SALIENT POINTS IN TEA CULTIVATION IN RELATIONSHIP TO GREEN MANURES AND SHADE TREES*

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Dr. EDEN said: Mr. Chairman and gentlemen, I am glad to have this opportunity today to address the Ceylon Association, because it will give an opportunity for an exchange of views. I am particularly conscious that circumstances turn the ordinary channels of intercourse into a one-way road, and that quarter by quarter, and year by year, through our publications, I get a platform to speak from, without much danger of being catechised. Some may think I have the advantage there, but I am not disposed to agree. Our function in Ceylon is to combine science with practice and I have always found that personal contact with the agriculturist or with those who like yourselves are mainly concerned with broader matters of policy, helped me, through the free exchange of viewpoints that it provoked.

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Your Association has given me a vast and complicated subject to speak on, and because I wish to leave ample time for discussion, I shall confine myself very stringently to the "salient" points. I think the proper starting point for my discourse today is to insist on the immense capital value of the soil that bears the crop, and the necessity for maintaining that value. In normal times, something more than ten million rupees worth of artificial manure is used per annum in Ceylon agriculture and you will be able to judge how much of that is spent on tea. But that manuring provides but a small quantity of the crop that is harvested. St. Coombs is, I think, a fairly average estate. During the last five years its manuring, which is very similar to that of many commercial properties, has cost about Rs. 20 to Rs. 25 per acre per annum. Out of the 700 lb. per annum of dry tea harvested, this manuring has accounted, according to incontestable figures, for no more than slightly over 100 lb. The rest is accountable to natural soil resources. Looked at from the purely one-sided view of nutrition, it means that the soil makes a yearly subvention to the manure bill of something between Rs. 120 and Rs. 150 per acre.

I have frequently explained in lectures published in *The Tea Quarterly*, that the preservation of fertility, from whatever aspect one chooses to view it, depends on the constant renewal of the supplies of organic matter in the soil. The hot humid conditions of the tropics speed up the burning up of these natural supplies at a rate vastly in excess of that experienced under temperate conditions. I have also previously explained that the conservation of nitrogen, the most costly nutrient of all, is linked up with the possibility of combining it with carbon in the form of organic matter. That, in fact, in any other combination it is liable to be quite rapidly lost in wet climates.

Now without recapitulating the arguments in detail, it will be sufficient to say that the growth of a plant itself is nature's way of achieving that combination. Permanent grazing land and permanent forest are examples of stable conditions of soil and nutrient conservation. Green manuring in its various forms is an adaptation to suit the needs of intensive crop production, of the continuous building up and breaking down of compounds of carbon and nitrogen in the plant and the soil respectively.

Green manuring of temperate annual crops differs markedly in practice, though not in principle, from green manuring of perennial crops under tropical and sub-tropical conditions. The former is usually a system of catch crops or leys grown to benefit succeeding main crops. Under our conditions we have to grow our green manure

and our main crop at the same time. We have a continuously growing main crop, and within limits a continuously growing source of green manure. We are consequently spared the rather difficult adjustment of green manure and main crop which has sometimes led in temperate agriculture to disappointment and failure. On the other hand, we have our own problems which may be summed up in the words "establishment," "competition" and "control".

Tea, a natural forest species, benefits by shade, provided that the plants that give it do not compete with undue severity either below or above ground. I am continuously asked for advice about the regulation of shade, so I propose to make this problem the starting point of the more detailed part of my address. I favour a medium high shade that is lightly patterned, rather than low lopped, more closely planted species. True, the harder a dadap or a gliricidia is lopped, up to a point, the more vigorous and bushy its head of possible green manure. But in using shade trees I believe that the shade question should come first. The bulk of green stuff for returning to the soil can be had otherwise, notably from bush species.

The grevillea in my opinion is an excellent foundation for the purpose. The shade is light and feathery and its mulch is a good protective against soil erosion. Judicious lopping of the side branches will give almost any density of shade required, and in young tea it can be planted thick enough to give adequate shade and wind protection. According to the programme I am about to outline, the planting of dadap and gliricidia and such species can wait till later, and when these latter have grown to something like maturity, it is probable that thinning out will be necessary. At this stage this can be confined to the green manure trees other than grevillea. In place of those removed, new and carefully protected plants of the same or of an alternative species can be planted. When next thinning is required (having in the meantime kept a careful watch on the side branches of the grevillea), the latter will be ripe for felling. Alternate lines or alternate trees in the line will go for firewood, again with protected replanting.

