Sustainable Land Management in Sri Lanka

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Introduction

On a global scale, an extent of about 1.5 billion ha is utilized as crop lands. Of these 38 % is affected by land degradation processes. It is also known worldwide that about 55% of the gross value of food is still produced under rain-fed agriculture. Cropland in dry rain-fed areas is used primarily by smallholder farmers to cultivate field and cash crops. Total irrigated cropland worldwide is 252 m ha. This is 17% of the total crop lands. About 20 % of the irrigated crop lands are affected by salinity . It is widely accepted that land degradation is one of the most critical problems affecting the future economic development in Sri Lanka. The demands of a rapidly expanding population has created pressure on the island's natural resources, and these in turn have resulted in a high level of environmental deterioration. The more important manifestations are: heavy soil losses; high sediment yields; soil fertility decline and reduction in crop yields; marginalization of agricultural land; salinization; landslides and deforestation and forest degradation. Severe erosion takes place in the hill country on sloping lands under market gardens (vegetables and potatoes), tobacco, poorly managed seedling tea and chena cultivation.

Conservation of soil resources is now defined as sustainable land management, which includes the processes defined by various organizations such as United Nations, World Bank, WOCAT (World Overview of Conservation Approaches and Technologies) etc. Most widely used definition at present is that of WOCAT, which defines it as 'the use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions.

Indigenous Sustainable Land Management Practices in Sri Lanka

In indigenous agriculture, farming was practiced both under rain-fed and irrigated conditions. Soil management involved mainly two activities, namely, tillage and soil conservation. Soil conservation was meant for erosion control and maintenance of soil fertility. Similar to present scenario, the purpose of soil management was to achieve sustainable production, improved soil fertility, weed control and soil moisture retention. However, different strategies were adopted for different farming situations that existed in different regions of Sri

Table 1 : Crops grown in different chena types

Type of Chena	Soil fertility level	Crops
Virgin chena from dense forest	Very fertile	Mustard, legume, vegetable
Chena from secondary vegetation	Fertile	Legume, vegetable, coarse grain
Chena abandoned for few years	Moderately fertile	Coarse grain, sesame
Chena continued for few years	Less fertile	Sesame,
Upland paddy chena	Imperfectly drained soils	Rice, vegetable

Lanka.

Indigenous agriculture was based on more realistic principles. People observed the natural phenomena operating around them, and studied how it could be manipulated for their needs. They observed the state of the natural forests, its anatomy, association of different species for coexistence, regeneration after fire, spatial variations etc. The farming systems which included chena, paddy and home garden cultivation evolved with interaction of man with the environment, and developed in harmony with natural ecosystems . Their experiences and observations on rainfall pattern, wind, temperature, humidity and soil behaviour have been used to adjust their cultivation activities. When they realized that some of the tragedies they faced in farming were due to reasons beyond their control, they sought the devine support of the religion, as well as the spiritual and cosmic influences. The most important fact was that they realized that without primarily giving due respect to the resources being used for farming, they could not expect the sustainability of their food sources.

Tillage was practiced to make the soil surface weed free and smooth for seed germination or for the plant growth. In rice cultivation in lowlands, the land was prepared by a set of operations. It included repairing earth ridges (dykes) meant to store water, irrigate to create stagnant water for about two weeks, facilitate first ploughing in stagnant water as well as second ploughing to convert soil clogs to syrupy mud, draining water from the smoothened and level land, and finally the sowing of sprouted seeds. Tillage was done by a buffalo drawn shallow plough. This tillage operation could lead to the formation of a hard pan at 4-6 inches depth, and thereby prevent rapid percolation of water along with nutrients. The draining water flow did not cause any soil erosion. The plough blades were different from place to place. In areas where soil was soft, a plough made of wood was used, and where soil was hard, a wooden plough fitted with an iron blade at the cutting edge was used. In boggy soils of the wet zone areas, the plough was replaced by turning over the soil with mammoty (hoe) using manual labour. Special mammoties were used for this purpose. In land preparation of low lands for rice, dykes constructed took a special form. The dykes were plastered with mud so that they were kept weed free for some time and thereby seal off the dyke from water leakage.. Robert Knox (1681) , observed that when dykes are plastered with mud, the weed seeds cannot germinate and pierce through the compacted plastered layer of the soil, thereby keeping the dyke weed free for a longer period of time.

Fig 01 : Terraced lands in paddy cultivation

In indigenous farming crops were selected to suit the fertility level of the soil, which gets depleted with chena cultivation. (Table 1).

When chena cultivation is practiced continuously for a few years, the land tends to get infested with weeds, thus necessitating weeding prior to the preparation the of seed beds. Under such circumstances weeding was done traditionally with minimum tillage techniques. The weeds were scraped with mammoties and left for drying and burnt in the field itself. If the weed mass was low, no burning was done, and the dried weeds were left on the soil surface as a mulch, thereby helping to reduce soil erosion, and conserving the soil moisture in the field.

