

SOIL EROSION CONTROL MEASURES FOR TEA LAND IN SRI LANKA*

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INTRODUCTION

The great diversity of agro-ecological conditions encountered within Sri Lanka supports a wide range of crops. About 2.2 million hectares of Sri Lanka's total land area is used for permanent cropping. About 1 million ha are under tree crops, including tea (0.24 million ha), rubber (0.29 million ha), coconut (0.42 million ha) and minor export crops (0.04 million ha). Paddy land covers approximately 0.65 million ha and 0.6 million ha is under a wide range of mixed crops and home gardens. In addition, about 0.2 million ha of an estimated 1.0 million ha of 'Chena' (shifting cultivation) land are annually planted in assorted field crops.

Sri Lanka's land area of 6.66 million ha is divided into three major agro-climatic zones—wet, intermediate and dry—based on rainfall, vegetation, soils and present land use. Within the wet and intermediate zones, a subdivision based on elevation takes into account the temperature limitations for the more important crops grown in the country. The low country is accordingly classified as land below 300 m and mid-country as land between 300 m and 1,000 m above sea level, while the up-country is land more than 1,000 m above sea level (Fig. 1).

The rainfall in Sri Lanka follows both a regional and a local pattern. The monsoonal rains occur as a regional phenomenon, while the convective intermonsoon rains are a local phenomenon. The mean annual rainfall ranges from 5,000 mm in the very wet regions to 1,250 mm in the semi-humid regions, and it follows a distinctive bimodal distribution. The intermonsoon convection rains are short, intense thunderstorms that often attain intensities of up to 100 mm/h. Nine, out of ten soil orders of the U. S. Soil Taxonomy are encountered in Sri Lanka, the most common of which are Alfisols, Ultisols, and Oxisols.

Soil Erosion on Tea Land

Soil erosion on tea land is generally considered to be more severe than with the other two major plantation crops of rubber and coconut, because of the steep topography of tea plantations and the methods of crop and soil management practiced.

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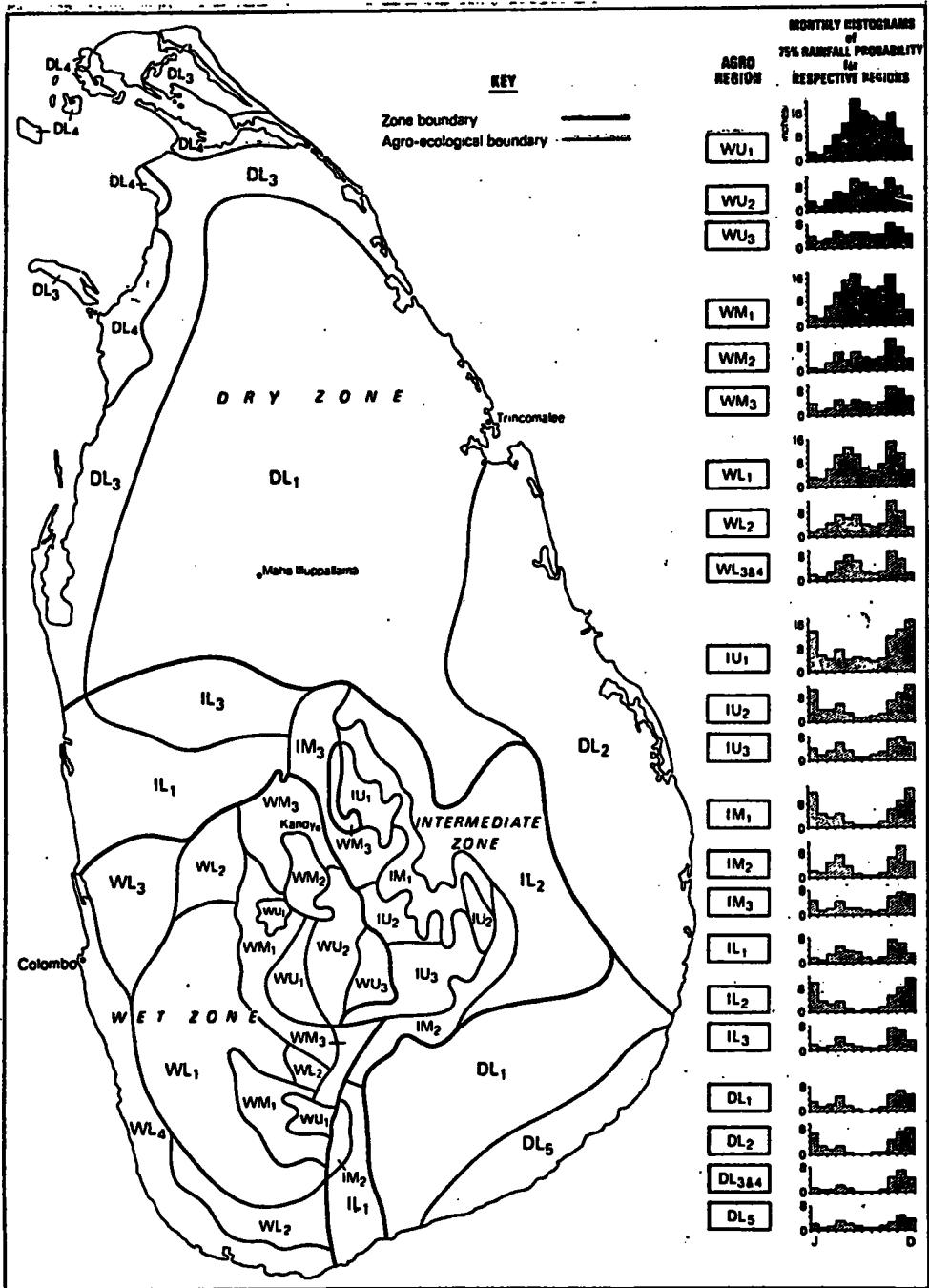


