

*THE ROLE OF GREEN MANURING IN THE MAINTENANCE OF THE FERTILITY OF TEA SOILS.

By

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In a recent talk given to a number of District Planters' Associations, which is being published in the *Tea Quarterly* (1) Mr. Lamb dealt with the general problem of the maintenance of fertility in tea soils. In my talk today I propose to try and go on from where he left off and deal more specifically with the contribution made by green manuring to the maintenance of our soil fertility.

Most of you are undoubtedly familiar with the very high degree of fertility that is, in general, originally exhibited by jungle new clearings. Furthermore, there would appear to be some considerable degree of correlation between the length of time that the cleared area has been under its original stand of jungle and the level of fertility found on opening up. This is not entirely a chance effect but is in fact a real indication that tropical rain forest conditions, which are the conditions under which our wet zone jungles all develop, do lead to a continuous building up of soil fertility. Once, however, such cleared land is utilised for growing crops, a marked change usually sets in and, instead of finding our soil fertility increasing, we find that there is a tendency for it to decline. It is accordingly much of the purpose of what is normally called good agricultural practice to arrest this potential decline and to enhance or maintain our initial fertility level. Before therefore attempting to lay down a code of good agricultural practice for our own particular crop, which in this case is tea, let us try and see in what way jungle conditions differ from those under which tea is grown as an economic crop.

A tropical rain forest, as the jungle is more correctly called, is essentially an ecological unit. This means that although there are a vast number of different species growing together in the jungle, they form a more or less closely knitted community in which each plant species has its particular place and function. In essence our tropical rain forests consist of a number of layers. The first or lower layer consists of shade loving ground plants, bushes and small trees; none of which attain any great size. Above this lower layer are the jungle trees proper which form the actual forest canopy. Both these layers are of course intimately knitted together by climbing plants and creepers in enormous variety. Finally, standing out above the general level we have the isolated big trees, mainly dipterocarps, of which *Shorea*, one of our timber trees, is a typical example.

This is admittedly a very incomplete description of a tropical rain forest, but the fact to which I want to draw your attention is that we do have a complete canopy of vegetation covering the ground; in actual fact a very dense canopy made up of several layers. This has two effects. Firstly, almost no sunlight penetrates through the canopy and reaches the soil beneath, and secondly, heavy rain is intercepted by the canopy and can not beat down directly on the soil below. However, I think the most important difference between tea estates and jungle conditions is that the whole of the leaf fall from this dense mass of jungle vegetation remains on the area. It is this large amount of leaf fall which helps to make our jungle soils.

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Summing up, therefore, soil fertility is built up under jungle conditions because :—

- (i.) The vast amount of vegetable material produced in the area remains there and goes to form the rich layer of soil on the jungle floor, and,
- (ii.) This is protected by the forest canopy from the deleterious effects of exposure to sunlight and to the weathering action of heavy rainfall.

Finally, not only is the whole of the organic matter produced kept on the site, in contrast to the vast amount removed as crop from tea estates, but no mineral nutrients are removed either. Mineral nutrients are of course removed in large quantities in the crop from tea estates but, as these can be easily replaced by fertiliser applications, I do not propose to deal with them further today.

Accordingly, in order to maintain a high level of soil fertility the aim would appear to be to approach as closely as possible to jungle conditions in our agricultural practices. These conditions must, however, be such that high yields of the particular economic product we are growing can also be obtained. Fortunately, tea itself was originally a jungle plant and its actual home appears to be in the jungles of North India and Burma where it apparently grows beneath a canopy of *Albizia* type forest. There is thus nothing inconsistent with the possibility of obtaining high yields if we attempt to make our agricultural conditions approach to those of tropical rain forests. This then should be the object of a properly organised green manure policy on an estate. Here, of course, I include under the term green manure all vegetation normally grown on a tea estate, that is to say high and medium shade, bush green manures and ground covers.

Now all these green manures have to be grown interspersed with the tea and it is therefore important that we select satisfactory species which do not become liable to compete unduly with the tea and which will grow well under our particular climatic conditions. Fortunately, many plants of the *Leguminosae* possess root nodules which contain bacteria capable of fixing atmospheric nitrogen. These plants are therefore self-supporting to a great extent as far as nitrogen requirements are concerned and this valuable property naturally makes them a first choice as green manure plants. Even leguminous green manures, however, require quantities of the other two main plant foods, phosphoric acid and potash, and it is accordingly desirable in selecting suitable species to attempt to reduce competition for these two nutrients to a minimum. This object can be achieved, for example in the case of high and medium shade trees, by planting species which develop deep penetrating roots which reach levels of the soil far below that in which the main bulk of the tea bush roots are feeding. The establishment of such deep rooting species has also the additional advantage that, once their roots get well down, they will be exploring new layers of soil from which fresh supplies of plant food are brought up and returned to the top layers of the soil, where they become available to the tea, in the shape of leaf fall or loppings.