Indigenous Methods of Erosion Control

Indigenous people in Sri Lanka have paid much attention to arrest soil erosion at different levels. The emphasis was on reducing erosion in channels, streams, and tank bunds, and thereby reducing sedimentation

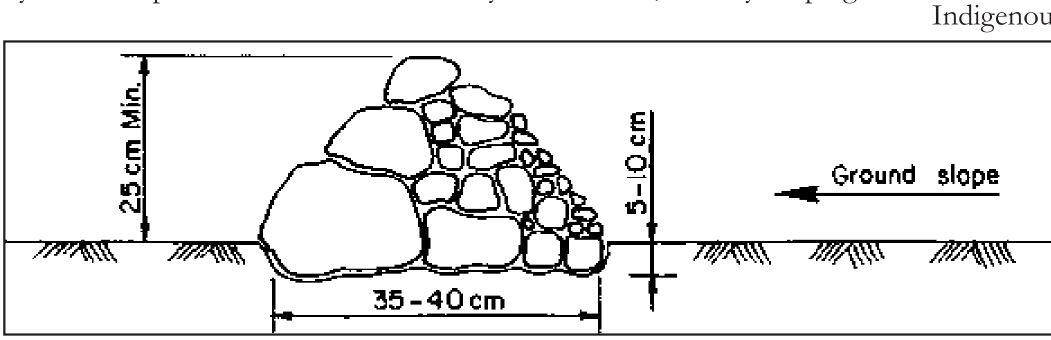

Fig 02 : Cross section of a stone ridge

of reservoirs. Many traditional villages have small tanks, around which the other land uses are organized, such as paddy fields, hamlet, upland cultivation, forest etc. Some of the erosion control and sediment avoiding techniques used in indigenous agriculture are described below .

Bench terrace (liyadda)

Soil erosion control has been achieved by terracing the land, especially in rice cultivation. Both highlands and lowlands have been terraced and leveled. Lowland paddy fields in hill slopes of the upcountry areas are good examples of terracing. The level benches help retaining water on the surface. This type of land development was done only in lands, which were used for continuous cultivation. The main land use in the highland was chena cultivation, where lands had been abandoned for regeneration after about 3-4 years of continuous cultivation. During this period, the land would have been subjected to severe soil erosion because of the rough nature of the surface. Further, on sloping chena lands, the farmers used to stack unburnt debris across the slope at regular intervals. The soil was minimally disturbed which helped to reduce soil erosion on these lands.

Soil ridge (niyara)

These are ridges made across the slope of uplands to reduce washing off of the soil from the field, where slopes are very mild. Spacing

Table 2 : Land suitability classes and soil and crop management practices

Land class	Land characteristics and limitations for	Risk for crop losses	Control methods
I	Flat to gently sloping (0-10%), very deep soil (>150 cm), no apparent erosion, suitable for many crops	Very low	Normal control methods are sufficient, general fertility management, tillage, erosion control by soil cover and minimum mechanical methods
II	Gently sloping (10-20%), deep soil (100-150 cm), erosion is apparent, suitable for many crops, not suitable for some crops	Low	Soil conservation measures are required. Crops need to be selected.
III	Sloping lands (20-30%), moderately deep (50-100 cm), moderate erosion, moderate crop losses, only selected crops can be cultivated	Moderate	Effective soil conservation measures are required, crops should be selected carefully, essential to select both conservation measures and crops
IV	Moderately steep lands (30-40%), moderately deep (50-100 cm), severe erosion, crops are limited	High	Very effective soil conservation measures are required, not suitable for continuous cultivation, suitable for carefully selected crops
V	Bottomlands, valleys, flat lands, poorly drained marshy lands, only suitable for paddy, some are not suitable even for paddy	No erosion risk	Not suitable for cultivation of crops other than paddy
VI	Steep lands (40-50%), shallow (25-50 cm), very severe erosion, crops are much limited	High, not suitable for normal cultivation	Suitable only for permanent crops, pasture, forestry and wildlife sanctuary. Any selected crop needs continuous cover and very effective conservation measures
VII	Very steep lands (50-60%), very shallow (<25 cm), very severe erosion with gullying, not suitable for cultivation	Very high	Suitable only for permanent crops, pasture, forestry and wildlife sanctuary. Soil conservation is essential for any open phases.
VIII	Precipitous (>60%), very shallow (< 25 cm) with rock outcrops, very severe erosion with land sliding, not suitable for cultivation	Very high	Suitable only for forestry, wildlife sanctuary and protected forest for recreation.

