time compared with budding in the field.

Where replanting is undertaken at short notice, and it is necessary to bud in the field, we recommend that one good basket plant and 4 germinated seeds should be planted per hole, to be sure of having enough good plants for budgrafting later. The number of plants per hole can be reduced to two within 6 months, to avoid wasting manure on the unwanted ones. When the plants are ready for budding the latest advice regarding choice of clones etc. can be obtained from the Botanical Division of the Institute or, if it is decided to plant clonal seed instead of budgrafting, all available information on this point will also be given.

Cover Plants

As soon as possible, after digging over for disease and making terraces, cover plants should be established. Where natural jungle plants were cultivated previously under the old rubber all except the best types should be removed. The debris may be buried, piled into heaps or contour bunds, or, where it is very dense, burnt in small heaps with as little destruction of humus as possible. Many undesirable types of natural cover, particularly grasses, bracken and rhododendron, which are partially checked by shade, spread rapidly once the shade is removed and if not eradicated at the start become expensive to control. This applies especially to a plant called *Eupatorium odoratum*, sometimes known as "Siam weed" or "German weed". This plant appears to have come from Siam and is working its way southwards. It does not seem to have reached Malacca yet, but in Kedah and Northern Perak it is becoming a serious pest in young rubber areas. Desirable jungle plants such as wild coffee, wild ginger, cassia, etc. should be retained as they will not only supplement the "artificial" leguminous covers specially planted but will form the nucleus of a natural cover in later years when the "artificial" cover plants have died out. As regards which "artificial" leguminous covers to plant, the choice depends largely on the lie of the land. The chief purpose of covers is to protect the soil from sterilisation by the sun and from erosion by rain. Both bush covers and creepers provide shade from the sun, but creepers are far more effective than bushes in preventing soil erosion. Unfortunately, as work in the last few years has shown, creepers have the disadvantage that they seriously retard the growth of the young rubber, whereas bush covers do not. Moreover, on heavy land, the deeper root systems of bush covers are of great value in opening up the soil and improving water percolation. Hence, on flat land, or on gently undulating land where erosion is not difficult to prevent, bush covers are best. On hilly land, where bushes would be unable to prevent erosion, creepers must be used. On medium slopes a combination of creepers on the terrace edges, to prevent their being broken, and bushes in between, is suitable. Whatever covers are used it is generally desirable, and in fact necessary, to manure them in the early stages in order to establish a strong growth quickly.

Menace of Soil Erosion

The importance of rapidly establishing cover plants to prevent soil erosion can scarcely be over-emphasized. In the past, not only in Malaya but in all new countries and in many old ones, the

seriousness of the erosion problem has not been realised and few steps have been taken to fight it. Recently world interest in the prevention of erosion has been aroused, and, although it is rather a digression from the main subject of this lecture, some of the results of research into this problem are of such vital importance that they are well worth bringing to your notice. Quite naturally, it was in countries where large quantities of food crops are grown that the menace of soil erosion first caused alarm. Whether we like to think it or not, we all live on the products of the top few inches of soil and to realise that this is slipping into the rivers and oceans at the rate of literally *hundreds of millions of tons per annum* is most disquieting. This menace is worldwide. It affects us in Malaya not merely as rubber growers but also as earthbound humans who cannot live without eating.

The Director of the United States Soil Erosion Service is the authority for the following figures, collected on a research station in Missouri. Equally convincing ones can also be obtained from other countries, more particularly some of the African Colonies. On loamy land with an 8 per cent slope, when completely free of vegetation, an average of *112 tons of soil per acre per annum* was lost by erosion. Under maize, *60 tons* were lost: under grass, only *one third of a ton* was lost; and under alfalfa, a very close-growing plant, only *one-fifth of a ton of soil per acre per annum* was washed away. These figures mean that on clean-weeded land the topsoil, which took centuries to accumulate would be completely stripped off in less than a *dozen years*, but under alfalfa it would last *five thousand* years.

