Importance of Soil and Water Conservation in Sustainable Land Management

Ministry of Environment &
Healthy Landscapes Project

2024

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1. INTRODUCTION

Sri Lanka's dry zone covers approximately 75% of the country's total land area and is characterized by relatively low rainfall and high temperatures. Although the land in this region is flat in nature, various researches have confirmed that soil erosion or soil washing is higher than we expect due to high rainfall intensity and the nature of the soil. Furthermore, as this region faces a long dry season of the year, the high risk of water shortage for the needs including crop cultivation has been observed. Therefore, soil and water conservation play a very important role in sustainable land management in this region.

Soil erosion is a major problem in this region, primarily caused by water (rain). This is often caused by heavy rains falling on exposed land especially during the *"Maha"* season. Due to this, soil nutrients are also washed away with the soil, the fertility of the soil decreases and the land becomes degraded and leads to decreased crop yield. Further, eroded soils are washed away and deposited in reservoirs and other water sources, resulting in the collapse of eco-systems and the reduction of water holding capacity required for agricultural activities and other needs.

As most of the people in the dry zone depend on rain-fed agriculture for their livelihood, water scarcity is a serious problem they face. Changes in rainfall patterns and rising temperatures due to climate change are leading to frequent and severe drought conditions, which the community is currently experiencing. In addition, there is a risk of depleting the underground aquifer in some places due to the over use of groundwater for irrigation and the water in some of those wells are being subjected to salinization.

Therefore, this booklet has been prepared in simple manner with the aim of increasing the knowledge and make aware on soil and water conservation especially among the rural farming community, thereby popularizing the use of these activities in sustainable land management. Further, this provides an understanding of soil erosion and gives guidance on soil and water conservation to officials of relevant stakeholder institutions and other segments of the society including school children.

2. IMPORTANCE OF SOIL AND WATER CONSERVATION IN THE MANAGEMENT OF LANDS IN CASCADE SYSTEMS

Considering the present management of cascade systems and associated croplands, it has been observed that they are often not managed sustainably. This can be attributed to various reasons, especially lack of awareness, lack of necessary inputs, lack of capital, problems of land ownership/tenure and economic difficulties arising from failure to achieve desired production targets and other environmental and social factors.

Especially the high lands (areas previously used as "*chena*") and the "gangoda" where the home gardens are located, and the tank catchment are often subjected to soil erosion due to the nature of the current use. Soil erosion in paddy lands are minimum due to bunds of paddy lands but there is certain amount of soil washed away when flooding and draining water after harrowing. Soil erosion is relatively less in areas with more forest cover and scrub areas where the land is well covered. This is best confirmed when considering the results obtained in a study conducted in the year 2022 in Palugaswewa cascade system[1]. The results are shown in Table 1. Thus, it is observed that in sub watersheds, the soil erosion is more in land uses that can lead to soil erosion or areas with less land cover. Further, last two rows of the table indicate that adaptation of soil conservation practices reduce soil erosion significantly. Therefore, soil and water conservation is very important in the lands associated with cascade systems as well as other cultivated lands.

[1] P. Kowshayini, H.B. Nayakekorala, S. Pathmarajah (2022). Greater Reduction of Soil Erosion Rates after the Introduction of Simple Conservation Measures to a Small Tank Cascade System in Palugaswewa, Sri Lanka. Proceedings of the International Research Conference of the SLTC Research University, Sri Lanka.

Table 1. Soil erosion in sub-watersheds of Palugaswewa cascade and reduction of soil erosion after introduction of conservation measures (Source: Kowshayini et.al. 2022).

	Land use (%) and sub watersheds used for the study					
	Alapath wewa	David Wewa	Yakadagas Wewa	Kudalugas Wewa	Udakadawala Wewa	Maha Wewa
Scrub forest	5.10	13.64	10.06	18.88	13.33	4.97
Forest	44.30	41.84	47.58	49.16	32.64	78.35
Paddy	--	--	2.34	--	30.19	5.66
Open Forest	--	41.0	8.10	31.96	2.32	--
Forest Plantation	22.60	3.54	1.43	--	--	--
Home Gardens	11.50	--	9.19	--	13.84	2.46
Chena lands	16.50	--	21.3	--	7.68	8.56
Soil erosion under present situation (Number of tons of soil eroded per hectare per year)	44.30	30.0	39.9	23.1	27.4	18.8
Soil erosion after introducing soil conservation measures (t/ha/yr.)	14.50	9.6	14.5	8.9	10.5	10.7
Percentage reduction	67.3	68.0	63.7	61.5	61.7	43.1

3. **SOIL EROSION**

Soil erosion is mainly caused by water (rain), wind and, in some temperate countries, melting of ice caps (glaciers). But in Sri Lanka, the soil erosion is often caused by rain. According to the Global Assessment of Soil Degradation due to human activities (GLASOD), the land area affected by wind erosion in Sri Lanka is zero. However, the area under erosion caused by rain is shown in Table 2 below.

