LET'S HALT THE DOWNSLIDE OF OUR PRIMARY CAPITAL

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Soil is the primary capital in agriculture and its preservation in a suitable state for healthy plant growth is of utmost importance for successful and sustained farming. It is erroneous to look at soil only as an inert medium that provides anchorage for plants. Although it is derived solely from rock material it is a mixture of rocks, minerals, organic materials and copious microflora and fauna, each component contributing its own share in making up a suitable environment for plant growth. A proper balance of mineral and organic matter, to result in proper tilth and microbiological activity, is essential for transformation, retention and release of nutrients from applied fertilizers. Thus, soil is not an inert medium but a living system and therefore needs utmost care in its use if one were to preserve its productive capacity or fertility. Under natural conditions there is generally a balance between soil formation and soil denudation *ie* the amount of soil that is lost is made up by the amount of soil formed. Loss of soil is a phenomenon that occurs at all times and is generally called "geological erosion". However, man's interference with the balance of nature in order to cultivate increasing extents of land accelerates this process and this loss is often termed "accelerated erosion". Soil erosion can be caused by several factors such as wind, water, ice, etc. In the tropics, however, soil erosion by water, *is* by rain *ie*. the most consequential. Contrary to earlier concepts which attributed soil erosion to moving water on the soil surface, it is now established that it is the impact of the falling rain drops that initiates soil erosion. Rain drops directly falling on the soil surface detach the soil particles that are held together and subsequently these detached particles are transported by moving water. Therefore, to prevent or reduce soil erosion we must first intercept the falling of rain drops at some point to break the speed and having thus reduced the impact, maintain the soil in such a condition that it will absorb and transmit the water into deeper layers. However, when the rainfall intensity exceeds the rate at which the water can infiltrate into the soil, we have to adopt measures to lead the water at non-erosive velocities away from the land. It is thus clear that the basic methods of soil conservation are:

1. keep the soil protected and maintain the surface in such a condition as to increase infiltration and percolation into deeper layers;

2. have some means of disposing off the excess water at non-erosive velocities.

It has been estimated that to form an inch of soil it takes about 300 to 1000 years. To lose an inch of soil, however, it would take only a few weeks. Furthermore, the results of soil erosion are not confined only to the land where erosion is taking place. The soil carried in run off water in streams and rivers are quite often deposited in plains below resulting in the sedimentation of reservoirs, drainage systems, irrigation channels and farm lands.

The large quantity of run off water discharged into rivers during heavy rains increases the incidence of floods and there is too little flow of water during periods of dry weather, adversely affecting irrigation systems, hydroelectric schemes and domestic water supplies. Negligence in care of soil could thus escalate into a serious national problem.

The problem of soil erosion on tea land is not new. As far back as 1928 it was well recognized that with the burst of every monsoon the capital of up-country agriculture was being washed out into streams and rivers. The Administration Report of the Department of Agriculture for the year 1927 stated as follows: "The importance of soil conservation in the hill country is recognised by all and much has been accomplished in recent years. Much however, remains to be done and until every planter in the up-country realizes that this is his main agricultural problem the situation cannot be considered to be satisfactory. If soil erosion can be checked and general soil condition and tilth maintained, crop yields will be sustained without the aid of increasing quantities of artificial fertilizers and the incidence of pests and diseases will also be reduced". It must also be mentioned that apart from agriculturists and scientists who highlighted this problem at that time planters themselves took serious note of it. The following, quoted from a publication in 1928 by Mr. E. O. Felsingher, a proprietory planter is worth remembering. "The facilities which I found existed for denudation struck me as something that called for immediate action since I felt that no resourceful man should countenance a practice which amounts to bringing the soil of an estate into the best possible condition through tillage and manuring, only to let this soil be carried away into the drains and untimately off the land". In spite of such warnings little progress was achieved during that time and consequently the Government in 1931 set up a Committee to investigate the soil erosion problem and that Committee concluded that the estate sector, especially the tea estates, were mainly responsible for the serious soil erosion problem. Since then care has been exercised to reduce this but even now *ie* more than fifty years hence one has to admit that the attention given to soil conservation and its importance and practice is nowhere near the consideration it deserves.