Now we here are not much interested in keeping our estates going for the next five thousand years, but we do want to keep them for more than a dozen. The only way to do so is to guard carefully what little soil remains. During replanting it is easy to provide high-yielding planting material and plenty of manure, but these alone cannot ensure success. If they could we should be able to grow rubber on the seashore. As it is, we need soil, and as soil cannot be made to order we must do all we can to maintain and improve that which we have. In the earlier days of rubber planting under clean-weeded conditions, enormous quantities of soil were lost. The land will not stand it a second time. Replanting offers handsome profits, but they will only be realised if the lessons in soil management, taught us at such great expense, are applied intelligently.

It might seem that the figures just given exaggerate the dangers of soil erosion as regards rubber estates in Malaya. This is hardly so. Rainfall is not stated but we may be sure that the rainfall in the corn lands of Missouri is neither so great nor so

intense as in Malaya. Moreover, those results were obtained from land with only an 8 per cent slope, *i.e.*, 1 in 12½, which, as anyone who has traced an estate road knows, is quite a gentle slope. Much, if not the greater part, of the rubber in this country grows on steeper slopes than that, which makes the matter still worse. It is therefore of prime importance in replanting that, in addition to terracing and bunding on hilly land, cover crops to protect the soil should be planted immediately and given unremitting attention.

Manuring

Next comes the question of manuring the replanted rubber. On flat coastal clay land, where there has been very little loss by erosion and where the soil is naturally rich, manuring might not always be necessary. In all other cases, regular manuring can be regarded as absolutely essential. The quantities of manure and the frequency of application will depend on the quality of the soil, which is best judged by the progress of the young trees, but it is advisable to allow for carrying out the full course. The first application of manure should be made in the planting hole at the time of planting. A "complete" fertiliser should be used, *i.e.*, one containing all three of the principal plant foods, nitrogen, phosphate and potash, and should preferably be of an organic type. Normally, further manuring in increasing doses is required every six months during the first two or three years, except during the budgrafting period, and then annually until maturity. Manuring after that will probably be required but is too far ahead to be forecast now. It is possible that careful management of the soil during the years before the trees come to maturity will greatly reduce the need for subsequent manuring. During the immature period, which is our chief concern, manuring should be with complete fertilisers. After the first application of a complete organic fertiliser it is usually safe, and much cheaper, to change to soluble inorganic ones or to a mixture of both kinds. As the trees approach maturity, if the growth is good, sulphate of ammonia, which supplies nitrogen only, can be used instead of complete fertilisers and will reduce the cost considerably.

Cost of Replanting

The total expense of replanting will vary very much on different estates with different types of land, different labour conditions, and so on, also we are still lacking in experience, so no accurate details can be given. It is, however, safe to say that the cost of felling, digging, terracing, cover crops, planting and maintenance to maturity, will be between $100 and

$160 per acre, exclusive of overhead charges and manures. The cost of manures will vary according to the stand of trees and the quality of the soil, but from $40 to $70 per acre will have to be spent during the immature period. Overhead charges, that is quit rent, salaries, etc., do not come into the argument either for or against replanting, as they have to be paid whether the area is replanted or not. The total cost of replanting up to maturity is therefore between $140 and $230 per acre, according to local conditions. Average costs will be about $55 for manures and about $130 for all other field works, or a grand average of about $185 per acre until the area comes into bearing.

Replanting *versus* Manuring

It now remains to discuss the economics of replanting in terms of comparative figures instead of broad generalisations. Any area of old rubber can be dealt with in three ways. It can be:—