Table 2. Area of land affected by soil erosion caused by rain water at different levels in Sri Lanka according to global assessment (Source: GLASOD).

Less (ha)	Moderate (ha)	Severe (ha)	Total (ha)	Total as a percentage of land area
72,000	157,000	845,000	1,074,000	46%

Therefore, this booklet is mainly considered the soil erosion caused by rain. Soil erosion is influenced by erosivity of the rain as well as the erodibility of the soil. While some soils are somewhat resistant to erosion, such soils are relatively less erosive. Soil erosion caused by water can be further classified according to its effect on the soil. They are; (1) the removal of soil as a thin layer or it is called sheet erosion which is the initial stage of the erosion, (2) The second stage is soil erosion as fine shallow ditches which is called rill erosion, (3) Washing away the soil in the form of large deep trenches or gullies, and (4) slipping of soil or landslides and river bank erosion. Classification and identification of such damage will help in choosing more effective soil conservation methods. For example, while increasing land cover is effective in reducing sheet erosion, it is not sufficient for gully erosion, which requires stronger conservation structures as well as land restoration.

Also, understanding the process of soil erosion is of great help in reducing that process. Therefore, the process of soil erosion is simply described in this section.

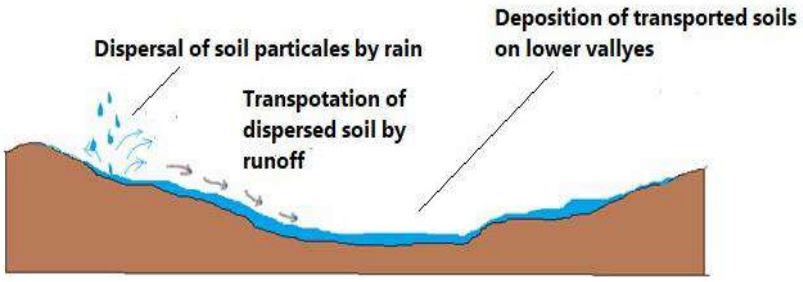
The process of soil erosion can be divided into three distinct stages. They are;

a) Detachment of soil particles by rain

b) Transportation of detached soil particles and

c) Deposition of transported soils in lower valleys.

Dispersal of soil particles during heavy rains.



Explain the process of soil erosion with a diagram of a profile of a land.

Considering the above three stages, if the first and second stages can be prevented or reduced, the third stage will also be reduced accordingly. Therefore, in soil conservation, strategies and activities have been developed with the aim of reducing the dispersal of soil particles by rain, and to minimize the transporting of such separated soil particles by water.

Furthermore, in addition to the soil erosion that occurs in the agricultural lands where cultivation is carried out, the soil is also washed away in the areas outside the agricultural lands (such as stream banks erosion, soil erosion of the tank catchments), and hence some strategies should be implemented to reduce it. As they are common lands, it requires collective action under the guidance of farmers' organizations.

4. METHODS OF SOIL AND WATER CONSERVATION

As far as soil and water conservation strategies are concerned, these are mainly designed to reduce the first two stages of the soil erosion process. Accordingly, various methods are used to reduce the dispersion of soil particles and the transportation of these dispersed soil particles with water. These on farm methods that can be followed are mainly of three types. They are;

a) Mechanical Methods
b) Biological Methods
c) Agronomic Methods

Conservation methods that can be applied off-farm can be identified as ditches, check dams, and stream bank conservation methods.

The ancient farmers traditionally took measures to reduce soil erosion by cutting ditches, by placing tree trunks across the slope etc., but nowadays these methods have been improved scientifically based on research data and specifications have also been introduced for them. Therefore, while soil erosion can be reduced more efficiently, the opportunity has also arisen to utilize the space for crop cultivation optimally. Accordingly, the Department of Agriculture has introduced specifications for mechanical conservation methods especially according to the slope of the cultivated land (Table 3).

Table 3. Department of Agriculture Recommended Intervals of Conservation Methods and Appropriate Conservation Methods to Use (Source: Soil and Water Conservation Manual 2014, Department of Agriculture).