Let us look at a tea estate in its various stages. If we consider the old seedling tea which comprises 85% of the total tea acreage the striking aids to soil erosion are as follows:

1. Most of the tea is planted up and down the slope thus aiding water to flow down the slope without any obstruction.

2. Most of the seedling tea is of low jat, not vigorous in growth and therefore does not cover the soil adequately.

3. The method of weed control adopted involves the use of scrapers and sometimes even mammoties when the weed infestation goes out of hand. This clean weeding exposes the soil and the use of scrapers leaves a loose layer of soil on the surface which can easily be carried away by water.

4. The speed of flow of water is high on steep slopes and water moving down a slope gains speed as it flows over a long distance. When the speed of water flow increases the soil carrying capacity of the water increases tremendously. It is to obstruct the flow of water

and break the speed that lateral drains are constructed. With such a devise any excess water can also be led away from the land at non-erosive speed. In most seedling tea fields either there are no drains or when present are cut at such a steep gradient that water gushes down or are filled up with soil eroded from above. The leader drains when present are not planted up with any low growing vegetation leading to scouring. Such a situation is a striking aid to soil erosion.

5. Vacant patches are very common in seedling tea fields. Once a tea bush dies either due to old age, drought, pests or diseases it is not a practice to fill the vacancy or even to plant it up with some kind of vegetation. When there are many such patches a proportionate surface area remains completely exposed, is subjected to the beating action of the rain and soil loss could be enormous.

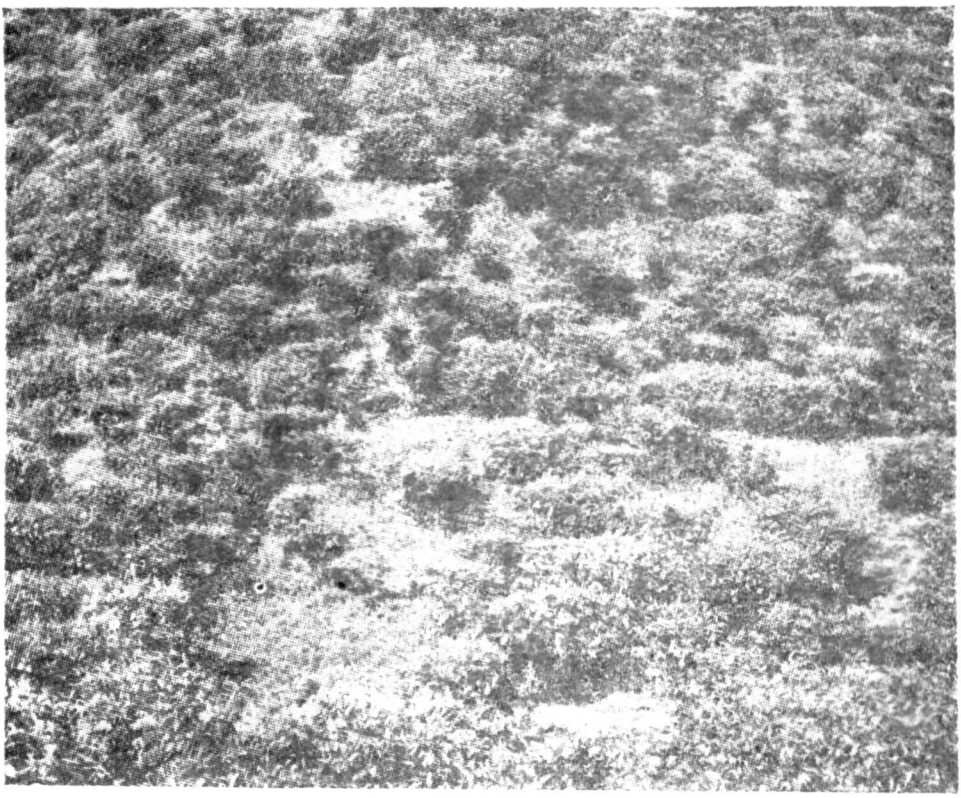

Fig. 1 — Vacant patches in seedling tea conducive for soil erosion

The above conditions prevailing on tea estates are most conducive for soil erosion and it has been estimated that during a period of six years as much as 100 tons of soil can be lost by erosion (Joachim, 1935).

Anti-erosion measures that could be adopted in old seedling tea are as follows:

1. Encourage ground cover by selective weeding. Retain soft weeds such as *Oxalis* and *Drymaria*; they will not compete with tea and in dry weather the weeds themselves will die. Avoid the use of scrapers and ban the use of mamoties for weed control and adopt chemical weed control methods.