Fig. 1 — Agro-Ecological regions of Sri Lanka

Recent observations estimate that as much as 30 cm of topsoil has been lost from upland areas over the last century, since tea was introduced into this area¹. This would translate into an average soil loss of 40 mt/ha/yr. Clearly, tea plantations over the years have contributed heavily to serious erosion problems, although other types of land use have also contributed.

Nearly 80% of the total area under tea in Sri Lanka is planted in seedling tea (tea grown from seeds). The older system of planting tea was mostly up and down the slope. Due to genetic variability, bushes established as seedling tea do not show uniform growth, and where crop canopy is poor, the spaces between the rows become channels for surface runoff. The practice of clean weeding with 'scrapers' further aggravates the problem, because it not only exposes much of the soil surface, but also leaves behind a layer of loose soil which is easily washed away by runoff water. In most seedling tea fields, there are either no lateral drains at all, or, if these are present, they are constructed on slopes ranging from 1 in 7 to 1 in 30 (14%–3.5%). These are designed more to carry water away than to conserve soil. If leader drains are built, they are not planted with low vegetation or stone paved, and are often transformed into ravines and gullies where much soil washes away from the side walls, exposing the tea roots. Vacant patches are common in seedling tea fields, due to the death of tea bushes from old age, drought, pests or disease. Very often, vacant patches are not planted with new tea seedlings or with any other vegetation. Hence, they are subject to the action of rain, and soil loss can be severe. In the mid-country and up-country regions, about 43,000 ha of old tea plantations appear to have suffered serious soil degradation.

Tea is mainly grown on Ultisols, which tend to occur in higher rainfall areas. These soils are found both down near the coast and in the highly dissected uplands. They are relatively stable, with erodibility or K values of 0.07 and 0.09 for the mid-country and up country Ultisols, respectively². Studies on the effect of rainfall on erosion indicate that the intensity of precipitation decreases with increasing altitude (Table 1). However, severe soil erosion is observed in upland areas in spite of the relatively low soil erodibility, and the low erosivity of the rainfall. This is due to the long, steep slopes, and poor crop and land management.