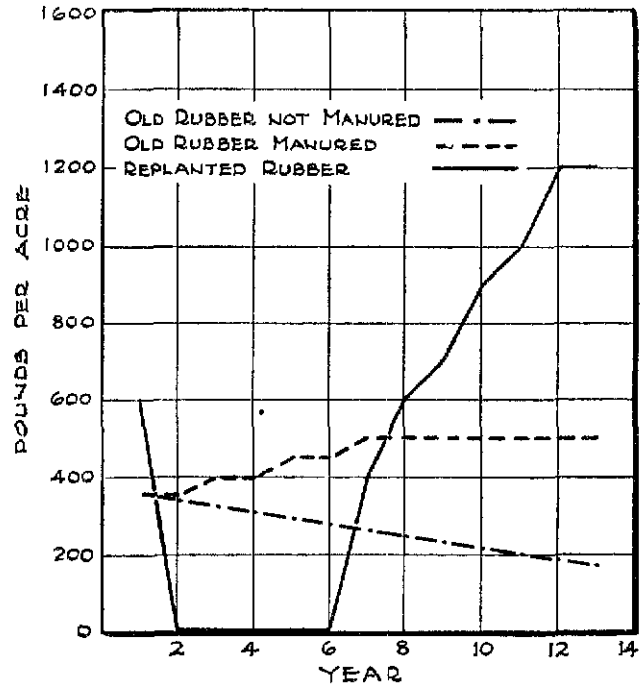
(a) Not manured
(b) Manured
(c) Cut out and replanted.

Let us assume that the old rubber is about 30 years old and is now yielding 350 lbs. per acre per annum. The trees are old but not decrepit, and would respond to manuring. If it is not manured its yield will decrease steadily, and this decrease can be reasonably estimated at 15 lbs. per acre per annum. If it is manured regularly its yield will increase slowly and may be estimated to reach a maximum of 500 lbs. per acre per annum after about 7 years. If the area is replanted with up-to-date high-yielding material, the tapping-to-death of the old trees will yield say 600 lbs. per acre, then for 5 or 6 years there will be nothing, until, in about the 7th year, tapping of the young rubber will commence with rapidly increasing yields. For the purpose of this lecture, in order not to run the risk of exaggerating the advantages of replanting, it will be assumed that the yield from the replanted rubber will reach a maximum of 1200 lbs. per acre per annum in about the 12th year. This estimate is probably too modest. Even so it is sufficient to prove the value of replanting, as is shown by the following table in which are given the yields which may be expected during the next dozen years from an old area (a) if not manured, (b) if manured, (c) if replanted; together with the cost of manuring in cases (b) and (c). The progress of the yields in the three cases is also shown graphically below.

TABLE

Year	Old Rubber Not Manured		Old Rubber Manured		Replanted	
	Yield lbs. per Acre	Cost of Manuring	Yield lbs. per Acre	Cost of Manuring	Yield lbs. per Acre.	Cost of Manuring
1	350	Nil	350	$15	600	
2	335	,,	350		(tapping	
3	320	,,	400	$15	to death)	
4	305	,,	400			
5	290	,,	450	$15		$60
6	275	,,	150			
7	260	,,	500	$15	400	
8	245	,,	500		600	
9	230	,,	500	$15	700	$15
10	215	,,	500		900	
11	200	,,	500	$15	1000	$15
12	185	,,	500		1200	
Total	3210 lbs.	Nil	5400 lbs.	$90	5400 lbs.	$90