2. Many soil conservation measures such as transverse drainage, establishment of contour hedges and dykes, terracing hillsides, etc. have been recommended and practiced in the 1920's. The most, effective practical and economic method, however, was, and still is, the system of lock and spill type lateral drains connected to a leader drain. The distance between the lateral drains would depend on the steepness of the land. This should be done in old fields where there are no drains. It is pertinent to point out here that this soil conservation measure was first designed, practised and recommended by Mr. E. O. Felsingher, proprietor of Primrose Hill Estate, Kandy and Fruit Hill Estate, Hatton, in 1928. A diagrammatic sketch drawn by him is shown below.

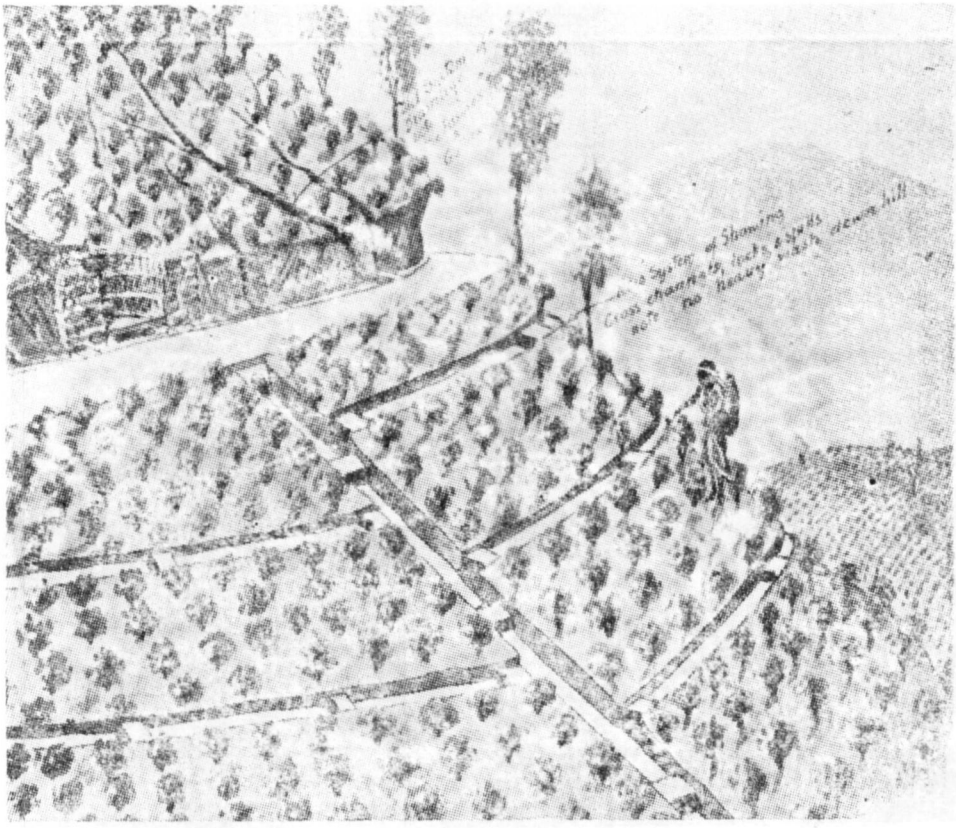

Fig: 2 — Diagramatic sketch of soil conservation measures

According to his calculations, in lock and spill type lateral drains $1\frac{1}{2}$ ft wide if silt accumulates to a depth of 6 inches this would amount to 50 tons of soil per acre. This indicates the importance of cleaning the lateral drains regularly and spreading the soil in the upper slope from where it came. The upper side of the lateral drains and road banks could be planted up with *Erogrostis*. The leader drains should also be planted up with some vegetation or paved with stones

3. Maintain the top soil in a friable condition to aid infiltration of rain water. Cultural practices such as mulching, forking and incorporation of organic matter often help achieve this.

4. When vacancies occur in fields, plant the patch with Guatemala grass or Mana grass or *Erogrosits*. The soil renovation brought about by these grasses will help in establishing the infills which would go in subsequently.

Another stage in the plantation where soil erosion is serious is when a field is replanted. The most vulnerable period is the time between uprooting the old tea and until the soil reconditioning grass sufficiently covers the ground. A second susceptible period is after uprooting the grass and until the new tea forms a complete ground cover. Hasselo and Sikurajapathy (1965) estimated a loss of 100 tons of soil per acre during a replanting period of four years.