TABLE 1—Mean annual rainfall, erosivity and elevation for selected tea growing areas in Sri Lanka

Station	Mean annual rainfall (mm)	Erosive rain (% rainfall > 25 mm/hr)	Elevation meters	Mean annual erosivity KE > 1 ft. tons/acre
Galle	2275	62	21	561 × 10 ²
Ratnapura	3200	56	40	706 × 10 ²
Katugastota	1975	47	457	361 × 10 ²
Badulla	1825	27	677	195 × 10 ²
Watawala	4000	33	994	513 × 10 ²
Nuwara eliya	1725	4	1881	27 × 10 ²

SOIL EROSION CONTROL MEASURES ON TEA LAND

The soil erosion that occurs under given conditions is influenced, not only by the soil and rainfall characteristics, but also by the management the land receives. When crops such as tea are grown on a plantation scale, erosion is inversely proportional to the level of management. With good management and the adoption of erosion control practices, erosion can be brought to a minimum and within the tolerance limit. However, problems arise when high standards of management are not maintained, as in the case of old seedling tea plantations, and in particular, the mid-country small holdings.

Cover Crops and Mulches

The effectiveness of cover crops in reducing soil erosion in old seedling tea has been well demonstrated and was recommended in the past. However, this practice is not now very popular in tea plantations. Instead, selective weeding is often practiced to encourage the growth of certain indigenous weed species not likely to compete with tea, which serve as useful ground cover. Weed species commonly recommended for this purpose are *Drymaria cordata*, *Oxalis corymbosa*, *O. latifolia* and *O. corniculata*⁵. The disadvantage of clean weeding using mechanical implements has already been mentioned, and should be avoided completely. The use of chemicals for weed control in tea plantation would clearly be desirable, in terms of minimizing soil erosion. Mulching with grass cuttings *Tripsacum laxum*, at the rate of 25 mt/ha (fresh), has proved to be very effective in minimizing soil erosion⁶. This type of mulching with grass almost completely eliminated surface runoff and soil loss.

When vacancies occur in the field, the bare patches should be planted with grasses such as *Tripsacum laxum*, *Eragrostis curvula* or *Cymbopogon confertiflorus*. The soil renovation brought about by these grasses will help in establishing the new seedlings to be planted.

Certain cultural practices, such as the addition of organic matter, and deep cultivation of the soil to break up any compact layers, generally help maintain the soil in a porous condition, and thereby increase the water intake capacity of the soil.

Contour Drains

The most effective and economical mechanical conservation measure is the contour 'lock and spill' type lateral drain. This is connected to a leader drain, designed to carry away excess water. The distances between lateral drains depends on the steepness of the land. Table 2 gives a detailed guide to the proper spacing of drains, worked out in an empirical study conducted in the Kotmale Revenue Division by the Soil Conservation Division of the Department of Agriculture, Sri Lanka.

TABLE 2—A guide to spacing of mechanical conservation measures for different slope gradients

Slope of land (as %)	Recommended spacing between two consecutive mechanical conservation measures (in m)	Total length of measures required on a uniform slope (in m/ha)
0—10	15	646
11—20	12	795
21—30	9	1044
31—40	6	1665

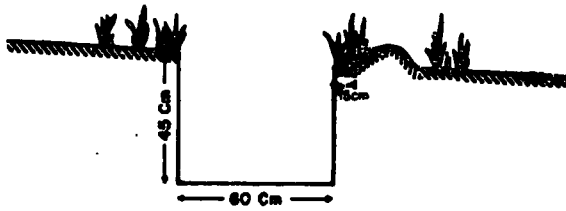
The excavated 'lock and spill' type of drain should have a minimum width of 60 cm and a depth of 45 cm. The soil excavated from the drain should be heaped on the lower edge of the drain to form a small bund, leaving a 15 cm berm between the bund and the edge of the drain. To consolidate the upper and lower lip of the drain, a suitable grass species, such as *Paspalum dilatatum* or *Eragrostis curvula*, should be planted. When the drain is first excavated, spill blocks 30 cm × 30 cm should be left uncut at 3-4 m intervals, (Fig. 2). It is recommended that the drains be constructed along the contour, but if a gradient is required it should be no more than 1 in 120.

It has been estimated that, if silt accumulates to a depth of 15 cm in a lock and spill type lateral drain 45 cm wide, this would amount to 124 mt/ha. This indicates the importance of clearing the lateral drains regularly, and spreading the soil on the land above the drain.

