IDEAS ON THE EXPERIMENTAL REPLANTING OF TEA

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Replanting of old tea is a subject which will command ever increasing attention, and this article is an attempt to summarise the Institute's findings to date, and to give a guide for future replantings. An address given to the Nuwara Eliya District Planters' Association was used, at their request, as the basis of the article, and we have taken the opportunity of including points raised at the Experimental Committee meetings and in private discussions with superintendents. The emphasis here is naturally on soil conditions, and for these ideas the author takes responsibility, while acting as spokesman on other matters.

Replanting on St. Coombs.—First, what replantings have been done by the Institute and with what results?

In 1952, two acres in No. 10 field were replanted with ten different clones, and in 1952 a start was made on nineteen acres in No. 1 field using more or less the same clones, and by the end of 1955, eight acres had actually been planted. The No. 10 area has been a definite success, and the No. 1 area has been, just as definitely, a failure.

It is not pleasant to have to record a failure, but it should be remembered that in our search for sound agricultural practices we are bound to come across those which are not so acceptable. It is, indeed, preferable that a Research Institute should be the first to meet them, on a small scale, thereby preventing their perpetration on a much larger scale. In 1952, and even in 1956, replanting of old tea was a highly empirical agricultural operation with the inevitable risks, and we should be glad to have the opportunity of trying to explain the failures and of planning future experimental replantings on a surer basis. We will compare the conditions in the two fields, as far as is relevant, before drawing conclusions for suggestions for general methods of replanting.

Soil conditions in the St. Coombs replanted areas.—No. 10 field was opened from rich patana in 1931, while No. 1 field was opened from jungle in the 1880's. No. 10 lies on a moderate north-east slope in a sheltered valley with an annual rainfall of 80-90 inches, while No. 1 is on a steep to very steep south-west slope at the highest and most exposed point for several miles, and where the rainfall is known to be less than it is in the No. 10 area.

Even a cursory examination of the two soils shows that they are not similar, and chemical analyses done in 1955 bear this out.

Table 1. *Analyses of soils in Nos. 1 and 10 fields, St. Coombs.*

	No. 10		No. 1	
	Top soil	Sub-soil	Top soil	Sub-soil
% Organic-matter	9.2	6.4	4.8	2.8
% Nitrogen	0.35	0.23	0.23	0.17
Depth	0-6"	6-12"	0-6"	6-12"

Further detailed analyses on a wide range of soils, done in 1955 and 1956, all point to the fact that the breakdown of organic matter is acccelerated to a remarkable degree either by aerating the soil or by alternately wetting and drying it. This chemical knowledge will be emphasised subsequently, and it is unfortunate that it was not available before the two clearings were started.

It has been established for several years, in many other countries, that if fresh green organic material is turned into the soil, the soil microbes are stimulated to such an extent that they decompose the new addition very rapidly and they may even continue, under their own momentum, to break down some of the original soil humus which had previously resisted their attack. The net result has sometimes been that digging in fresh organic material has led to an overall decrease in soil humus, and with our knowledge of microbial liveliness in Ceylon tea soils we may assume that a similar state may hold good here.

To return to the two fields which were planted in Guatemala grass after the tea had been removed. In the first place the uprooting process aerated the soil, and secondly, an even greater disturbance was imposed by the digging of an one-foot wide trench on the line of the future tea row. The loppings from the Guatemala grass were put into the trench and covered by a little soil pulled in from the original spoil from the trenches. While the grass was growing the soil was very largely exposed to alternate wetting and drying; as soon as the grass had formed a reasonable soil cover it was cut, soil was disturbed, and fresh areas of soil were subjected to the next cycle of exposure. Manure for the grass was forked along the grass rows and the trenches were left with a mixture of loose soil and fresh grass loppings. At the final cutting, when the grass was removed entirely, the trenches were filled in and left for six months. Presumably if the level sank in that time more soil would be cut from above.