The following soil conservation measures should be undertaken during the replanting period. Soil disturbance is heaviest at the time of uprooting, deep forking and levelling. The loose layer of soil at this time is easily washed off. The following procedure may reduce soil loss considerably.

1. avoid, as far as possible, land preparation during heavy rains;

2. reduce, as much as possible, the time-lag between uprooting, levelling and planting the grass for soil reconditioning;

3. the above could be achieved by uprooting in small blocks and completing all operations upto planting of the grass in each such block;

4. after uprooting and deep forking it is not necessary to thoroughly level the soil. Speed of water flow is high on highly levelled ground whereas a rugged surface would help break the speed of flow and thus reduce erosion;

5. lateral drains and leader drains should be cut before the grass is planted. A certain degree of collapse of drains does occur. But it is always possible to clean up subsequently. Since the soil is completely exposed and because the erosive power of water is higher on longer slopes, these drains would reduce soil loss substantially. If possible the upper end of drains should be planted with *Eragrostis* at about 6" spacing. This would retain and prevent collapse of sides. The lateral drains should be spaced 20'–40' apart depending on the slope. They should be 18" wide and 18" deep and be of the lock and spill type.

The gradient of the drain should be 1 in 100 to 1 in 120. The drain should be cleaned regularly and the soil spread out above the drain. On steep land, contour terraces should be constructed if rocks are available. Leader drains should be constructed along natural drainage lines and be designed to receive the excess water from the lateral drains and dispose of it at non-erosive velocities to prevent the formation of gullies. The size of these drains could vary and would depend on the quantity of water discharged at peak rates of flow during heavy storms. They should be constructed in a stepwise manner to reduce the flow velocity and pervent scouring. It is preferable to build the sides and the bottom with stones to stabilize the

channels. A suitable grass such as *Paspalum dilatatum* or *Eragrostis* should be planted on the sides to provide additional stability. The construction of check dams at frequent intervals would assist in the detention of soil carried in the run - off water.

Once the drains are cut the grass should be planted immediately. Until the grass establishes itself and provides sufficient ground cover weeds must be encouraged to grow and no scraping should be done.

After the soil reconditioning period the time between uprooting the grass and until the new tea covers the ground sufficiently is another phase which is vulnerable to soil erosion, although during this phase soil erosion s less than that in the first phase. It is customary to hole the entire area before planting commences. It has to be borne in mind, however, that the heaped up earth after holding can be washed down very easily. The soil should preferable be trapped in the hole in case of soil wash. It is preferable to hole in blocks and finish planting each block and then proceed to the next. Although this phase is considered less susceptible to erosion Manipura's estimate shows that about 20 tons/acre of soil can be lost during the 2nd year after planting. The figures from subsequent experiments show even a larger amount of soil loss. There is enough evidence to show that soil loss is high during the first and second year after planting and is considerably low or negligible in the 3rd year when the tea has covered the ground. It has also been established that mulches and *Eragrostis* as ground cover substantially reduced soil loss, and that cover crops such as *Crotalaria* or weeds, although reduced soil loss, were less efficient. Although mulching is the ideal conservation practiced material for mulching is not always available in large quantities. Cover crops seem the next best. It appears that it is very desirable to grow at least one row of a cover crop in between the tea rows and lop it frequently and use the loppings as mulch. The cover crop can be cut almost to ground level at the onset of the drought, the soil mulched and any competition for moisture avoided. The cover crop should be managed in such a way as to reduce competition for light and moisture.

Apart from all the anti-erosion measures recommended some thought must be given to the following factors:

1. Trees of any form in a tea field intercept the rain and reduce the speed and therefore reduce the impact of rain drops on the soil thus reducing soil erosion.

2. Weeds could be kept under control by some form of slashing sothant they are not allowed to flower and get out of hand. This would eliminate the necessity for the use of the most undesirable implement the scraper.

3. When uprooting old tea if one starts at the top of the hill there is the advantage of preventing soil wash. As the tea lower down would serve as a barrier to down slide. If uprooting is started from the bottom of a hill there is every likelihood of a landslide.

4. Maintenance of field paths in a proper state with some kind of soil cover would prevent the path serving as a channel for water flow ultimately being transformed into a gully.

5. When forking is undertaken it should be done as recommended. Deep-forking aids infiltration but a shallow forking would only result in a loose layer of soil being exposed and this would ultimately be carried away with rain water.