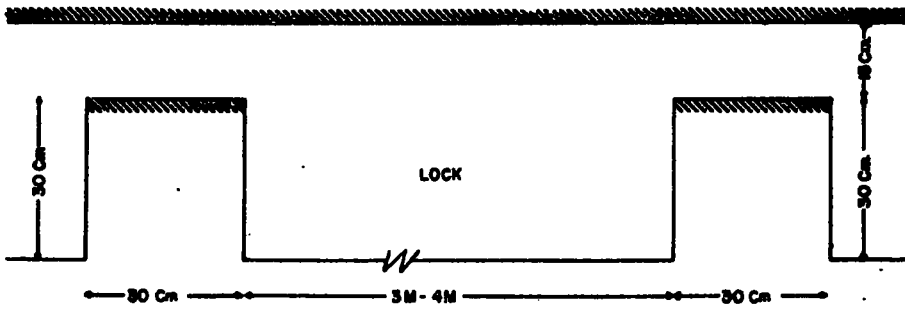
Controlling Erosion During Replanting

Many tea plantations are now carrying out the large-scale replacement of old seedling tea bushes with high yielding vegetatively propagated tea (V. P. tea or clonal tea). Until the new bushes are well established and have grown to form a good cover, much of the soil is exposed to raindrop action, leading to considerable loss of fertility from erosion. Hasselo and Sikurajapathy³ have estimated soil losses of 250 mt/ha over a replanting period of four years.

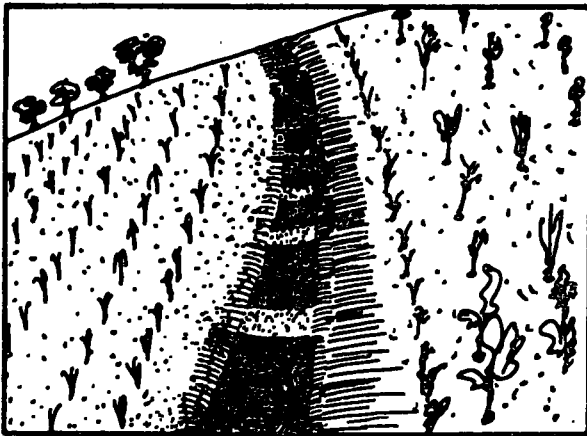
The main method that has been suggested for maintaining an effective soil cover during the replanting period, after the old seedling tea bushes are uprooted, are mulching with cuttings of Gautemala grass (*Tripsacum laxum*) or Mana grass (*Cymbopogon confertiflorus*). At present, mulching is carried out, either by growing Gautemala or Mana grass *in situ* prior to replanting and leaving the grass residues on the soil surface, or by mulching after replanting with grass grown elsewhere. Manipura, Somaratne and Jayasooriya⁴ have shown that during the month of April, when high intensity intermonsoon rains occurred, soil losses in bare clean weeded plots were 40 mt/ha, compared with only 0.07 mt/ha in a mulched plot. Mulching also resulted in a marked reduction in surface runoff.



GROSS SECTION



SECTION ALONG THE DRAIN



LOCK AND SPILL DRAIN

Fig. — 2 The lock and spill type lateral drain

Once high yielding, V. P. tea bushes are well established, planted along the contour using some of the agronomic and mechanical conservation practices mentioned above, these give sufficient cover and protection to the soil. This is confirmed by the soil erosion studies undertaken in a 5000 ha watershed research project in the mid-country wet zone of Sri Lanka.

SOIL EROSION STUDIES ON WELL MANAGED VEGETATIVELY PROPAGATED TEA (V. P. TEA OR CLONAL TEA)

Three macro-scale plots of half a hectare each were selected on the Giragama tea estate, situated in the mid-country wet zone of Sri Lanka. These plots are located in a watershed research project, as mentioned above. The plots were already planted in established V. P. tea, planted along the contour, with 'lock and spill' type contour lateral drains which in turn connected to a leader drain. The slope of the land is in the range of 30-40%. The plots were isolated by earth bunds 45 cm high along the plot boundaries. The soil in the plots was classified as a Reddish Brown Latosol, which belongs to the great group of the order Ultisol in the U. S. Soil Taxonomy.

The runoff from each plot was led along the leader drain, through a paved approach channel fitted with a 30 cm H-flume, to a series of collection tanks. This system of tanks was capable of collecting runoff water from a maximum continuous rainfall of 25 mm/ha, sustained for 20 min, and with 100% runoff (Fig. 3).

