SOIL CONSERVATION UNDER THE PLANTATION SYSTEM OF TEA CULTIVATION IN CEYLON*

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A visitor to Ceylon is bound to be impressed by the turbulent slopes which form so much of the landscape, and also by the rain which hurls itself upon the hills. A visitor who is also a soil scientist will be still more impressed when he sees the tea plantations with their apparent attraction for the steepest and wettest districts. He will notice at once the original, and now illegal, practice of planting in neat rows running straight up and down even the steepest slopes, and he will immediately remember his preconceived ideas on soil erosion and will wonder just what equilibrium has been reached between the tea bush and the top soil. Let us hope that our hypothetical visitor will find the energy to push his way through some of the vigorous plantation tea and examine the soil. It will give him plenty to think about.

Those were my first impressions a few years ago, and nothing which I have since seen in the tea plantations has caused me to believe that soil erosion there is, or need be, a serious problem provided that certain basic agricultural principles are followed.

Tea, being a woody perennial which forms a rigid stem and root system early in its life, affords an excellent measure of the degree of soil movement. There are also many examples of varied planting conditions: tea following jungle, or rubber, or coffee, and so forth. Some of the present tea itself was planted eighty years ago, and some is on land which has been under the plantation system of cultivation for over a century. What is the general picture of soil erosion under such varied conditions?

The answer is quite simply, that very little soil movement has occurred. There is a little banking up on the upper sides of the bushes, and a little hollowing at the base of the stem on the lower side. These effects may be more pronounced at mid-country elevations, as I shall mention later, but such movements do not necessarily mean that soil has actually left the hillside at all. To a large extent they represent local re-distribution between the individual tea bushes.

I can imagine that some of you are preparing to disagree with this last statement, possibly on the basis of an argument which has common currency in Ceylon. This argues that the colour of the main rivers after heavy rains is due to soil erosion from the hills, and therefore from cultivated areas. I should like to do my best to persuade you that this is based on careless observation and faulty interpretation. Any study of rivers should start at their source, and since our two largest river systems spring from areas which are largely planted in tea I have been able to draw some conclusions as to the origin of turbidity in the rivers.

It is notable that fast running mountain streams, draining large areas of tea, are usually very clear, and that only after a prolonged dry spell is there a cloudiness in the first rush of water. These clear streams can usually be followed down until they come into contact with drainage from roads, or building sites, and it is there that the real turbidity begins.

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That, I suggest, represents by far the most important source of soil in the rivers, and observation of the streams issuing from tea land agrees very well with observation of the tea land itself. There is, however, another source of turbidity in river water, namely ferric hydroxide, and this certainly does come from tea soils. Perfectly clear spring water will precipitate ferric hydroxide on standing, either in the laboratory or in the sluggish waters of pools and marshes. This deposit, on rocks or on water weeds, is very fragile and is easily washed off by turbulent water.

It would be interesting to know how much of the initial turbidity which we see in rivers after heavy storms is due to the stirred up iron deposits, and also how much more ferric hydroxide precipitates by the time the mountain waters are swirling through the low country. This, of course, is an integral part of soil formation, and has nothing to do with soil erosion.

I have gone into these points in some detail, and with some emphasis, because the Tea Research Institute bases its recommendations for management on the assumption that many years of practice have demonstrated that the tea bush can act as an excellent soil conserver, and that this conservation is best achieved by just those practices which favour the most efficient production of the tea crop. So far I have concentrated on observations and their interpretation, but I can support some of my contentions with actual analyses, which in themselves may be of interest outside the subject of soil conservation.

Everyone knows what soil fertility is, although no one can define it, but possibly the most important single component is the organic matter status. I have just completed an extensive survey of tea soils and, wherever possible, the adjoining jungle soils, covering all the areas under tea in Ceylon, from sea level to the heights of Nuwara Eliya, and from the deluges of Dolosbage to the comparatively dry bowl of Uva. I deliberately took my samples from the most varied conditions I could see, with the proviso that the tea was grown under plantation management. Arising from the results of the organic matter analyses are some relations which seem to have a bearing on the practical management of tea as a soil conserving crop.

The jungle soils, in the top six inch layer, and also in the second six inch layer, show a steady and linear increase in organic matter with a rise in elevation. Up to three thousand feet the points fall very closely on the line, but above this point the scatter is great. The tea soils, however, show a very different pattern. Up to three thousand feet there is little changes in the organic matter, with the exception of a most unexpected decrease between two and three thousand feet. This, although slight, is nevertheless real. At the higher elevations the organic matter increases rapidly, and shows a similar scatter to the jungle soils.

