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*FACTORS AFFECTING PRODUCTIVITY ON TEA ESTATES IN SRI LANKA

3—PROPER LAND USE

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The advantages of natural land units over artificially carved out estates are explained in the context of highland tea plantations in Sri Lanka in order to increase economic viability. The need to consolidate the basic resources of agricultural land, *viz:* soil, water and vegetation, is explained with specific instances cited where special attention is needed. It is suggested that land planning on tea areas be re-examined so that possible sites for human settlement and water reservoirs be demarcated for future use. Instances of incorrect land use are listed with suggestions for corrective measures.

INTRODUCTION

It was pointed out in the first article in this series (de Silva and Saravanapavan 1975) that tea estates are often divided into fields on an arbitrary basis. The same is true of the division of vast extents of land into estates themselves. Boundaries between estates are often arbitrary straight lines drawn across maps and demarcated on the land by straight drains. These boundaries signify nothing more than ownership distinctions and bear no relationship with natural boundaries. There are several kinds of natural boundaries but for the purpose of this treatise two types of natural boundaries will be considered. The first of these are the water courses and the second, the summits of hills or mountain ranges which form the perimeter of a watershed or catchment area. There are several reasons from the agricultural point of view why natural boundaries would have been more meaningful in the demarcation of land into production units particularly in the mountainous terrain where the majority of tea plantations in Sri Lanka are situated. This concept and its attendant advantages are discussed in the present article, together with suggestions for improving agricultural productivity and maintaining the land with all its resources intact for many years to come.

The advantages of selecting natural boundaries for land demarcation into management units are many. River or stream valleys and their watersheds form ideal natural units of land. Agricultural development of such units can begin at the tops of the hills and proceed downwards towards a stream or river. Where artificial boundaries such as ownership boundaries are present, development may not necessarily begin at the top of hills. For instance, the bottom portion of a slope may be replanted in tea by one owner, while the upper portion may be left unplanted by another owner. It could well happen that the lower replanted tea may become infested with parasitic nematodes from the old tea above it (Kerr & Vythilingam 1966).

The construction and maintenance of roads for transportation of agricultural produce is another factor to be carefully considered. It is well known that outlying divisions of estates are quite expensive to manage not only in terms of transportation costs but also when efficiency of work supervision is considered. For instance,

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an isolated division situated in another valley far away from the rest of the plantation could well be merged with another estate in the same valley rather than for it to be managed from far away. Such redeployment is possible when ownership considerations do not interfere with logical management procedure and natural agricultural considerations. This is now a reality in Sri Lanka, consequent to the ownership of tea estates being largely concentrated in the hands of the State. The same considerations could well apply to factories for processing agricultural produce. The produce from an outlying division may often be transported at great cost to the owner's factory rather than be processed in a nearer factory which happens to belong to another owner. All such cases merit careful study so that production costs can be brought down and overall profitability thereby increased.

RESOURCES FOR AGRICULTURE

Any land area, however large or small, has certain basic resources on which the success of agriculture in that area depends. The land areas themselves may be as large as a tea estate, or even still larger, such as a whole country, or they may be as small as one tea field of say, 50 acres or a small holding of two acres. The basic agricultural resources common to all agricultural units of land are:

1. The land and its soil
2. Water
3. Plants
4. Animals

In addition, human resources are, of course, necessary for the practice of agriculture. Besides these basic resources, there are other requirements which may come from outside the particular land area. These include fertilizer, agrochemicals, machinery, the infrastructural needs of humans, mechanisms for marketing the agricultural produce of the land, *etc.* These inputs have to be provided from elsewhere so that the land can provide its agricultureal output. Ideally, these outputs should exceed the inputs in financial terms. If this does not happen, that particular land area will be a financial loss and will ultimately become a burden to other areas which may be required to generate the funds needed for the inputs. Of course it may often be necessary, and even desirable, for a particular land area to be kept supplied with inputs from outside it, in excess of its agricultural output provided it is envisaged that such a need will only be temporary. It should be quite clear that it is not possible for inputs to exceed outputs indefinitely. It is sometimes possible that inputs given to one land area produce outputs elsewhere. An important instance that might be specifically cited is that funds expended on soil conservation measures in the south-western highlands of Sri Lanka may well lead to increased water resources in the North-Central Province, consequent to the diversion of the Mahaveli River waters into that province.