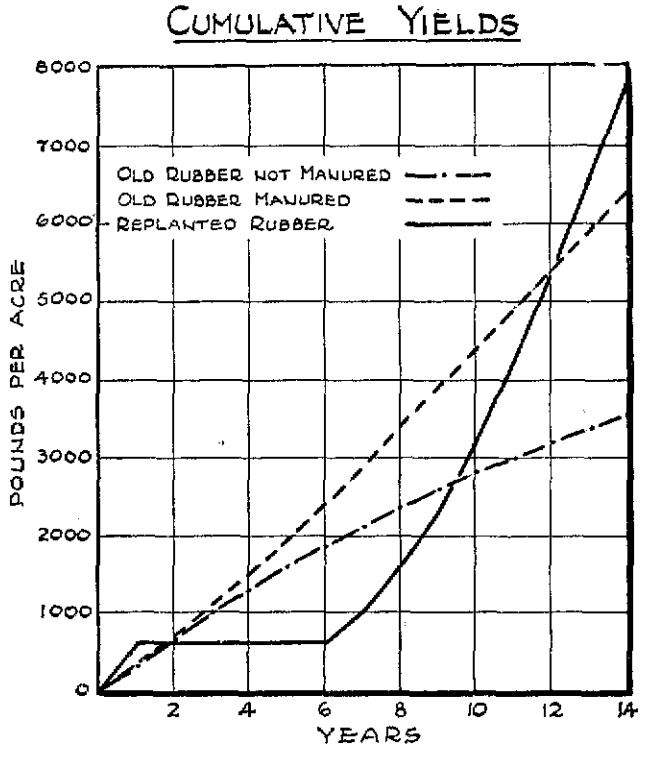
ANNUAL YIELDS



The two main facts which the above table and graphs illustrate are:—

(1) That during a dozen years a suitable area of old rubber manured at a total cost of $90 per acre can be expected to give 2190 lbs. of rubber per acre more than if it had not been manured. That extra rubber, after adding the extra tapping, manufacturing and packing charges on to the charge for manuring, will have cost well under 10 cents per pound to produce, so, at the present selling price of rubber (about 20 cents per lb.), manuring is evidently very profitable. *But,*

(2) That if the area is replanted, at the end of a dozen years it will have produced as much rubber as if the old trees had been kept and manured, *i.e.*, 5400 lbs. per acre, and the same amount of money will have been spent on manuring in each case, *i.e.*, $90 per acre. Unless it so happened that the price of rubber was high during the first half dozen years and low during the second, the balance would at least be even at this point, *but,* whereas the



old rubber would then be over 40 years old and getting near to the end of its life the replanted rubber would only just be reaching its best. It would be yielding at least 700 lbs. per acre per annum more than the old rubber would, even assuming the

old rubber could continue to give 500 lbs. per acre, which is extremely unlikely. In the 13th year alone this excess of yield would, at present prices, pay for the cost of replanting (about $130 per acre, above), the manures having already been paid for, and we should start the 14th year with an area on which all extra charges had been recovered and which would be yielding at least 1200 lbs. per acre per annum.

Conclusion

Figures like these speak for themselves. They are based on conservative estimates and yet they show clearly that replanting is profitable enough to deserve immediately the very serious consideration of all rubber growers. It is even more attractive now than formerly, since it has been announced (in August 1935) that under restriction the deduction from standard production in respect of areas cut out for replanting will be only 110 lbs. per acre. If restriction is allowed to finish at the end of 5 years, planting on virgin jungle land will be permitted in 1939. That would naturally be preferable to replanting old rubber land but it is by no means certain to happen. In any case it is to the advantage of all concerned—whether producers or consumers or governments levying taxes—for as much as is economically practicable of the old rubber now in existence to be replaced with new high yielding stock. All rubber growers therefore, from the largest European company to the smallest of Asiatic small-holders, possessing suitable land and able to raise the necessary money, would be well advised to take advantage of the present restriction period to replant as much as the regulations permit.

APPENDIX

Costs of Replanting

The following is an estimate of the costs of an average replanting programme, the details of which will vary considerably on different estates and on different types of land.

Item	Cost per acre	
Felling	$45	(variable)
Digging	10	(very variable)
Terracing and Holing	15	
Cover Plants, including manure ...	10	(variable)
Nurseries and Planting	7	
Budgrafting	12	
General upkeep to maturity ...	20	(variable)
Manuring	55	(see below)
Sundries, say	11	
Total ...	$185	

Details of the manuring of the replanted rubber up to maturity are shewn below. These figures are based on an initial stand of 200 trees per acre, gradually thinned out to about 130 before maturity. The amounts of manure and frequency of application will vary according to the type of land and progress of the plants, and under good conditions some of the later applications may be lessened or even omitted.

Time	Manure per hole	Cost per acre (without labour)
At planting	½ lb. Sterameal ...	$ 7.00
6 months later	3 ozs. Enpekay No. 1	2.00
(No manuring during budgrafting period)		
9 months after budding	¼ lb. Enpekay No. 1 ...	2.50
15 „ „ „	½ „ „ „ ...	5.00
2 years „ „	¾ „ „ „ ...	7.50
3 „ „ „	1¼ „ „ „ say	10.00
4 „ „ „	2 „ „ „ „	13.00
5 „ „ „	2 „ sulph. ammonia „	8.00
	Total ...	$55.00