Runoff water flows into the first tank, which is divided into two by a brick wall. This wall acts as a baffle to prevent any turbulence from entering the next tank. Overflow from the first tank is led into the second through a multislot device, consisting of ten 90 cm pipes built into the tank wall at the same level, only one of which is connected to the second tank. Thus, only one tenth of the water leaving the first tank is collected into the second. Similarly, the second tank has nine outlet pipes and is connected to the third tank with single 45 cm pipe. Each tank has a separate drainage outlet.

Runoff was measured by taking the height of the water level in each tank and correcting for rainfall. Three water samples of 250 ml, including sediment, were taken from each tank after the water was thoroughly mixed to obtain a uniform solution. Soil loss was calculated by evaporating these samples at a temperature of 105°C.

RESULTS

This experiment was initiated in 1979, and the results over a period of nearly four years, from January 1980 to September 1983, are given in Table 3.

The data indicates that during the period of study, the maximum soil loss measured during any one year was only 330 kg/ha, well below the tolerance limit of 9 mt/ha⁷. However, no measurements were taken in the lateral lock and spill drains, from which the silt was taken during the period of study and put back on the land. The runoff was also minimal, on average less than 1%.

COLLECTING TANK SYSTEM FOR HALF HECTARE RUN-OFF PLOTS

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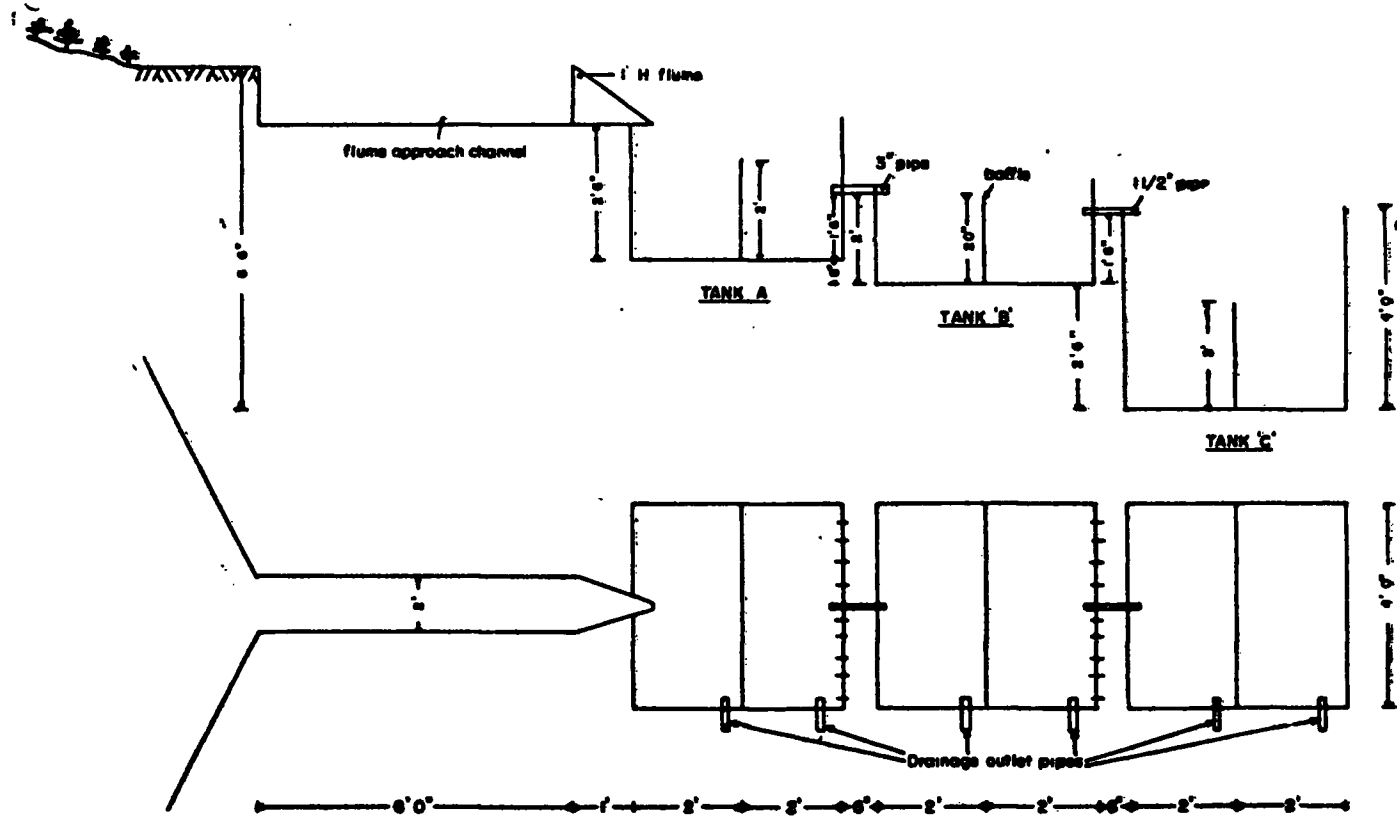