Once a satisfactory stand of shade trees and green manures has been established there is, I think, little cause to worry about their requirements of plant food, since all nutrients taken up will be eventually returned to the soil again as leaf fall or loppings. Once this type of closed cycle has been successfully established for our green manures all we need concern ourselves about is in returning to the soil the plant food removed in our crop. However, it must be borne in mind that, when establishing a new stand of shade or green manures, some plant food is likely to be required and provision should be made in your estimates for the necessary fertilisers, otherwise the tea is liable to suffer temporarily.

Finally, before passing on to more particular recommendations about different types of shade, I would like to say just a few words regarding the enormous importance of organic matter in the soil. Under tropical conditions, organic matter is destroyed very rapidly and, unless a basic level is maintained, it is quite impossible for a healthy population of soil micro-organisms to exist or for a reasonable soil structure to be maintained. Organic matter, originally supplied in the shape of leaf fall or loppings, is turned into humus by all the multitudes of micro-organisms

which live upon it and it is this humus which plays an essential part in binding the soil particles together and so producing crumb structure. Without some reasonable degree of soil structure, there is no aeration nor does the soil drain properly, with the consequence that plant growth can not proceed satisfactorily and only poor crops will be obtained even with heavy applications of inorganic fertilisers. Organic matter is most quickly destroyed under conditions of exposure and insolation and it is accordingly most important that we should not allow soils to remain bare for any considerable length of time. This is a very valuable point to keep in mind when new clearings or replanting work is undertaken; that a great deal of our soil fertility can be destroyed by a few months' exposure of bare soil to the action of hot tropical sun and rain. So, therefore, if you are clearing old rubber land for the purpose of planting up in tea, make every effort to maintain existing soil covers as long as possible. For the same reason, the establishment of a new canopy of high and medium shade and bush green manures and ground covers should be carried out at the first opportunity on any new clearing.

Before I offer any comments on the types of shade and green manure plants normally grown on estates, I think I better try and give you a brief outline of what appear to me to be the desirable qualities to be looked for in these plants. These would seem to be :—

- (i.) The ability to supply a large amount of organic matter either in the form of loppings or leaf fall. This requirement is perhaps not so essential in the case of ground covers.
- (ii.) The ability to provide a suitable degree of protection, both to the soil and to the tea plants growing on it, from the effects of driving rain, sunlight and wind.
- (iii.) The ability to grow easily under the particular climatic or elevation conditions encountered. In what follows, therefore, I shall attempt to confine my remarks to species which should be suitable for growing under low-country conditions.
- (iv.) The plants must not compete unduly with the tea bushes for either plant food or light and air.
- (v.) They must not be unduly susceptible to pests and diseases.

High and Medium Shade Trees

I think the best species are probably the dadap, the *Gliricidia*, the various species of *Albizzia* and the *Grevillea*. With the exception of the *Grevillea*, which belongs to the *Proteaceae*, all these trees belong to the *Leguminosae* and are nitrogenous. In spite of it being non-nitrogenous, however, the *Grevillea* is probably one of the most widely used types of high shade in Ceylon and it does not seem to compete unduly with the tea because it would appear to be usually fairly deep rooted. This is a most valuable feature which enables it to bring up considerable supplies of plant food from the deeper layers of the sub-soil. This penetrating action of any deep rooting shade is also very valuable in breaking up the sub-soil and so enabling the shy-rooting tea bush to put its roots further down. The chief drawback of the *Grevillea* in the low-country would appear to be its susceptibility to the *Phyllosticta* leaf disease. This disease can be controlled to some extent by pollarding the *Grevilleas* at frequent intervals. *Albizzias* grow very fast in the low-country and this tends to be rather a drawback because they soon get too big and have to be removed. Otherwise, they provide excellent quantities of lopping material. In certain areas wood boring and bark eating caterpillars of the genus *Arbela* may cause a certain amount of trouble. The dadap is, of course, an excellent medium shade tree at almost all elevations but its susceptibility to the root knot eelworm may cause trouble in growing this species in areas where eelworms are prevalent. Various species of *Derris* often appear to grow well under low-country conditions but I think this genus is somewhat undesirable owing to the readiness with which it produces root suckers. Another species worth trying appears to be *Dalbergia Assamica*. This name is actually incorrect but is the one by which the species appears to be known in Ceylon.