Slope (%)	Interval between soil conservation structures (m)	Suitable conservation measures
Less than 10%	18	Soil bunds, Lock & spill drains, Terraces
10% - 20%	15-18	Soil bunds, Lock & spill drains, Terraces
20% - 30%	12-15	Lock & spill drains, Terraces, Stone bunds
30% - 40%	9-12	Lock & spill drains, Terraces, Stone bunds
40% - 50%	6-9	Terraces, Stone bunds , Single platforms
50% - 60%	4.5 -6	Stone bunds , Single platforms, contour platforms
More than 60%	Mechanical measures are not used	

Below are the various methods that can be used under the three methods mentioned above. If further instructions are required for the use of these methods, it is possible to get them from the Provincial Department of Agriculture and Coconut and Export Agricultural Crops Extension Officers. Further, training programs on soil conservation methods are also implemented by those departments, so it is possible to get practical training on this.

a) Mechanical methods

- Soil bunds
- Lock & Spill drains
- Stone bunds
- Terraces
- Contour platforms
- Single platforms

b) Biological methods

- Live Hedges
- Cover crops
- Use of mulches

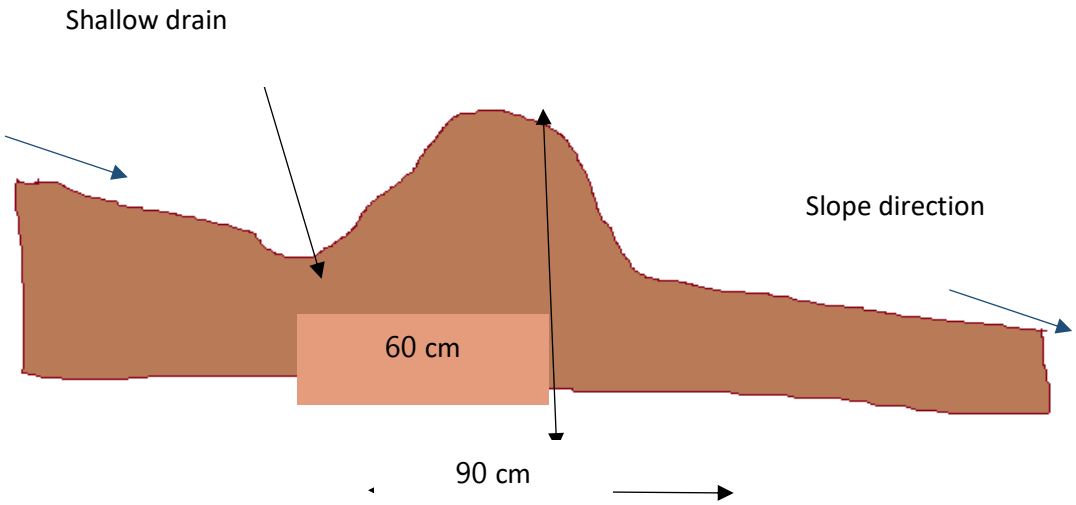
c) Agronomic Methods

- Contour planting
- Minimum tillage
- Selective weeding
- Use of organic manure and appropriate fertilization
- Establishing of forests or planting of permanent crops

Soil Bunds

This method is best suited for dry areas with low soil moisture. Also this method is suitable for the lands with less slope. Accordingly, this method is the most suitable method for the cultivation of highlands of cascade systems. Thus, by establishing an earth bund across the slope on the land according to the contour lines, the length of the slope decreases, so the speed of surface water flow decreases during the rain. Further, the silt is not washed away by these soil bunds and accumulates in the cultivated land itself.

The success of this system depends only on the proper maintenance of these soil bunds, so it is necessary to ensure that the surface of the soil bund is not washed away by growing grass on it and that animals such as cattle do not damage the soil bund during non-cultivation period.