Fig. 3 — Collecting tank system for half hectare run-off plots

TABLE 3—Soil loss and runoff from half hectare well managed V. P. tea plots

Month	1980				1981				1982				1983			
	Rainfall in mm	Runoff in mm	% runoff	Soil loss in kg/ha	Rainfall in mm	Runoff in mm	% runoff	Soil loss in kg/ha	Rainfall in mm	Runoff in mm	% runoff	Soil loss in kg/ha	Rainfall in mm	Runoff in mm	% runoff	Soil loss in kg/ha
January	3.5	—	—	—	56.5	0.17	0.30	1.27	0.0	—	—	—	4.5	—	—	—
February	0.5	—	—	—	6.0	—	—	—	0.0	—	—	—	4.0	—	—	—
March	82.0	0.25	0.3	8.19	157.5	0.36	0.23	7.92	95.5	0.2	0.21	3.13	20.0	0.04	0.19	1.75
April	205.0	1.05	0.5	42.09	136.1	0.71	0.52	3.04	262.5	1.43	0.54	17.12	77.0	0.26	0.33	22.18
May	124.0	0.46	0.37	11.14	60.0	—	—	0.65	378.0	2.98	0.79	11.19	158.5	1.70	1.07	37.79
June	170.5	0.34	0.2	8.46	240.5	—	—	2.53	306.5	1.53	0.50	3.52	167.0	1.54	0.92	19.15
July	155.0	0.57	0.37	11.41	283.0	1.78	0.63	2.30	245.0	1.31	0.53	2.22	106.0	0.40	0.38	11.44
August	149.0	—	—	9.66	116.0	0.45	0.39	1.51	101.5	0.26	0.26	—	198.5	0.80	0.40	19.12
September	169.9	0.24	0.14	15.83	410.0	2.9	0.71	1.78	17.0	—	—	—	65.9	—	—	—
October	295.5	1.03	0.35	121.41	122.0	0.10	0.08	—	253.5	0.98	0.38	3.70	—	—	—	—
November	310.5	2.27	0.73	95.63	352.0	1.71	0.49	3.95	279.0	1.77	0.63	3.96	—	—	—	—
December	107.5	0.45	0.42	6.23	49.0	0.08	0.16	—	195.0	0.94	0.48	1.98	—	—	—	—
Total	1772.9	6.66	0.38	330.05	1988.6	8.26	0.42	24.95	2133.5	11.40	0.53	46.82	801.4	4.74	0.59	111.43

A similar experiment was conducted on a poorly managed seedling tea plantation, which had vacant patches and had been clean weeded, for a period of six months. The experiment was abandoned at the end of six months, as the land use was changed by the landowner. During this short time, the poorly managed seedling tea plantation on comparable slopes in the same location recorded a soil loss of 20 mt/ha.

CONCLUSIONS

High yielding V. P. (clonal) tea production under high standards of managements, even on steep slopes, can provide sound protection measures for land in heavy rainfall areas, as well as supplying a crop of major economic importance to Sri Lanka. The 'lock and spill' type contour lateral drains, together with agronomic conservation measures such as mulching, have proved to be good examples of manipulating topography and management in such a way as to significantly reduce soil erosion on hilly terrain, even on upland with long, steep slopes. Good land management, and good maintenance of the 'lock and spill' drains, are essential components of a successful low-cost management system.

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