The success of agriculture on a given land area, given the necessary inputs, will depend on the availability of the basic resources of that land area and how they are utilised. Each must be continuously improved and consolidated in order to achieve continued agricultural development. These factors, in relation to tea estates, are discussed below. (Animals are specifically excluded from the scope of the present article).

THE LAND AND ITS SOIL

Soil is one of the basic resources of agricultural land. It is the product of the weathering of rock. This is a protracted process that may take centuries. Good soil is the most important component of agricultural land. Every effort must therefore be made to conserve and build up soil and to prevent its erosion (Manipura 1971; 1972). Erosion occurs very quickly when soil is exposed by the removal of vegetation. If this practice is necessary, then proper soil conservation measures are required to prevent soil erosion.

Where tree crops are grown, soil erosion is minimal, but it is abundant when root crops, vegetables or field crops are grown. The construction of silt pits along drains and water courses would help counteract erosion in areas where field crops are grown. Covering ground bared for growing crops even temporarily with thatch is most desirable as erosion is considerably reduced. Wherever exposed soil is seen, erosion will take place. Soil may become exposed for various reasons. Often it is because the species planted in a particular area is unsuited to it and this species does not grow satisfactorily or not at all. Growth may be poor because the soil is too poor for that species, whereas an alternative species may be more suited to that area. For example, on tea estates, tea is sometimes planted on steep land, or on patches of very poor soil. Where plant growth is poor, it is known that they are prone to attack by pests and disease (Shanmuganathan 1965 ; Sivapalan 1967) and ultimately some of these plants will die, leaving exposed soil. It is necessary to exclude such areas from planting in tea (Shanmuganathan 1972). These areas may not be able to support several small root systems such as those of the tea plant, but they may support a smaller number of relatively large root systems of larger species such as trees (Fig. 1). In other words a few trees may be able to grow in an area where several tea plants cannot and the presence of the trees would minimise soil erosion in that area. The same applies to areas with exposed boulders lying close to each other (Fig. 2). It would be very much easier and less expensive to grow trees in such areas rather than attempt to make this land suitable for tea. This concept of "mini diversification", merits more widespread application on tea estates than is practised at present in Sri Lanka. It further helps to break up the monoculture of tea which is a disadvantage from the point of view of pest management (Calnaido 1972).

Soil conservation works such as proper siting, repairing, and recutting of drains, desilting them and placing the silt above the drains, the building of terraces, the planting of species like *Eragrostis curvula* above banks near roadsides, footpaths, hill cuttings, drains, *etc.*, the building of leader drains and catch pits, the thatching of exposed areas and ensuring minimal disturbance of the soil during weed management are all necessary measures to minimise soil erosion (Manipura 1971; 1972). *E. curvula* provides an excellent thatch which can cover the ground and help check weed growth. In general, the steeper the bank, less grass need be planted. On gently sloping banks several rows can well be accommodated (Fig. 3).

It is interesting to speculate as to what would happen to tea land in the highlands of Sri Lanka if such measures were not carried out, while at the same time subjecting the soil to scraping for weed removal. Our view is that a good tea area may become uneconomic and non-viable in about ten years. On some land it could well be much less (L. M. de W. Tillekeratne 1976; personal communication). Assuming this figure of ten years to be fairly correct, the question arises as to whether, and if so what extent, we should depreciate the soil in financial terms just as we do for manufacturing plants, machinery, buildings, vehicles, *etc.* which, after all, are economically replaceable unlike soil.

The practical hazards of permitting soil erosion to continue, such as the silting of lakes, rivers and reservoirs and problems of flooding are too well known to merit discussion here, but emphasis is placed on the fact that no plant can grow satisfactorily without good soil.

WATER

Water is vital for any form of agriculture. Its collection, storage, and use should therefore be regulated as efficiently as possible with wastage cut right down to what is ultimately unavoidable. This is particularly important in the south-western monsoon zone of Sri Lanka which forms part of the catchment of the Maha-veli Ganga because it is the precipitation in this area that enables water to be diverted to the North-Central Province from Polgolla. Expenditure on water conservation in this catchment would, therefore, be recouped in the North-Central Province as well as on the spot. Ideally, we should permit water to flow into rivers after the soil is saturated with it and can absorb no more. For water to percolate into the ground it needs time. Its run-off should therefore be delayed for as long as possible (Fig. 4). This can be achieved in two ways, firstly by the presence of a cover of vegetation, the litter from which forms a padding for the soil, helping to hold back the water, and secondly by the construction of dams, bunds, barriers, *etc.*, which would control the flow of water. When water percolates into the ground, it feeds springs which continue to provide water long after it has stopped raining, and, ideally, well into the drought. Failure to store adequate supplies of water below the ground is the result of wrong procedures being adopted in land use, whether it be in agriculture or urbanization (de Silva 1974). The consequences are the drying up of streams and rivers in dry weather, and, therefore, a retardation of agriculture, the lack of urban water supplies and the restriction of sources of hydropower, all of which are detrimental to the country. The planting of a proper cover of vegetation cannot be over-emphasised.