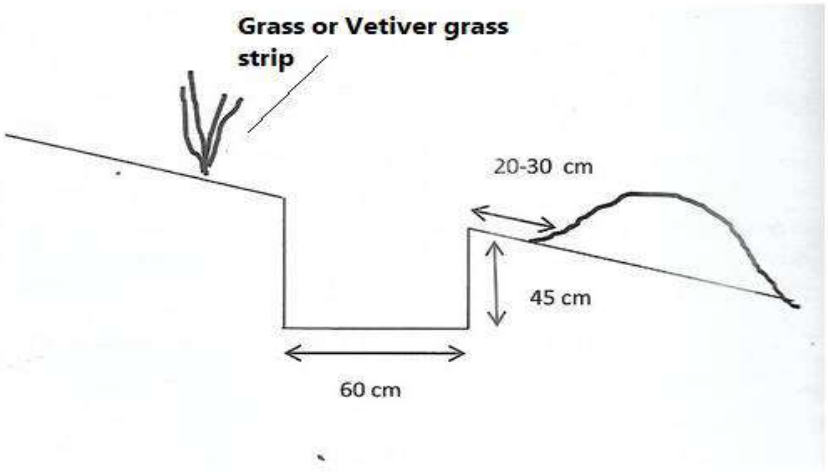
Cross section of a soil bund

Soil bund established in Maize cultivated land

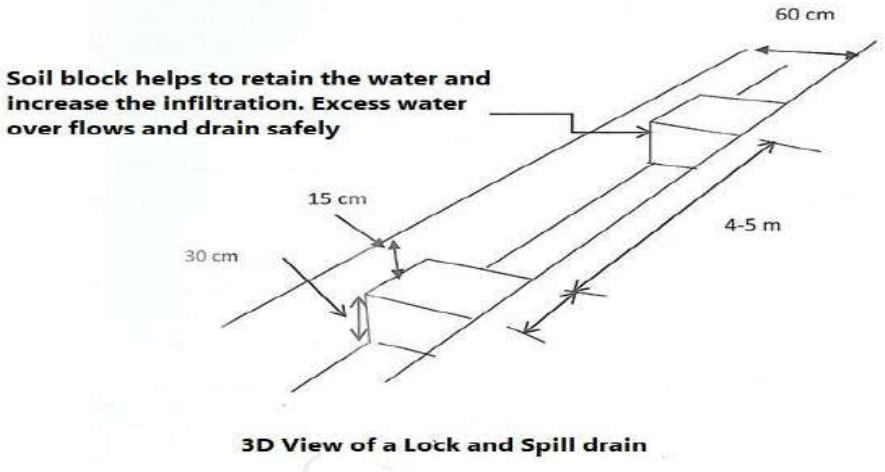
Lock and Spill Drains

Here, drains are cut across the slope, and the drain is not cut continuously, leaving earth blocks in places. (See the figure below). It allows more rainwater to percolate into the

soil, reducing runoff with the soil. Also, the distance and speed of rainwater runoff is reduced. This method is most suitable for moderately sloping land, less suitable for landslide prone areas and very dry lands.



Dimensions of Lock and Spill drain

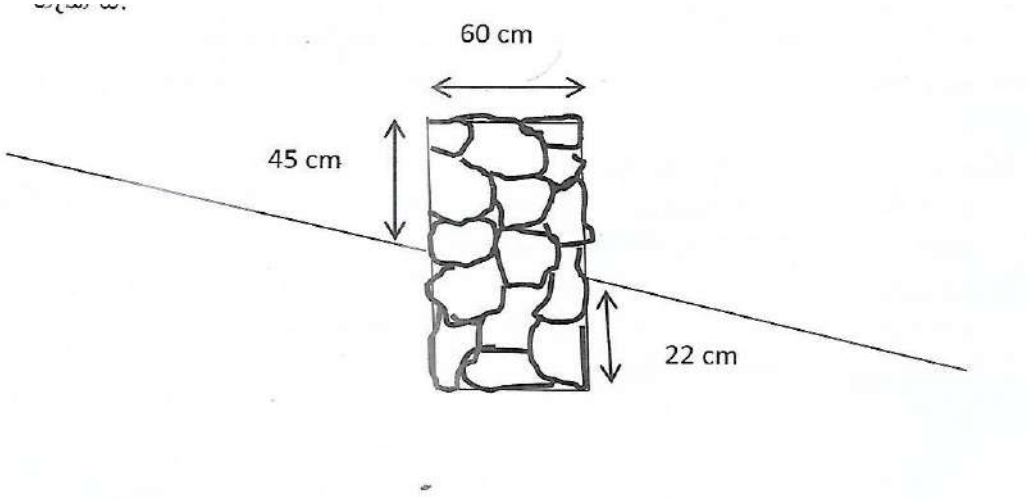


3D View of a Lock and Spill drain

Lock and Spill drain on cultivated land (Source: SriCAT)

Stone Bunds

A method that can be applied to land where stones are abundant. Reduces surface runoff distance and runoff speed. Suitable for steeper land. Can be applied to short term crops, fruit crops, export crops and plantation crops. Here too, stone bunds should be properly maintained. Poorly maintained conservation systems (especially soil and rock bunds) are more likely to cause damage to the land when they break during rains than land that are not conserved. Therefore, maintenance of these structures is crucial.



