International Soil and Water Conservation Research 4 (2016) 195–198

HOSTED BY

Contents lists available at ScienceDirect

International Soil and Water Conservation Research

journal homepage: www.elsevier.com/locate/iswcr

Original Research Article

Farming methods impact on soil and water conservation efficiency under tea [*Camellia sinensis* (L.)] plantation in Nilgiris of South India

Dhruba Charan Sahoo [a,*], Made Gowda Madhu [a], Sivagnanam Santhana Bosu [b], Om Pal Singh Khola [c]

[a] *Indian Institute of Soil and Water Conservation, Research Center, Sunabeda 763002, Odisha, India*
[b] *Tamil Nadu Agricultural University, Agricultural Engineering College and Research Institute, Coimbatore 641003, Tamil Nadu, India*
[c] *Indian Institute of Soil and Water Conservation, Research Center, Nilgiris 643004, Tamil Nadu, India*

ARTICLE INFO

Article history:
Received 10 November 2015
Received in revised form
14 July 2016
Accepted 21 July 2016
Available online 23 August 2016

Keywords:
Contour staggered trenches
Conservation efficiency
Cover crop
Vegetative barrier

ABSTRACT

Growing of tea on sloping land without any soil and water conservation measures causes enormous soil loss especially in the initial years. For sound soil and water conservation planning, there is a need to evaluate the various conservation measures as related to the amount of expected runoff and soil erosion. In this context, a field study was conducted in the farmer's field in Nilgiris of South India, for evaluating the impact of farming methods on soil and water conservation efficiency under new tea plantation. One year old B-6 tea clones were planted at double hedge spacing (135 cm × 75 cm × 75 cm) in two slopes (8–12% and 30–35%) with treatments *viz.*, contour staggered trenches (CST), vegetative barrier (VB), CST alternate with VB, CST with cover crop of beans and farmers' practice of plantation. Minimum runoff (14.6%) was observed from CST with cover crop of beans followed by CST (15.4%) under 8–12% slope range with exactly similar trend in runoff from the plots under 30–35% slope. Contrary to runoff, minimum soil loss was observed from CST (4.9 and 6.9 t ha^{-1} yr^{-1}) followed by CST with cover crop of beans (5.3 and 7.3 t ha^{-1} yr^{-1}) under 8–12% and 30–35% respectively. Implementation CST and CST with cover crop of beans are resulted in better soil moisture under both the slope ranges in comparison to remaining measures as well as farmers' practice of plantation. Therefore, either CST alone or in combination with cover crop of beans are recommended for soil and water conservation under new tea plantation in the hill slopes.

1. Introduction

Soil and water have always been vital for sustaining life and becoming more limited as population increases. These resources are already under intensive use and misuse. Every year millions of tons of soil are washed away to the rivers and sea by erosion. The swelling population, poor land management, vulnerable soils and hostile climates add up to lethal combination that promote soil erosion bringing with it environmental degradation. Soil erosion is a serious problem and major contributor to the soil loss in the new tea plantation areas, as it is cultivated in the altitude ranging from 500 to 2500 m above mean sea level with slope range of 10–50%. In India, tea is grown over an area of 5780 km^2 mainly under rainfed sloping conditions (Madhu, Sahoo, Sharda, & Sikka, 2010) with annual rainfall varying from 1150 to 6000 mm. In Nilgiris of south India, tea is cultivated in areas having well distributed annual rainfall of about 1200 mm. Growing of tea on sloping land without any soil and water conservation measures causes enormous soil loss especially in the initial years (Madhu, Sikka, Tripathi, Raghupathy, & Singh, 2001). The problem of erosion in new tea plantations in Nilgiris is getting as high as 28–40 t ha^{-1} yr^{-1} over the years in the absence of any vegetative canopy and soil conservation measure (Chinnamani, 1977; Madhu & Tripathi, 1997). Therefore soil loss assessment is a major concern in long run as it affects the yield of green leaves and its sustainability.

Various factors such as rainfall intensity, duration, slope and cultural practices influence the runoff and soil loss behavior in new tea plantation. The farmers' practice of tea plantation, involves uprooting of bushes and shrubs for land preparation and planting the tea clones at desired spacing without following any conservation measures to control runoff and soil erosion. The

* Corresponding author.
E-mail address: dcsahoo@gmail.com (D.C. Sahoo).
Peer review under responsibility of International Research and Training Center on Erosion and Sedimentation and China Water and Power Press.

http://dx.doi.org/10.1016/j.iswcr.2016.07.002
2095-6339/

disturbance of top soil in process of land preparation and plantation leads to considerable soil erosion through accumulated runoff along the slope length. Many tea estates in Darjeeling hills in the North-East India, the Nilgiris and the high range in south India have recurrently suffered from soil erosion problem. In Sri Lanka, Krishnarajah (1985) reported a loss of 20 t of soil per hectare within six months in absence of any earthwork. Soil erosion on sloping field in tea plantation area also leads to a lot of environmental problem. The on-site impacts caused to thin soil layer, deterioration in soil structure and decrease in soil nutrient (Zhang, Zhang, Bu-zhuo, & Yang, 2003). Evidence of soil degradation can be seen in the low soil organic matter content, cation exchange and water-holding capacity, highly acidic pH, high soil compaction, erosion, nutrient leaching, accumulation of xenobiotics and toxic aluminum present under intensive teal plantations (Senapati, Panigrahi, & Lavelle, 1994; Senapati et al., 1999). Therefore, proper planning and implementation of soil and water conservation measures is very much needed in the initial period of plantation. Keeping these in mind, the study was conducted to estimate the conservation efficiency of different farming methods in the initial stages of tea plantation under different slope ranges in Nilgiris of South India.

