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Enrichment planting to prevent the soil erosion in forest catchment of Nilgiri foot hills for biodiversity conservation and to combat the global warming

***Panneer Selvam[1], K., Ezhumalai, R.[2], Sivaprakash[3], M., Thangamani[4], D., Baranitharan[5], K., & Sathyabama[6], B.**

[1&4] Institute of Forest Genetics and Tree Breeding, R.S. Puram, Coimbatore.
[2]Institute of Wood Science and Technology, Malleshwaram, Bangalore.
[3,5&6]Forest College and Research Institute, Metupalayam.

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Abstract

Watershed development plays a major role in conserving water. Watershed management programmes has emerged as an appropriate strategy to manage natural resources (land, water and forests) and to provide sustainable livelihood to the rural poor. Watershed Management steps are predominant to conserve water and reduce the water loss, soil erosion. In forest areas due to heavy pour the soil erosion takes place in gullies and streams which are also leads to more siltation in the check dams and percolation ponds. Hence improving gullies and streams is an important step to control the soil erosion. The enrichment planting of different plant species of binding grasses, checking cactus, creepers, herbs, shrubs, small trees, climbers and anchoring tree species in the splash, sheet and rill eroded sites along the ridges and banks of the streams and gullies. The check dams will also check for the water and increases infiltration of water. These enrichment planting activities will reduce the splash, sheet and rill erosions. The waterholes and ponds also percolate the water up to the sub soil level. Due to these activities the ground water level will be enhanced and the local farming and wildlife will be supported. This watershed programme in the catchment area increases the green cover and if this watershed model is promoted throughout the forest catchments it may enhance the ground water table, the enrichment planting increase the green cover, maintain the balance ecosystem, conservation of biodiversity, mitigate the global warming and enhance the rural livelihoods.

Introduction

Water is the most vital element of all natural resources and it is essential for life. Forest and woodlands have a close relationship with water resources. Sustainable forest management is essential to ensure the supply of water and provide protection from natural hazards such as flooding or soil erosion. Forest watersheds supply a high proportion of the world's accessible fresh water for domestic, agricultural, wildlife and ecological needs in both upstream and downstream areas. The increase in population has created more and more demand for land and water, which are the vital needs for agriculture. On the other hand, replenishment of ground water storage is not in tune with the rate of ground water exploited. Natural recharging of ground water has also slowed down due to heavy pour of rainfall. Raindrops hitting leaves, stems and other plant parts get interrupted

*Corresponding author
E-mail: panneer@icfre.org

and redistributed, thereby reducing the velocity of direct soil impact. Well-established vegetation slows water movement across the soil surface, which both reduces erosion and allows more of the water to soak in. Lastly, plant roots help to hold or lock the ground in place. It is the key challenges faced by land, forest, water resources and ecosystem functions. The wise management of water resources requires accurate information on relationships between land use, water yield and quality over soil erosion.

Tamil Nadu state has about 133 major watersheds, which are further sub- divided into 18568 micro watersheds. Traditional management of watersheds from an aquatic perspective has centred on mitigating impacts related to land use change. The infiltration capacity of the forest soil is much higher than the bare soil. The forest canopy cover reduces soil erosion by diminishing the impact of raindrops, which otherwise would have fallen on compact and barren surfaces. The overall evapo-transpiration, interception loss and Canopy Storage Capacity (CSC) from forests apparently vary with the characteristics of the forest types (Zhang *et al*., 2006). In the projected crown area of 20 m^2 the CSC values correspond to 6.0 - 50 kg of water stored on the tree canopy (Huang *et al*., 2005).

Use of soil and water resources by vegetations largely determines the agronomic, ecological and hydrological outcomes of plant growth. Changes to the hydrological balance that accompany the clearing of native vegetation and forest catchments can lead to hypersalinization and land degradation (Eastham *et al*., 1994; Nepstad *et al*., 1994) and emphasise the need to understand how different plant species use soil water there is increasing evidence of transfer of water from deep soil layers to dry soil by plant root systems (termed ``hydraulic lift'' by Richards and Caldwell 1987) which suggest that existing hydrological and physiological models of water uptake and loss to the atmosphere by plants require further understanding. Ground cover is considered as the most suitable solution to protect the soil erosion. Grasses such as "Vetiver" and other appropriate species is a natural soil-binder and provides the best natural solution against erosion (Sanyal *et al*., 2006). Further, reforestation and climate change would likely to produce the hydrological effects and thus place double pressure on water resource, as both key drivers may lead to water yield reduction (Cui *et al*., 2012).