The construction of dams achieves water storage above ground level. The siting, planning and construction itself is a specialized operation and cannot be carried out without expert advice. Also, it is illegal to tamper with water courses without the approval of the appropriate authorities. However, it would be useful if proposed sites for reservoirs can be identified and the matter discussed with the officials and experts concerned. On tea estates there are already several artificial reservoirs. If the construction of a reservoir is planned, then all the work in the catchment area above the proposed dam must be carried out well in advance. This includes forestation or reforestation, replanting tea, proper drain construction and other soil conservation measures. Grazing should not be permitted in the catchments of lakes but fodder grass could well be grown in some areas. Vegetable and field crop cultivation is to be avoided in the catchments as the cultivation of soil will lead to erosion and the silting of lakes. Human settlements are best avoided in the catchments as the cultivation of soil will lead to erosion and the silting of lakes. Human settlements are best avoided in the catchments immediately above such lakes in order to avoid pollution of the lakes. Ideally, vegetable and field crop cultivation with channelled irrigation where feasible, can be practised below the reservoirs. Stall-fed cattle could also be housed close to such areas below lakes, so that the manure could conveniently be used for vegetable cultivation (Fig. 5). Finally it may be noted that such lakes could be stocked with fresh water fish, a valuable source of protein for humans. The present national target of 600 tons (Mendis 1976) could well be stepped up if greater interest could be generated.

VEGETATION

Tea, of course, is the major product from tea estates in Sri Lanka. By-products from tea are not produced on an appreciable scale. On many estates, almost

all the high land has been planted with tea and there are hardly any secondary products. Tea has often been planted whether the land is suitable for tea or not. This has been done in order to obtain as much of the finished product as possible from the estate. Ravines have often been drained and steep areas terraced for tea planting. If the tea did not grow satisfactorily, or if it died, the soil was exposed and subject to erosion. The concept put forward in the present article is that the proper species must be selected for a particular land area (Fig. 5). Of course this means that we have to diversify away from tea on land clearly unsuited for tea irrespective of how big or small these areas may be. Such land can be classified as follows:

1. Ravine environs where tea will tend to grow poorly because the soil is waterlogged.
2. Areas at very high elevations where repeated attacks of frost occur.
3. Areas with underlying slab rock, gravel, quartz, heavy clay or other unsuitable soil.
4. Areas which are steep and where the soil is eroded.
5. Areas where soil factors such as pH are unsuitable for tea.
6. Areas which are severely windswept.
7. Areas suitable for the settlement of people.

Ravines are waterlogged for most of the year and tea does not thrive well in them. Alternatives are fuel trees and fodder grass, particularly in areas above reservoirs, but also elsewhere. Fodder grass may be grown as a ground crop under fuel trees, if sufficient light is available. It is said that certain species of *Eucalyptus* tend to dry out soils but this report refers to areas with very little rainfall and is unlikely to be applicable to the wet montane zone of Sri Lanka. It is not suggested that all ravines be put into *Eucalyptus* but some could well produce this valuable fuel and paper resource.

Below reservoirs and in other suitable low-lying areas intensive vegetable cultivation could well be practised (Fig. 5). Low-lying areas are far more preferable to highland for vegetable cultivation which may cause severe erosion of soil in highland. It is logical to tie up vegetable cultivation with fodder grass production in nearby areas because the cattle manure available could be profitably used for vegetables (Fig. 5). Also, it is easier to transport fodder grass than cattle manure. The grass could therefore be away from the cattle but the cattle are best kept close to the vegetable areas, this being preferable even from the point of view of security. What must be emphasized however is that adequate care must be taken to ensure that water resources of ravines are protected. Soil conservation measures such as the construction of bunds and silt pits are required below the vegetable cultivation areas in order to prevent soil being washed down (Fig. 5).