2. Materials and methods

2.1. Study area

A field study was conducted during 2007–2009 in the farmer's field representing the most common area for tea in Nilgiris district (11° 26′ 40″ N and 76° 45′ 58″ E, 2150 m above mean sea level) of South India. The climate is temperate to sub-tropical with long term mean annual rainfall of 1276 mm with 79.4% occurring during South-West and North-East monsoons. The mean monthly maximum and minimum temperatures are 22.1 °C and 8.5 °C occurring in April and January, respectively with mean annual temperature of 15.0 °C. Mean relative humidity is about 76% most of the time, favoring tea cultivation in the region.

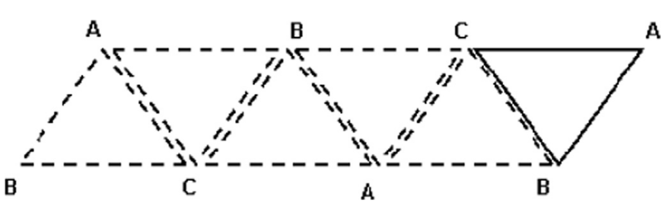

Fig. 1. Triangular frame for double hedge layout.

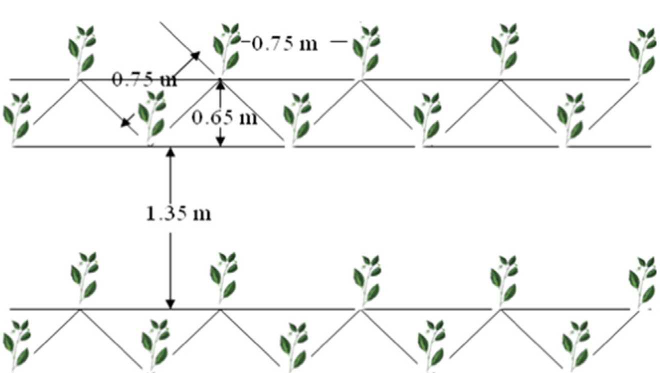

Fig. 2. Layout of tea plantation.

2.2. Layout and plantation

The experiment was laid out in a Randomized Block Design with four replications in 20 plots each on two slopes (8–12% and 30–35%) to accommodate four farming methods and one farmers' practice of cultivation. Double hedge planting (135 cm × 75 cm × 75 cm) along the contour line accommodating 13,200 plants ha^{-1}was followed by using a triangular frame (0.75 m each side) for laying out the double hedge rows and plant spacing (Figs. 1 and 2). One year old B-6 tea clones were planted before the onset of North-East monsoon during the month of September, 2007 in humid climate and moist soil for better establishment of young tea plants.

2.3. Treatment details

Treatments*	Specification
T_1: Contour staggered trenching(CST)	180 × 30 × 45 cm (Length × Width × Depth).
T_2: Vegetative barrier (VB)	Two rows of geranium at P-P and R-R spacing of 30 cm.
T_3: CST alternate with VB	180 × 30 × 45 cm alternate with VB at same spacing.
T_4: CST with cover crop	180 × 30 × 45 cm with beans as a cover crop during monsoon period.
T_5: Control	Farmers practice of cultivation without any conservation measures.

*All the conservation measures are taken in the space between the double hedge rows.

2.4. Runoff, soil loss and soil moisture monitoring

The multi-slot divisors are installed at the down end of the plots for runoff monitoring by measuring the runoff depth collected in each compartment in the stilling tank as well as in the collecting tank (Figs. 3 and 4). The plots were separated to isolate the runoff from the adjacent plots using 60 cm height strips of metal sheet. The soil loss was estimated from runoff sample of 500 ml collected from stilling tank after stirring to determine the soil loss. Events wise runoff and soil loss analysis was made and expressed in mm and t ha^{-1} yr^{-1}, respectively. Soil moisture content was monitored by collecting soil samples using auger at

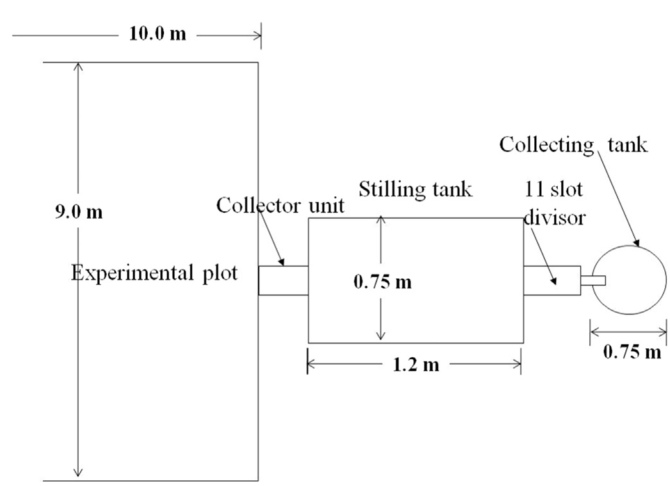

Fig. 3. Plan of experimental plot and runoff collection unit.