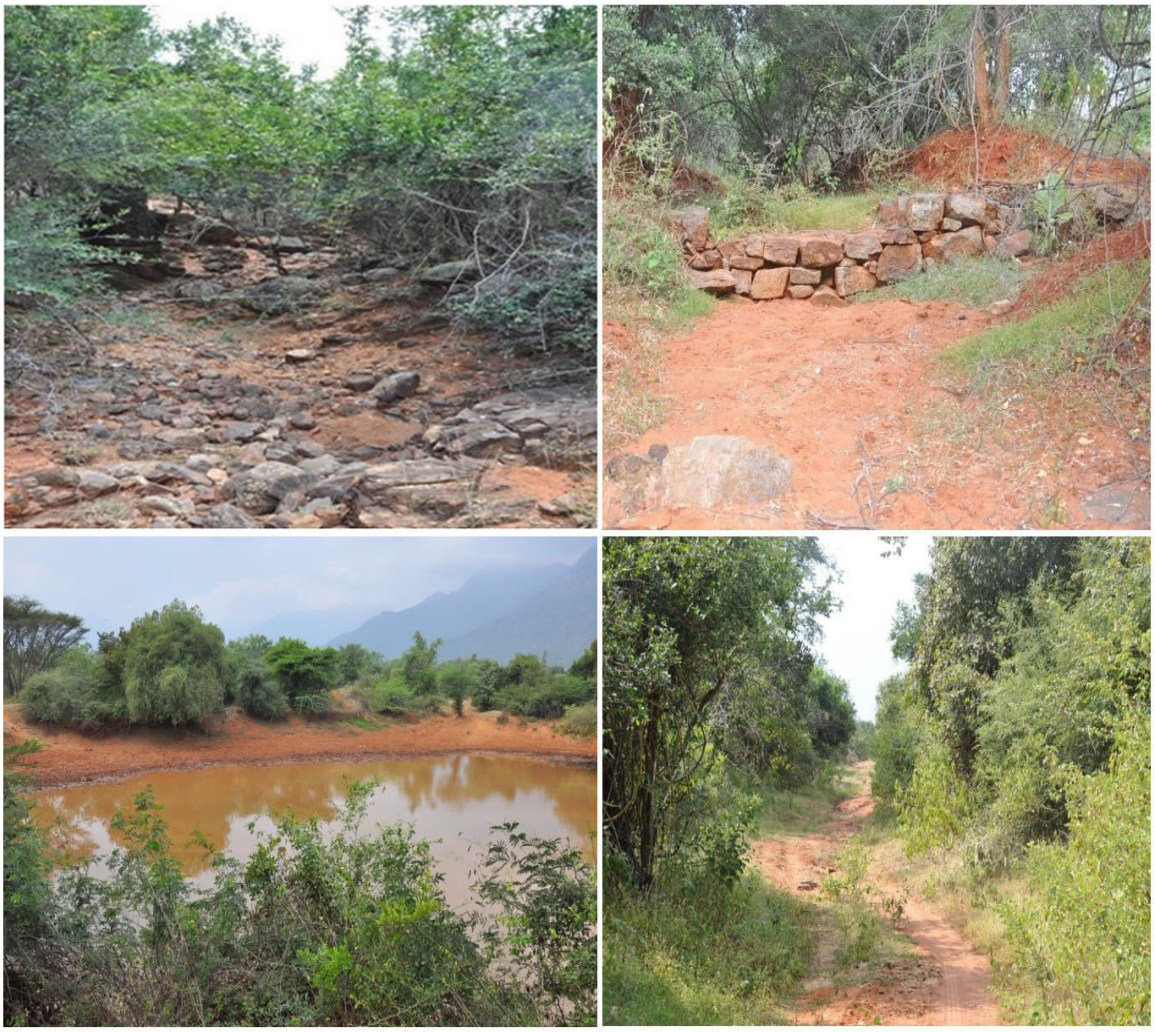
Materials and Methods

Study area

Coimbatore district lies between 10"-10' and 11"-30' northern latitude and 76"-40' and 77"-30' eastern longitude. Coimbatore district forms a part of the upland plateau region of Tamil Nadu with many hill ranges, hillocks and undulating topography with a gentle slope towards east except for the hilly terrain in the west. The undulating topography with innumerable depressions, are used as

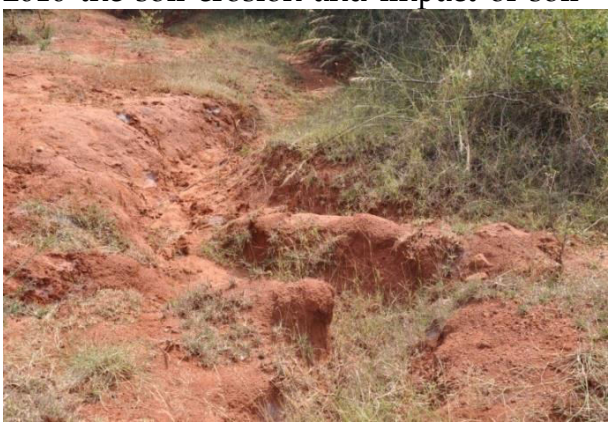
tanks for storage of rainwater for agriculture.

Field surveys were carried out to study the watershed management strategies and assess the benefits of watersheds, enrichment planting, wildlife and biodiversity. The rill, sheet and splash eroded sites were studied the impects of the erosion and loss of soil. Few vegetation covered area that prevented the heavy pour of rainfall and soil erosions. This vegetation such as binding grasses, checking cactus, climbers, creepers and small trees prevents the erosion in gullies and streams and these plantations should be enriched using natural vegetations like binding grasses, checking cactus, creepers, herbs, shrubs, small trees, climbers and anchoring tree species



Results and Discussion

Field surveys were conducted in different parts of Jakkanari beat of Metupalayam range in Coimbatore forest division. Based on the survey proper watershed management study sites are selected. Geographical Information was collected using GPS at the selected sites. In the past 1994-2000 there were less soil erosion and from 2010 the soil erosion and impact of soil erosion are severe. The eroded soil are flooded