There is some evidence to indicate that the presence of trees in areas subjected to repeated frost attacks reduces the damage caused by frost to tea. The damage is not completely eliminated, but it is minimised. *Grevillea robusta* appears to achieve the desired effect. Areas with unsuitable soil are best planted with trees and if needed, grass, as a source of thatch. This subject has been fully discussed above. On the perimeter of exposed slab rocks it is preferable to plant a tree species with a spreading habit such as *Albizia* sp. rather than one with an erect habit as the

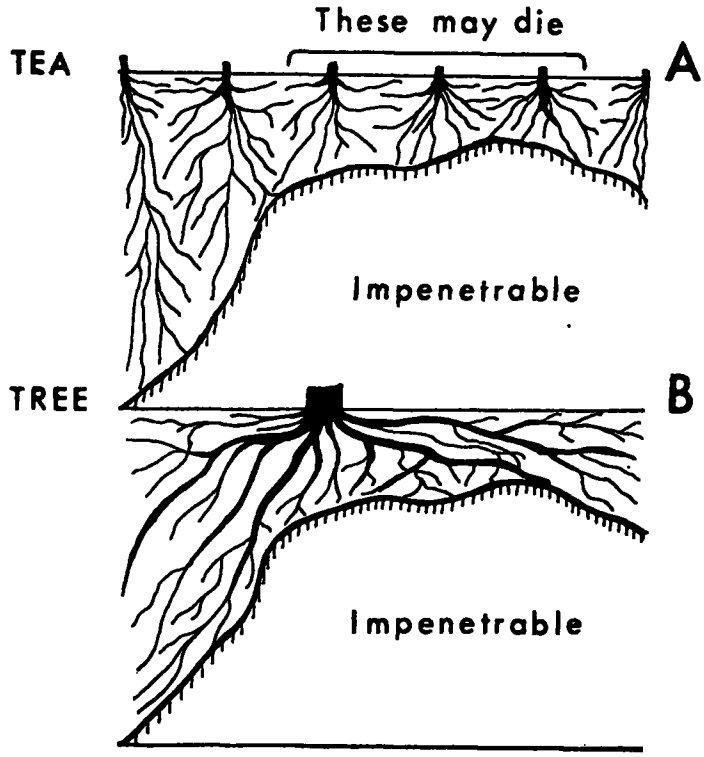

FIG. 1 A—*Root systems of several tea plants in a particular land area*
B— *Root system of a single tree in the same land area*

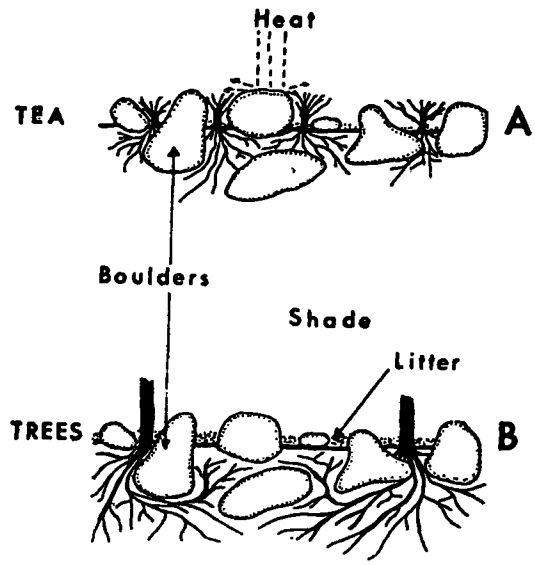

FIG. 2 A—*Tea plants grown amongst boulders*
B— *Trees grown amongst boulders. This is preferable to growing tea.*