If I have made my meaning clear, you will see that by these means one achieves a rotation of shade and green manure, part of which, the grevillea, is on a 30-year cycle or some such period in alternate 15-year periods, and part on a shorter, say 12-year cycle in alternate 6-year periods. Dovetailing these cycles the one with the other enables one to produce and maintain a shade of any desired density, without going to the extremes of laying bare a whole large acreage because a whole stand of shade has been allowed to pass the optimum point. In the beginning, such a programme involves

taking out trees, particularly grevilleas, that are perhaps not as mature as timber requirements would warrant. But this is to my mind a small disadvantage to set against a well developed shade policy. It means thinking some years ahead and not leaving decisions to the moment when estimates for a particular year are to be passed. I submit that it is neither difficult nor uneconomic in practice.

The loppings of shade trees are naturally a very considerable portion of the material used as green manure. Extra bulk can be obtained, as I have indicated, from bush green manures. I am of the opinion that their use should be encouraged and that sole reliance should not be placed on shade trees. Bush manures are more amenable to immediate treatment and, for example, in time of drought, they can be vigorously cut or pulled up so as to lessen the demand on soil moisture. Here again rotation should be aimed at, though there will be times when it will be impossible to grow bush manures on account of the density of tea itself. I would add one comment. After thorough discussion we have decided to recommend that the larger tephrosia, *T. vogelli* should not be used exclusively in tea because it is a host for an eelworm which affects dadap severely. By alternating tephrosia with, say, crotalarias, less encouragement is offered to a potential enemy.

The next salient point is how to use the green stuff that is provided by shade and bush species and also by pruning. There are three main schools of thought represented by those who advocate:—

(1) Immediate forking in green.

(2) Forking in after allowing normal leaf fall.

(3) Composting as a preliminary process.

The decision between (1) and (2) is largely a matter of cost and convenience. There is little, if any, loss experienced by letting prunings or loppings dry. There is probably some delay in the rotting process, but as far as applications at pruning time are concerned, such delay is of little account since it occurs at a time when the plant makes little claim on outside sources of nutriment.

The question of whether to compost raises an altogether different issue. The point to be considered is whether there is any attendant disadvantage in green manuring as we know it, that composting effectively overcomes, without bringing any new disadvantage in its train. Moreover, advantages and disadvantages have to be weighed against an inevitable enhancement of cost, however reasonable the cost of manufacture may appear to be in certain circumstances.

Composting has appeared recently like a comet in the agricultural firmament of Ceylon. Now, generally speaking, astronomers are very well informed about comets before they impinge on the notice of the general public. Similarly what has been so new and exciting to the general community has been well known to scientific agriculturists for a considerable time. There have been many kinds of compost, all making use, consciously or unconsciously, of the same fundamental principles, and many claiming virtues identical with those put forward to-day. Here is a reference to one of them:—

> "On the whole it may be safely asserted that manure goes much farther in composts than in any other way. It is a safe and effectual mode of applying various substances to the soil. The mass becomes one uniform body, equally nutritious in every part. The gelatinous and mucilaginous substances are dissolved, and intimately mixed with each other, and when applied to the soil become instantly the food of plants. There is little or no waste from evaporation, but rather a gain of nutriment from the atmosphere; and the quantity may easily be divided and appropriated, according to the size of the field to which it is to be applied, and the quantity which each part may require. It may be mixed with the soil, or applied to the surface; it may be used at any time of the year, but its effects are more certain when applied as a top-dressing, either early in autumn, or when vegetation commences in spring; and it may be prepared at any time, whenever occasion requires its help."