Bush Green Manures

In this category, the best species are probably the familiar boga (*Tephrosia candida*) and the various *Crotalaria*s. Several species of *Crotalaria*s are likely to do quite well under low country conditions, but *Crotalaria usaramoensis*, is probably one of the best. Incidentally, you may be interested to know that I found a species of *Crotalaria*—*Crotalaria retusa*—growing freely on the top of Sigiriya rock. It is a comparatively low growing species and might be well worth a trial as a type of bush ground cover in new clearings. *Desmodium gyroides* is another plant which also appears to do quite well in the low-country. All these are nitrogenous plants belonging to the family *Leguminosae*.

Ground Covers

The choice of a suitable ground cover is probably one of the most difficult things confronting us in regard to green manuring. A very large number of species have been tried out but in nearly all cases they show various disadvantages, thus they may climb into the tea bushes or form too dense a mat for a fork to be put through in manuring operations. Today, I only propose to refer to two types. The first is *Desmodium ovalifolium*. Experiments, using this species for a ground cover, have now been in progress on Enselwatte Group, Deniyaya, for the past six or seven years. Two similar fields were taken and one was planted up with *Desmodium ovalifolium* while the other field was left uncovered. Uptodate, yields have been consistently increasing in the field with *Desmodium* cover as compared with the uncovered field, and are now something like 100 lbs./acre per annum ahead. I am very glad to say that the Superintendent of Enselwatte, Mr. Fernando, has written an article on his experiments which will be published in a forthcoming *Tea Quarterly* (2). Provided that he is given due notice, Mr. Fernando will, I am sure, be only too pleased to show anybody interested round this experiment.

The second genus to which I am going to refer is *Stylosanthes*, of which two species (*S. gracilis* and *S. mucronata*) were obtained from Peradeniya a short while ago. The plants are rather like a type of lucerne and spread very readily over the ground but do not root at the nodes. Accordingly, they produce a mat which can easily be rolled back for manuring or other cultivation purposes. They are now being grown experimentally on a number of estates and such reports as we have received to date are most encouraging. They are, I think, probably well worth a trial. All the species I have referred to are again, of course, members of the *Leguminosae*.

Whilst on the subject of ground covers, I think it is worth while for me to point out that with the short pruning cycle customary in the low-country, there is very much more ground exposure during and after pruning than is the case in the up-country tea districts. For this reason, therefore, it seems to me most important that attention should be given to the subject of ground covers in the low-country.

Poor Areas

Before finally concluding, I would like to make just a few remarks about poor areas. In many cases it is becoming increasingly apparent that the inability of poor areas of tea to respond to improvements in fertiliser application and better cultivation methods may be ascribed to the complete lack, or perhaps I had better say, shortage of organic matter in the soil. Rehabilitation of these poor areas is accordingly only possible if the organic matter level is restored to something like a normal figure. Green manures themselves will only grow very badly in these poor areas and so it is quite impossible to expect the stand of green manure in a poor area to be sufficient to produce the required amount of organic matter since, to achieve any lasting results, application rates must be of the order of 20 tons to the acre. Here then is a case in which organic matter must be brought into the field from outside. Where estates have spare land available, the production of the necessary green material is comparatively simple. Grasses such as Guatemala or Napier, if properly manured, are likely to produce the heaviest crop of green material possible per acre and are capable of giving several cuts in the year. After lopping

the grass will probably be best utilised as a thatch rather than being dug in green or turned into compost. Sunflower is another valuable green manure plant which can be grown in ravines and waste places and provides a large amount of soft green loppings. These should however be forked in green rather than used as a thatch, otherwise considerable wastage will result. Compost and cattle dung, etc., are, of course, equally good sources of organic material for rehabilitation purposes. However, on most estates they are unlikely to be available in anything like the quantities necessary for this work and it is therefore obviously desirable to concentrate on the cultivation of grasses and other high yielding sources of green material. Grasses must not, of course, on any account be grown in the tea.

Finally, I must confess that we still have a very great deal to learn about the principles of green manuring and what are the best types of green manures to grow in the low-country. As you probably have now heard, we have just taken over Pembroke bungalow, approximately four miles from Kalutara, as a headquarters for Mr. Walter, our Low-country Scientific Officer. In due course, when he gets settled in, I am hoping it will be possible for him to try out a number of different green manures at Pembroke. In the meantime, we shall be grateful for any information that can be given to us regarding different green manures which have been tried out successfully on low-country estates.

References

- (1.) Lamb, J.—The Maintenance of Fertility in Tea Soils. *Tea Quarterly*, XXII, Pt. II, pp. 45, 1951.
 - (2.) Fernando, T. M.—*Desmodium ovalifolium* as a Cover Crop for Tea. *ibid*, pp. 49.
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