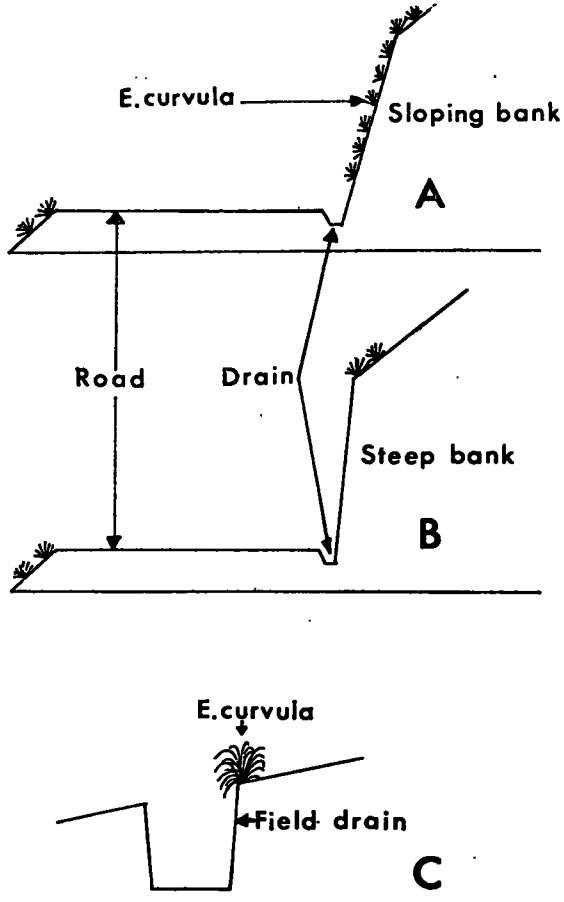

FIG. 3
A—E. curvula *grown on sloping bank*
B—E. curvula *grown on steep bank*
C—E. curvula *grown above field drain*

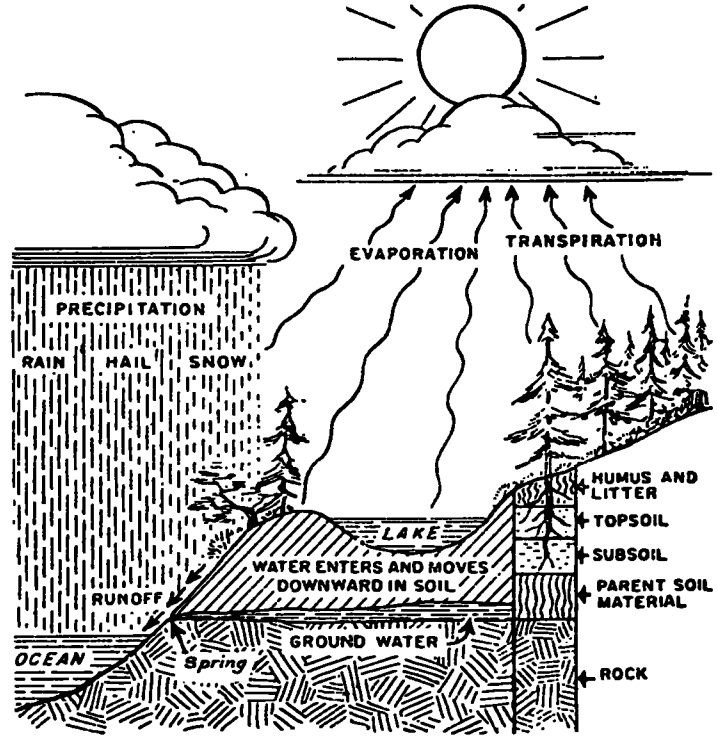

FIG. 4 *The water cycle (courtesy of the U S Department of Agriculture)*

spread of the foliage in the former will cover the rock and provide shade and reduce the desiccating effect when the rocks get heated particularly at lower elevations. (Fig. 6).

Where it is necessary to have protection from wind, belts of trees may be needed. The crests of hills are the areas most exposed. Wind has a desiccating effect and the presence of wind breaks generally improves humidity, and enhances water retentivity because of reduced desiccation. The presence of trees on crests of hills are desirable instead of tea because the tea would suffer damage from wind more than trees. Generally, wind protection is obtained for a distance five times the height of the wind belt. Care must be taken to position the wind belt which should be against the direction of the wind. *Grevillea robusta* spaced 2.5 to 3 m. apart in two or three rows with staggered planting is a suggested possibility. The steeper the land area the more trees it should have (Fig. 7) and there should be no soil disturbance as tea plants need not be uprooted where it is intended to diversify into timber. It is advantageous to plant trees in between tea in very steep areas and abandon the tea when it is no longer productive as a result of shading by the trees. This procedure is suggested where the original planting of tea was on steep land and where diversification into fuel or timber species is envisaged.

SETTLEMENT OF PEOPLE

It was a practice in the past for authorities to select land for the settlement so people merely on the basis of accessibility to roads. On the other hand estate. have not been unwilling to release their steepest and worst tea areas for this purpose. The groups of people who have been settled in these areas now find that their life is difficult and are tending to leave such settlements. The land itself has been eroded and much of it is no more than completely wasted. Water is often not available and the people, far from leading a prosperous life, have been reduced to bare subsistence. The question is, what went wrong? The author takes the view that it is ultimately tied up with the wrong choice of land. What then would be the correct choice?