and deposited as siltation in check dams and percolation ponds. So, it leads to non availability of water for the wild life during summer. The proper and intensive watershed management studies have to be carried out in the forest areas for effective utilization of water and control of soil erosion, siltation etc.



Enrichment planting

Soil erosion is majorly due the lack of vegetation in the gullies and streams. The heavy pour directly hits the soil and eroded it. Hence if there is little vegetation it will support to reduce the direct hitting of the soil. Enrichment planting is one of the major activities in watershed management that provisions watersheds with a "sponge effect". Forest soil, roots and litters act as a giant sponge, soaking up water from rain and runoff then releasing gradually over an extended period. Therefore, vegetated watersheds play a key role in the management of water resources, mainly by improving water quality and flow regime. The rising limb of the Instantaneous Unit Hydrograph (IUH) prior to treatment was very steep, which indicates that water from the watershed rushed away within a short period of time, whereas after treatment there was a delay in runoff and leads to smooth flow of water. Similar analysis has been conducted for many other watersheds and it has been found that runoff peak and volume are reduced by 30-40% as compared to pre-treatment. This reveals that more water gets infiltrated into the soil profile resulting in a reduction of runoff peak and volume flow. Similarly, the sediment yield was reduced to 45% as compared to pre-treatment rate for the same amount of runoff (Sthapit., 2008).