At the lowest and at the highest elevations there is very little difference in organic matter between jungle and tea soil, but in the mid-country the difference is at its greatest. To take this a step further, I have taken profile samples from selected areas, and we have a fairly clear picture of the organic matter distribution down the profile. This can help to decide whether the present top soil in the tea fields, which I have just been considering, is the original top soil depleted of organic matter, or the original sub soil which has now come to the surface through erosion. No cultivations practised in tea plantations could ever invert the soil layers.

I am convinced from the analyses that in the majority of areas the present top soil under tea is the original soil with very little mechanical loss. In the mid-country zone, where the organic matter is unexpectedly low, it seems that the high rate of decomposition of the organic matter has been accompanied by more erosion than at elevations above or below. More erosion, certainly, but still not very much. When you remember that the chemical analyses include raw organic matter, which is impossible to exclude entirely from the samples, and that the jungle soil has the

greater proportion of this, you will see that I have deliberately understated the evidence in favour of soil conservation.

Organic matter as such is a well known soil stabiliser, whether by virtue of its physical buffering action when present on the surface as a mulch, or by reason of chemical interaction within the soil to produce stable aggregate units. It was a logical step to follow the organic matter survey by physical analyses of the water stability of aggregates, and this is being done now. If I comment on some of the preliminary trends of this work I must ask you to remember that they are only tentative comments.

It does not seem as though there will be a very close correlation between organic matter and water stability of aggregation, as measured by the usual wet sieving of fresh soil on a bank of sieves, and correcting for stones. However, the breakdown of aggregates by air drying the soil and then sieving under water is lessened where the organic matter is highest. The low organic mid-country soils, while being surprisingly water stable in their moist state, disperse much more readily once they have been dried.

Jungle soils are more aggregated than the corresponding tea soils, and with the latter the second six inch layer is often more aggregated than the top layer. I do not think this is connected with the clay content, nor with the nature of the clay mineral, and organic matter can not account for the higher aggregation in the sub-soil. To some extent ferric hydroxide will, I am sure, be found to be associated with this phenomenon, as also with the aggregation in the mid-country soils, but my progress in these analyses has been so little that I prefer to leave this aspect with the comment that we probably owe a lot to the iron bacteria for keeping some of the soils in their place.

We also are fortunate in that tea requires an acid soil, which automatically means that the predominantly kaolinitic clays are highly aggregated, and that this extends, as far as I can judge, to the full depth of the profile. High aggregation, and therefore rapid penetration of rain, is necessary in the lower layers as well as in the top soil.

I want to revert to my comment on the poorer aggregation often found in the top soil, because this will lead me back to considerations of practical management, and thence to my conclusions.

I attribute much of the friability of the top soil to purely human factors. Tea necessitates repeated and frequent walking in the rows, and in the past the plantations suffered from clean weeding. The implement commonly used for this, a right angled metal strip on a short handle, is the most insidious thing to be found in Ceylon. It almost seems as though it was designed deliberately to reduce the surface soil to dust, and above all to pull it down hill. We must be grateful to the dense mat of the surface feeding tea roots, and possibly to the iron bacteria as well, for re-aggregating the powdered soil and lessening the risk of clogging percolation channels.

The other implement used in cultivation, the long tined fork, also moves soil down hill, but as a block and not as a dust. Here the opening of large percolation channels offsets the disadvantages of assisting the unavoidable tendency of soil to move down steep slopes. Tea requires well drained soil, and in Ceylon this invariably means a steep slope, so that cultivation operations must always have their dangers. How, then, has the Tea Research Institute decided to compromise on this, and what recommendations do we put forward to continue the present trend of increasing vigour of plantation tea?

Let me state them very briefly. To protect the soil from drying out, the tea bush itself should be encouraged to cover it as rapidly as possible. Thus, pruning should be light and no more frequent than is necessary, and plucking and manuring should be designed to give a healthy bush, and not the maximum crop over a short period. On this principle, of the best cover crop for tea being the tea bush, we can see how the other points I raised can be dealt with.

Tea leaves form a stable surface mulch which minimises the trampling damage to the soil. Weeds no longer become a problem under vigorous, dense, tea and the weed scraper with all its harmful effects can, mercifully, be forgotten to a large extent. With a reduction in the clogging of the percolation channels there is less necessity to use a fork, and we may perhaps look forward to the day when some areas need no forking at all.

In mid-country areas this may never be achieved, but here the inclusion of a wad of organic matter behind the fork is suggested to maintain good percolation.

I have purposely said nothing about contour planting, nor about the necessity for protecting drain and bank edges with stones or with the cheaper cover crops. This latter point is a matter for common sense, although it is often ignored.

I have been more concerned to examine the evidence for or against soil conservation under the old up and down tea planting, and to suggest that this tea, which will be with us for many years to come, can, by the adoption of simple agricultural principles, continue to increase its contribution to Ceylon's prosperity with no attendant risk of disgorging Ceylon's greatest asset into the sea.