Land for housing and colonization schemes should be selected in the hill country if they satisfy the following requirements:

1. Water should be available throughout the year. This is ensured if the bottoms of valleys are selected rather than hill tops.

2. The land should be flat or gently sloping and should be located closer to the bottoms of valleys. Hill tops or steep land should be avoided as soil erosion is likely to be severe.

3. Land suitable for farming should be located in close proximity to residential homesteads to provide the people with a profitable occupation. Where land selected is unsuited for agriculture, the occupants have sometimes abandoned such land and moved out.

4. Infrastructural amenities should be available and the land should be accessible to bus routes. New road construction to service areas suitable for the settlement of people is preferable to selceting the wrong land merely because it happens to be near a main road or bus route.

It is true that infrastructural amenities are needed but what is extremely necessary is that areas suitable for human settlement be identified and earmarked at least for the future when the necessary amenities can be provided later, even if

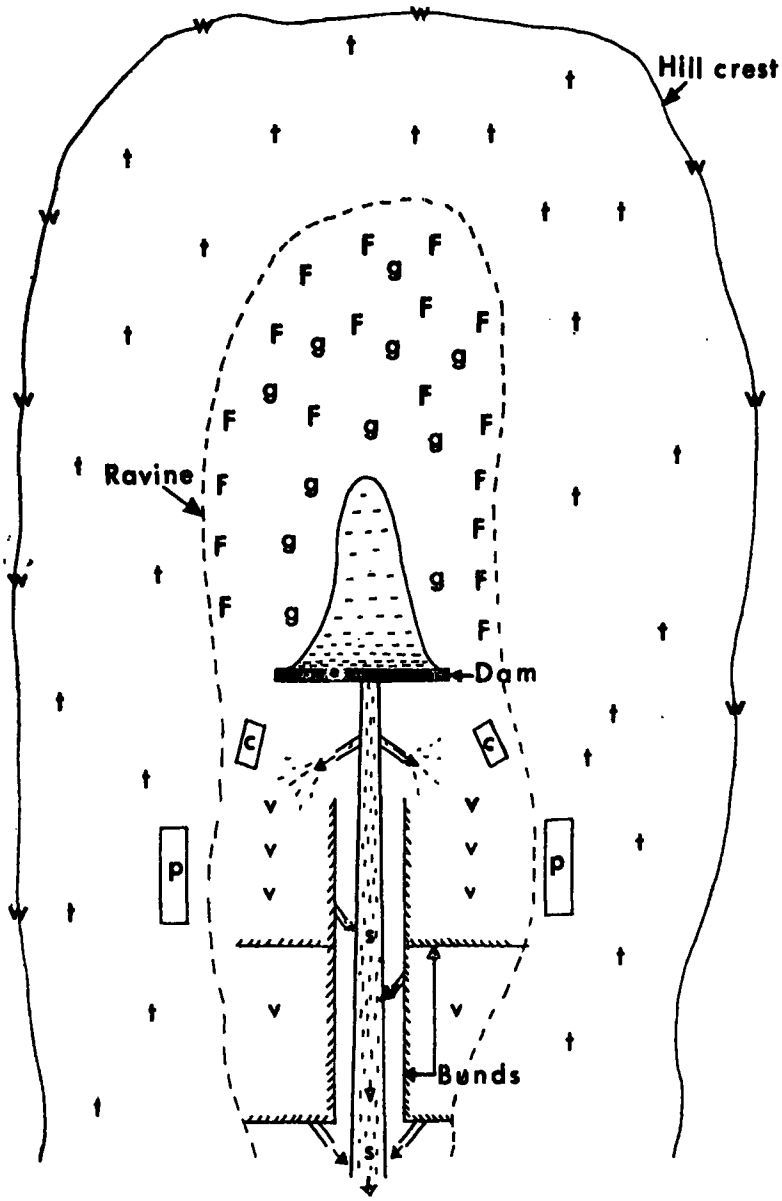

FIG. 5—*Diagram showing ideal layout for optimum land use,* C—*cattle sheds,* F—*fuel trees,* G—*fodder grass,* P—*housing units for people,* S—*stream,* T—*tea,* V—*vegetables,* W—*wind breaks.*