It is easy to be wise after the event, but it is difficult to see how these energetic operations could have done anything but decrease the soil humus, lower the water retaining capacity and increase the danger of erosion, which may be considerable if soil is repeatedly dried and disturbed on steep slopes. An added disadvantage would arise if the trenches were topped up with some of the original subsoil. Yet another danger, and a very real one if the labour were unreliable, would be that the final consolidation of the trenches may be insufficient, leaving the young plants in loose soil, very prone to drying out, and continually sinking. If the sinking were to go far enough there would be a danger of water standing round the stems of the young plants, on what would then be consolidated soil.

Applying these remarks to the two areas on St. Coombs we can begin to explain why one succeeded and the other failed. The successful No. 10 clearing was planted on rich firm soil which was able to stand the drain on its reserves of humus, and which may well have benefited from the enforced aeration. The subsoil here was quite rich in itself and extended to a good depth. There was not the same rate of loss of water as would be expected from a steep, exposed site.

The No. 1 area was planted on soil which had suffered from a far longer period of cultivation, and which, judging by analyses of nearby jungle, had never had such quantities or depth of humus as the No. 10 patana soil. The No. 1 soil was already low in organic matter and very liable to go powdery when dry, so that any further steps in this direction would be detrimental. Add to this the previous comments on loss of water, both by drainage and by wind action, and it will be seen that differences in behaviour might be expected, even with identical planting methods.

Transplanting.—So far the method of planting and the plants themselves have not been mentioned, but both these factors helped to accentuate the differences between the two fields, and both are intimately tied up with soil conditions.

The earlier field under the better soil conditions, was planted up with plants removed straight from the propagation beds, in Hersall transplanters, and there was both selection of good plants from the nursery and close supervision of the planting in the field, by the Institute's field assistants. The larger No. 1 field made use of balled plants, and the greater demand on plants meant that no selection was possible. Also, as this was entirely a St. Coombs estate operation, the immediate supervision was not of such a high standard.

Transplanting of woody plants has long been regarded as a tricky operation, by that class of horticulturalist which has been designated by the expression "green fingers", and there is every reason to believe that tea plants need just as much care as any others. It is also recognised that any set back incurred in the early stages of a perennial plant's life will almost certainly stunt growth for many years after. This is not the place to go into details, but the Plant Physiology Department has for many years advocated the use of well fed, selected basket plants for the planting of clonal areas, on the grounds that replanting is such an expensive operation, that it is a pity to "spoil the ship for a ha'porth of tar".

A basket plant carries its food reserves into the field with it, and the young, weak, roots are able to grow out into the surrounding field soil as they find conditions favourable. A balled plant carries less reserves and the young roots are often damaged seriously, and there is little protection afforded if the field conditions are bad. A basket offers a guide to planting depth, and from our own observations, ranging from roots sticking up out of the soil like an inverted umbrella to plants buried up to the second branch, it is not always wise to trust the average labourer to handle balled plants properly.

A young plant trying to establish itself after moving into the field has to draw on its internal food reserves to promote the development of the root system, which will eventually support the whole of the plant's food manufacturing processes. The easier it is for the roots to grow rapidly, the quicker the plant will respond. Young roots are favoured by well aerated, moist soil, that is open enough to permit easy physical penetration and close enough to ensure that the roots can keep in contact with water reserves throughout their wanderings. With the right combination of air and water supply roots can grow most vigorously and also extract mineral nutrients from the soil and manure most efficiently.

Many replantings will, naturally, be done on the areas with bad soil conditions, and it is with these in mind that we suggest a method for improving old cultivated soil and which we think will avoid some of the drawbacks of the previous trenching method.

Soil rehabilitation.—There are various reasons why the Institute has recommended an interval under another crop before replanting with tea, and one of these aspects, concerning root diseases, has already been dealt with by the Pathologist in the 1955 Conference report. Another aspect is biochemical in nature, as far as we know, and although it is not proven in tea-growing it is well known with many other woody perennials. When such a plant is pulled out of the soil there is usually a toxic effect noticeable on young plants of the same species if they are planted immediately afterwards.