Strategy 1 : Increase soil cover

Strategic factor	Activities	Benefits
Soil and crop management (Ec.)	• Leave all the crop residues in the field • Conservation tillage that leaves the residues on the soil surface • Apply organic materials as manures or mulch • Adopt inter-cropping and relay cropping • Leave the weed residues on the surface	It will reduce soil erosion, increase the infiltration rate, reduce the water loss through evaporation, reduce the soil temperature, improve seed germination, increase organic matter content in surface soil layer, improve the soil stability, stimulate soil biological activity, increase soil aeration, facilitate biological pest control and suppress weed growth

Strategy 2 : Increase soil organic matter content

Strategic factor	Activities	Benefits
Soil and crop management (Ec.)	• Apply compost • Add green manure • Add liquid fertilizer • Apply straw mulch	It will increase in the stability of surface aggregates, increase the moisture retention capacity of the soil, increase the capacity of the soil to retain nutrients, stimulate the soil biological activity

between niyaras had been decided by experience, based on rainfall, type of crops and the soil. The niyara retained the rainwater falling within two niyaras, preventing surface flow and thus reducing soil erosion. Openings (wakkada) have been kept at regular intervals of the niyara to permit flow of excess water in the event of high rainfall (Fig. 1).

Banks of streams and canals are subjected to erosion due to the scoring or scraping action of flowing water. Such erosion has been traditionally controlled and embankments stabilized using techniques presently known as 'bio-engineering techniques'. Trees/ plants, which tolerate wet or flooded conditions have very extensive root systems. Such plants have been grown along stream banks. Plants such as areca nut (Areca catechu) and vetakeya (Pandanus species) were the common examples. Bamboo is also a plant, which is grown to protect river embankments from river bank erosion. The roots of these plants have floating roots, which reduce the velocity of flowing water, thereby reducing erosion of banks and beds. All the plants used for this purpose have economic value too.

Stone ridges (gal weti) and leader drains (neththi kanu)

Inspection of very old homesteads show that stone ridges have been erected across the sloping lands to prevent soil erosion. These ridges have been constructed with rubble available in the land itself. The rubble has been set together with soil. In construction of these stone ridges, the farmers have stacked larger rubble on the downhill side while smaller ones were stacked on

Strategy 4 : Reduce runoff

Strategic factor	Activities	Benefits
Mechanical measures (LSmax)	• Collect the runoff in structures within which the water can infiltrate • Construct structures that collect and lead the runoff away from the field • Establish permeable barriers along the lines of contour to reduce runoff velocity	It will reduce the losses of soil, water, nutrients, fertilizers and pesticides, increase the moisture available to the crop and consequently grain yield and biomass production.

Strategy 3 : Increase water infiltration and moisture retention capacity

Strategic factor	Activities	Benefits
Soil and crop management (Ec.)	• Maintain a protective cover of residues over the soil • Reduce wind velocity by installing wind breaks • Create surface roughness between the crop rows • Keep fallow periods between cropping. • Apply organic fertilizer	It will reduce crop moisture deficit, increase the yield and production of the crop biomass, and reduce runoff.
Mechanical measures (LSmax)	• Adopt contour ridging • Reduce the land slope by terracing	It will reduce runoff and increase the yield and production of the crop biomass.

Strategy 5 : Improve rooting conditions

Strategic factor	Activities	Benefits
Soil and crop management (Ec.)	• Loosen the soil around plants to reduce compaction and increase porosity • Improve drainage by placing drainage channels where soils are poorly or imperfectly drained • Make furrows or raised beds	It will improve root development and growth, and as a result the crop will absorb more moisture and nutrients, reduce probability that the crops will suffer from drought.

uphill side (Fig. 2).

The soils washed down the hill get collected in the upper depressions. In later years when the plantation crops such as coffee, tea etc. were introduced, these techniques have been used in those plantations. Even today, there are people in the hill country, who have mastered the construction of such stone ridges. In order to carry water down the slope without subjecting the soil to erosion, farmers have constructed neththi kanu. These are drains made of rubble without using any cement.

Present Soil and Crop Management Practices

In classifying a land for agricultural purposes it is important to identify its suitability and limitations. Land is categorized into eight land classes in Sri Lanka (Table 2).

Table 2. Land suitability classes and soil and crop management practices

Sustainable Land Management Strategies

Universal Soil Loss Equation (USLE) developed in 1978 is still valid and can be used to assess the erosion status and decide the most appropriate soil conservation measures for a given area. The equation was slightly modified to apply for Sri Lanka as follows:
A = RK (LS)max Ec., where,
A = Soil loss (mt/ha), R = Erosivity (mt.m/ha), K = Erodibility
(LS)max = Maximum slope - length factor one can achieve by manipulating land slope and length in a given piece of land, and
Ec = soil and crop management factor termed as Erosion Coefficient.
Mechanical measures can be adopted to reduce LSmax factor, and consequently soil and crop management practices can be adopted to reduce Ec factor.

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