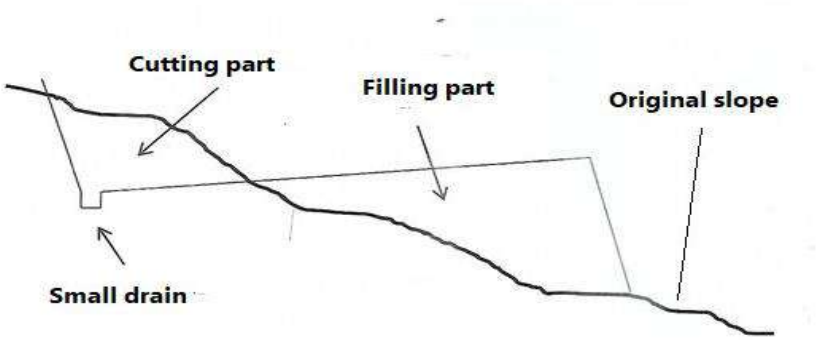
Cross section of a stone bund

Terraces

The terraces reduce the speed and distance of surface runoff and allow more water to infiltrate into the soil. Furthermore, the creation of a platform for crop cultivation makes crop management easier.

It is suitable for sloping land and can be used for cultivation of crops such as potatoes and vegetables.

Here, the slope is cut and fill the outer slope is filled with that cut soil to form a platform, so the width of the platform is determined by the depth of the soil and the angle of the slope.



Cross section of a terrace with its original slope

Contour platform and Single platform

Contour platforms are suitable for moderately or steeply sloping land. Reduces the speed and distance of runoff. Suitable for plantation crops.

Individual platforms can be set up in lands where contour platforms are difficult to build due to steeper slopes and rocks.

Live Hedges

Here, leguminous plants like *Gliricidia* are planted along the contours in two rows in a zig-zag pattern across the slope of the land. Reducing the speed and distance of surface

runoff by soil bund is also done by this live hedges. In addition, providing green manure, being able to obtain firewood, and fixing of atmospheric nitrogen are additional advantages. In the dry zone, the application of Sloping Agricultural Land Technology (SALT) as a single row instead of the double system has been tried.

The hedge rows can be formed by using about 75 cm tall moderately matured Gliricidia (*Gliricidia sepium*) stems. Instead of Gliricidia, Pawatta (*Justicia adhatoda*), Flemingia etc. can be used as hedgerows.

Live hedges established field

Gliricidia grown as Single rows

Cover Crops

Soil dispersion by rain water will be reduced by cover crops. Mostly, cover crops are used in plantation crops. In addition to covering the soil, nitrogen is also supplied to the soil by leguminous cover crops.

Cover crops used in rubber plantation (Photo from the internet)

Mulching

Here too rain water is prevented from hitting the ground directly. Straw, grass and leaf litter can be used as mulch. Nowadays, the use of polythene film as mulch is popular. Mulch also suppresses the weeds. Also, mulching conserves soil moisture while maintaining soil temperature at optimum levels.

A farmer in Palugaswewa DS Division used straw a mulch in his chili cultivation.

Among agronomic practices such as contour planting, minimum tillage, selective weeding, use of organic fertilizers, afforestation or permanent cropping, contour planting reduces the surface runoff. Other methods increase the soil cover. The use of organic fertilizers and proper application of fertilizers will result in proper coverage of the crop. In addition, organic fertilizers increase the cohesion of soil particles and increase the absorption of rainwater into the soil.

5. Water Conservation

Soil conservation and water conservation are two interrelated processes. Here, water conservation implies the maintain of the soil moisture at optimum level for crop cultivation. Most of soil conservation activities also helps to conserve the soil moisture.

For example, the use of mulch minimize the soil erosion while also protecting the moisture in the soil. Therefore, those methods will not be described here again.

Conservation of visible water is important as soil moisture conservation. In this case, attention should be paid to the efficient use of irrigation water and to avoid situations where the water is wasted. Methods that can be used to conserve irrigation water.

- Use of mulches minimizes loss of soil moisture through evaporation
- Increasing the amount of water absorbed into the soil by increasing the amount of organic matter in the soil and increasing the water holding capacity of the soil.
- Using methods like drip irrigation systems so that the amount of water applied to the crops is not wasted.
- Selection of crops that can withstand drought/low water conditions
- Taking proper measures to prevent wastage of water due to improperly maintained structures of canal dams and tanks.

Soil and water conservation is an essential and very important part of sustainable land management. Therefore, it is very important to develop the knowledge and skills of the farmers on the use of soil and water conservation methods to promote sustainable land management. This booklet is an initial attempt for that, and necessary steps should be taken at the institutional level to promote it further.