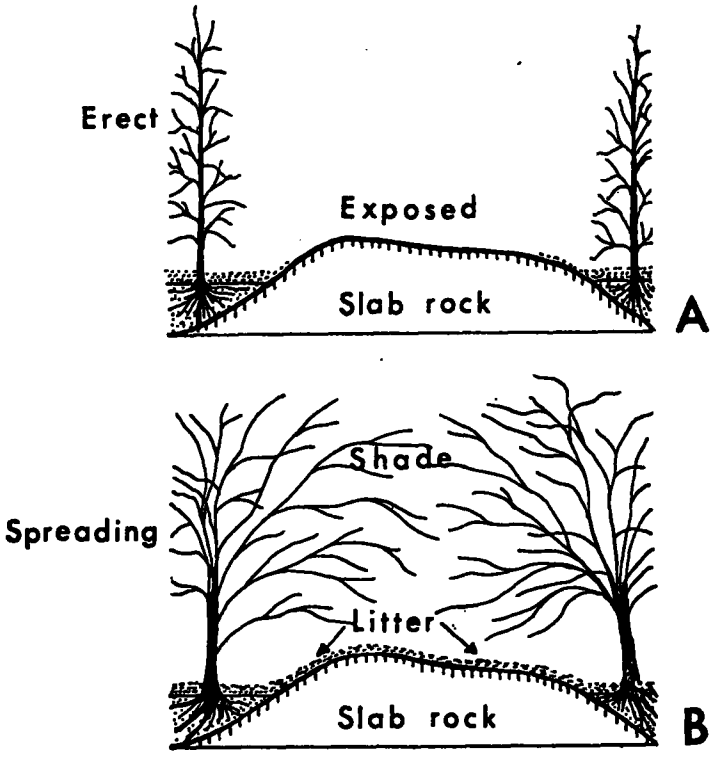

FIG. 6 A—*Trees with erect habit growing around slab rock*
B— *Trees with spreading habit growing ground slab rock*

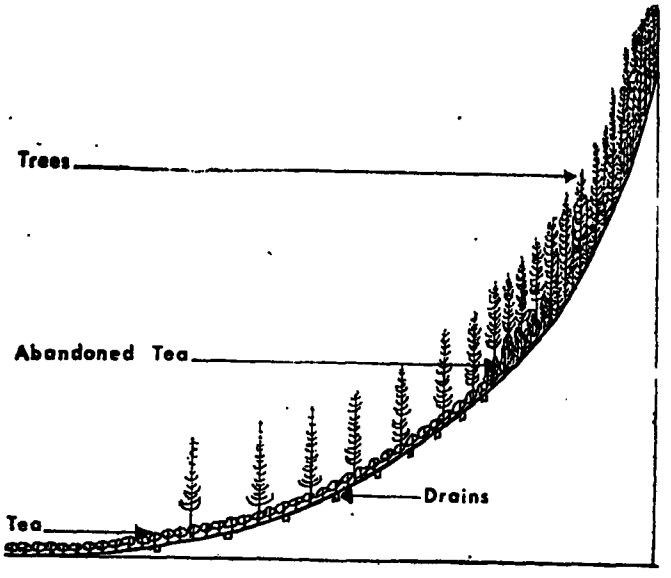

FIG. 7 *Spacing of trees on land of varying slope*

they are lacking at present. An awareness of the need for selecting suitable land for human settlement is emphasized. Whether this land is released now or in the future is secondary, but it is important that we select the right land now rather than put it into tea or some other crop, and release the wrong type of land for human settlement.

Finally it must be pointed out that the needs of humans are the most difficult to satisfy. Land which is unsuitable for human settlement can always be released for agriculture or forestry as a second priority.

SUMMARY

This article pinpoints the need for more attention to be paid to proper land use in tea plantations in the highlands of Sri Lanka. The reasons for neglect and lack of emphasis on this important subject have undoubtedly been connected with the reluctance of management to spend much money because of the rather parochial context of profitability of individual estates, particularly in the short-term, leaving long-term benefits and wider national considerations as a matter of lower priority. It has been the purpose of this article to attempt to reverse this trend. Specific instances where more attention to proper land use needs to be paid are cited. The points mentioned are by no means a complete list of matters needing attention but they are, in the author's view, items needing immediate attention, particularly because they have been neglected for so long.

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