Our opinion is that grasses are the most useful crop for rehabilitation, from all aspects, and for ease of planting and of the final removal we recommend those with tussocky growth, such as Guatemala, manna, and napier. Adaptability to conditions in a particular locality will govern which of these species is used, its planting distance, frequency of cutting, etc.

Grass roots in general have a marked effect on the soil, in that the latter falls into quite stable crumbs which resist disintegration under rainfall or mechanical action, such as walking or cultivation. The longer the period in which the soil is under grass the more numerous and stable are these crumbs, and it is their properties which are likely to be of such value in bringing old soil into a fit condition for young tea. The body of a soil rich in stable crumbs will be well drained and aerated and will offer little resistance to young roots, and at the same time the individual crumbs are able to hold reserves of water. Such a soil can be trampled without becoming packed too closely, and firm contact between the soil crumbs merely forms a continuous net-work of moist soil surrounding the air channels. This action of the grass roots takes place during the life of the grass, and as soon as the grass plant is killed the roots begin to decay. An individual plant of one of the large grass species can produce several miles of roots, which penetrate the soil extensively and to considerable depth. As these roots decay they leave well marked drainage channels behind them.

Apart from these physical effects of grass roots there are important chemical actions, which again apply to grasses in general. Their roots have a good foraging ability for potash and phosphate, and they can often make use of resistant forms of these nutrients which other plant species are unable to break down. When the grass dies, these hard won food reserves are released slowly to the soil in more available forms, both from the roots and the leaves, and other plants are then able to make use of them.

Finally, the effect of the above-ground part of the grass. If the setts are planted closely there will be a very good protection of the soil from sun and rain, and as soon as the first loppings are spread on the surface this protection will be as good as can be desired. If each lopping is spread on the soil, with no digging in, any undesired microbial activity resulting from cultivation and exposure will be avoided. The lower layers of the thatch will, under protection from the newer, upper layers, decompose very slowly and will gradually permeate the soil as stable humus. We must again emphasise that we consider thatching to be the best method of increasing the humus content of a soil, and that forking organic residues in is likely to result only in excessive microbial activity for a short period. This activity in itself may be desirable at certain times, but not, we suggest, during this period of rehabilitation.

Manuring.—If we are going to rely on Guatemala grass to do so much work in reconditioning and protecting the soil, we should help it by manuring generously. Not only will this increase the production of organic matter, but it will also ensure that the Guatemala does not leave the soil starved of nutrients, and as the grass is a gross feeder this could easily happen.

In all probability broadcasting the manure on top of the thatch would be sufficient, but light forking may be done if it is thought necessary. Such a forking would not bring about the excessive stimulation of the microbes which we are trying to avoid. Some of the manure will become incorporated with the thatch, and this will prove of value later on, but sufficient manure will certainly wash down into the soil to reach the Guatemala roots. Our recommendations on manuring Guatemala grass will be found in the *Tea Quarterly*, March/June, 1956.

A most important point is that when the Guatemala grass is finally cut out, ready for the planting of the tea, the area should again have a broadcast manuring. The reason for this will be explained in the next section, but here we would suggest that this application could be from 3 to 4 cwts. per acre of the Guatemala mixture, and we must also emphasise that generous manuring over the whole of the rehabilitation period will more than pay for itself in terms of rapid establishment of the tea.

Soil activation.—So far we have been suggesting ways of repairing the damage done to the soil by past cultivation, of building up the reserves or organic matter

and mineral nutrients, and, above all of keeping the soil microbes healthy but not too active. All these aims, we believe, can be achieved by planting one of the large grasses closely, by manuring it well, and by cutting the tops and leaving them on the surface with no further soil disturbance.