Use of perennial grasses as vegetative barriers to reduce soil

erosion from farm and non-farm lands is increasing world-over. A number of perennial grasses have been identified for their soil conserving properties, but their effectiveness varies with location and method of planting. Installing vegetative barriers in combination with suitable mechanical measures, like bunds or trenches or both, on the appropriately spaced contours may enhance their conservation potential. Hence, the effect of vegetative barriers, *viz*., *sambuta* (*Saccharum* spp.) —a local grass, vetiver (*Vetiveria zizanioides*) and lemongrass (*Cymbopogon citratus*) planted in combination with trench-cum-bund, on runoff, soil loss, nutrient loss, soil fertility, moisture retention and crop yield in the rainfed uplands, was studied in Kokriguda watershed in southern Orissa, India through 2001–2005. However, runoff, soil and nutrient losses were studied for 2002, 2003 and 2004 only. Analysis of the experimental data revealed that on a 5% slope, the lowest average runoff (8.1%) and soil loss (4.0 Mg ha^{-1}) were observed in the *sambuta* + trench-cum-bund treatment followed by vetiver + trench-cum-bund (runoff 9.8%, soil loss 5.5 Mg ha^{-1}). Lemongrass permitted the highest runoff and soil loss. Further, the conservation effect of grass barriers was greater under bund planting than *berm* planting. Minimum organic C (50.02 kg ha^{-1}), available N (2.49 kg ha^{-1}) and available K (1.56 kg ha^{-1}) loss was observed under *sambuta* with bund planting. The next best arrester of the soil nutrients was vetiver planted on bund. Significantly better conservation of nutrients under *sambuta* and vetiver resulted in the soil fertility build-up. Soil moisture content was also higher in the *sambuta* and vetiver than lemongrass treated plots. Increase in the yield of associated finger millet (*Eleusine coracana* (L.) Gaertn.) due to vegetative barriers ranged from 18.04% for lemongrass to 33.67% for *sambuta*. Further, the *sambuta* and vetiver treated plots produced 13.23 and 11.86% higher yield, respectively, compared to the plots having lemongrass barrier (1.17 Mg ha^{-1}). Considering the conservation potential, and crop yield and soil fertility improvements, the *sambuta* barrier with trench-cum-bund is the best conservation technology for treating the cultivated land vulnerable to water erosion. Farmers also showed greater acceptance for the *sambuta* barrier as it is erect growing and available locally. Vetiver with-trench-cum bund can be the second best option (Anchal Dass *et al*., 2011).

Enrichment planting with different plant species of binding grasses, checking cactus, creepers, herbs, shrubs, small trees, climbers and anchoring tree species can be carried out at the splash and rill eroded sites along the ridges and banks of the gullies and streams. The binding grasses such as *Cynodon dactylon, Cymbopogon martinii* will help to prevent soil erosion and enhance infiltration of water. Taxa such as *Aloe vera, Agave ameicana,* and *Agave sisalana* checks the runoff and the herbs like *Andrographis paniculata, Ocimum sanctum* and creepers like *Carissa*

carandas, Citrullus colocynthis, Evolvulus alsinoides and climbers such as *Acacia insia, Pterolobium indicum* and shrubs like *Dodonea viscosa, Jatropha gossypifolia, Adathoda vasica* are supporting to minimise the soil erosion in streams and gullies. Planting of small trees such as *Murraya paniculata, Vitex negundo* and the bigger trees such as *Azadiracta indica, Acacia nilotica, Albezia lebbeck, Hardwickia binata, Ficus spp., Ziziphus mauritiana* etc. are also supporting to enrich the species at the eroded sites.

Conclusion

It is essential to ensure the supply of good-quality fresh water, provides protection from natural hazards such as flooding or soil erosion. The need of water is obvious for every living organism for its very existence and survival. So, watershed development plays a major role in conserving water. Watershed management programme is an appropriate strategy to manage natural resources (land, water and forest) and to provide sustainable livelihood to the rural poor. Streams, gullies and percolation ponds also play a major role in watershed management by increasing the ground water table. Hence, promoting watershed and controlling the soil erosion in forest catchment is an important step in the initial stages of splash, sheet and rill erosion level. Enrichment of binding grasses, cactus, creepers, climbers, herbs, sh rubs and tree species may prevent soil erosion and enhance the biodiversity and support in mitigating global warming.

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