That might have been written yesterday, but it was actually written 120 years ago, in 1817, and is taken from Sir John Sinclair's Code of Agriculture. Moreover, as a subject for agricultural research, compost is not a new claimant for attention. It is now over 20 years since two workers in this country united their previously independent efforts on the question of rotting down for agricultural use, straw and other waste materials. Those elegant researches associated with the names of Richards and Hutchinson and their collaborators, have done much to place our knowledge of the chemistry of the compost heap on a firm foundation. Consequently, when Ceylon became interested in compost, there was a very considerable body of knowledge to work on. It may surprise you to learn that one of the first advisory visits I made on my appointment to the Tea Research Institute 10 years ago, in 1927, related to the correct procedure for composting. I think I may say that the result of that enquiry was a higher grade of compost than had previously been produced. With this digression, necessary in order to introduce a sense of perspective into the question, I shall return to the point at issue.

The outcome of the work which has been done over an extended period is that certain substances are intrinsically unsuitable for green manuring in bulk, and that others are only suitable when the proportions of carbon and nitrogen they contain fall between well defined limits. What it comes to is this: I spoke of the combination of carbon and nitrogen conserving nitrogen in the soil. Then, if the proportion of carbon to nitrogen present is too high, the immobilization of the nitrogen is so severe that the availability of soil nitrogen for the plant is interfered with. What is an asset under the right conditions, becomes a liability under other quite different circumstances.

A sudden cutting off of available nitrogen by green manuring with unsuitable material is a very serious matter for short-lived annual crops without large food reserves. It is naturally less serious in a perennial which has reserves and which does, as we know, live on these reserves for quite a long time after pruning, *i.e.*, at the time when the most intensive green manuring is done. But as a matter of fact our green manures are not unsuitable material in the sense I have defined. They have not unsuitable proportions for direct green manuring, unless they are used in a foolhardy manner.

Of green manures used in Ceylon, Dadaps, Gliricidia, Tephrosia, and Sunflower (*Tithonia diversifolia*) have carbon-nitrogen ratios between 9.8 and 11.8. The figure of 10-12 is generally accepted as an optimum value. Tea prunings have a value of about 17. Only fresh grevillea droppings are unsuitable with a value as high as 58.

In any case, the use of artificial manures containing nitrogen, forked in with prunings and loppings constitutes a safeguard against any unavoidable deflection from normal. Recent work has shown that from this composting *in situ* in the soil, as we may call it, there is nothing to fear. An experiment at the Rothamsted Experimental Station, now in its ninth year, which has completed its second rotation, shows that straw (a totally unsuitable substance for direct incorporation) when ploughed in with sufficient nitrogen to adjust the carbon-nitrogen ratio, is at least as good as its equivalent amount in the form of either composted straw or farmyard manure. We have a similar trial with local materials in progress in Ceylon.

In brief, the evidence is that provided an immediate return of the nitrogen added is not required, our current practice of direct green manuring with loppings and prunings may be expected to hold its own. Compost can still make a useful contribution in special cases. I think the rearing of young tea and supplies is one of those cases. We have used compost for this purpose on St. Coombs for

the last 5 years, having started in 1932, well ahead of the general community. On young clearings, particularly where there is no well developed green manure source available on the spot, compost in the holes fulfils a purpose which the bulkier green manure does not fulfil so readily.

There remain two important aspects of this whole subject for which I must try and spare a word. The first is what is the effect of shade on quality, and the second, will compost improve quality as has been suggested more than once? To these two questions I can only honestly reply that we do not know. You will appreciate the fact that to devise an experiment which shall remain close to practical reality and yet separate the shade factor in different intensities from other factors such as competition of the shade tree or added nitrogen supply from leguminous shade interplanted with tea and so on, presents any experimenter with a formidable problem. I can only say that when I return to Ceylon I hope to tackle this intriguing problem to which the staff of the Institute has given much thought for some considerable time past.

On the other problem we have already made a start. As we had land which, as I have remarked, has received compost since 1932, we have a 5 years' cumulative effect already; this should give us a clear-cut answer now that tea from this source and from similar areas receiving identical treatment, except for compost application, is being manufactured. I may add that this experiment is the only one in existence where this clear-cut question is being asked and answered.

I see my time has run out, and as I am most anxious to hear your views, which will be a great help to me, I will not say anything further. With the Chairman's permission I should like to say that I shall be happy to try to answer any questions on any subject that concerns us at St. Coombs, whether dealt with in my lecture or not.