When the time comes to plant the young tea we have to reverse these processes whether we like it or not. The cutting out of the grass stumps and the holing for the tea automatically stimulate the microbes. After two years' accumulation of organic residues there should be plenty to spare for both microbes and tea, and the recent incorporation of the manure into the soil and the thatch will guard against competition for the mineral nutrients. Microbes are most efficient and voracious feeders, and they can multiply so rapidly that they could readily starve a young, weak, tea plant unless there were ample food reserves in the soil.

The dying grass roots will also be attacked by microbes, again drawing on reserves of mineral nutrients to assist their action, and the reason for the final manurial application, mentioned in the preceding section, is obvious.

When holes are cut there will be a fall-in of the lower, well decomposed, layers of thatch. This should be encouraged, as it will not hold the soil too open, and will carry a good reserve of absorbed inorganic manure with it. These rich organic residues, releasing nutrients slowly but steadily to the tea roots, are the best possible form of manure for young plants which grow rapidly and which have not yet been able to establish a good foraging root system. They also retain a high proportion of moisture.

The preceding discussion has, we hope, given the reasoning behind the Institute's suggestions for replanting, which are best summarised in the table on the opposite page.

Conclusions.—In the table it is suggested that the grass stumps may be useful as wind breaks. This is not so unlikely as it may appear, since it is well known that even small objects on the soil surface can deflect wind considerably. As the tea will be most susceptible to wind when it is first planted out, when it will not be tall, we suggest that the large number of stumps available might give valuable protection.

The table does not pretend to be a guide to all the operations involved in replanting, and one important factor has been left out, that of the shade tree programme. Shade and wind break plantings can only be settled by the demands of the particular environment and by the personal preference of the superintendent. An obvious danger to avoid is undue competition for water and nutrients between the shade and the tea, and for this reason we unhesitatingly condemn the idea of leaving any of the grass growing after the tea is planted. The author has a personal liking for *Sesbania aegyptiaca*, which is both easy to establish and easy to remove without damage to the tea, is rapid in growth, and which has an open head capable of giving a diffuse shade and a reasonable check to wind. The sparse foliage seems to be an advantage, in that the drain on soil moisture is almost certainly low.

We hope that these suggestions will afford a reasonable basis on which we can plan a practicable method of replanting old tea, and we have gone into the historical and theoretical reasons for our change of policy at some length because we want to show that we are not making this change lightheartedly. We feel that we have sufficient evidence, from field plantings and from laboratory analyses, to warrant the modification.

Table 2. *Proposed system of soil rehabilitation and replanting of tea*

Period	Operation	Intention
Soil rehabilitation	1. Following uprooting and contour lining plant thickly with grass, preferably 2 rows between the future tea rows.	1. Maximum soil cover; minimum soil disturbance.
	2. Manure regularly with little or no forking.	2. Maximum production of organic matter above and below ground; building up mineral nutrient reserves.
	3. Cut regularly and spread loppings all over surface.	3. Protection of soil from sun, rain, wind and packing by labourers' feet.
	4. Continue for preferably 2 years.	4. Disease control; build up of stable soil crumb structure.
Soil activation	1. Cut grass right out.	1.
	2. Leave grass stumps whole on the surface.	2. Wind break for young tea (see conclusions).
	3. Broadcast manure.	3. To assist the increased microbial activity from 1 and 4.
	4. Hole, incorporating old thatch in the holes.	4. To provide steady supply of nutrients to the young tea.
Planting	Use selected, well fed, basket plants; plant firmly and shade if necessary.	

Our new proposal is really very simple, and it can be described as an attempt to get back to jungle conditions, but for convenience and greater efficiency we have aimed at a grass jungle. The original tea plantings made use of fertility which had accumulated over the centuries, and which had often vanished alarmingly once cultivation had imposed new and exacting conditions on the soil. We can not hope to regain more than a small part of the virgin fertility in a rehabilitation period which, from economic necessity, can only last for one or two years, but as the object of replanting is to grow better tea, and as the future of the planting will depend so much on the initial success of the clearing. the Institute can not stress too strongly the need to implement all the proposals, set out above, in the most generous fashion.