Food and Scientific Reports
ISSN 2582-5437

Role of Agroforestry Measures for Soil and Water Conservation

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ABSTRACT

Degradation of natural resource *viz* soil, water, forest and climate is a major problems in modern agriculture. Out of which the soil and water the degradation to cause thread under sustainability of agriculture because decline productivity, profitability, imbalance in ecological system and environmental security. All these problems can be addressing through Agroforestry, it is viable option to maintain agriculture sustainability. This article deals with different measures of agroforestry for soil and water conservation.

Soil and water conservation has been a global concern in this millennium. Increase in mainly two principal anthropogenic activities, *i.e.* land use and fossil fuel burning has caused the soil and water degradation. Soil and water degradation are very crucial issues in the modern era (Gardner 1996). Soil and water are the major input of agricultural production. With degraded land and polluted water, survival of human being is in danger. Soil and water degradation are connected to total environmental existence. Greenhouse effect & water pollution are two major concerns of global consequence. Therefore, to resolve these problem sustainable soil and water conservation option was given due emphasis like that of agroforestry.

"*Agroforestry is a collective for land-use systems in which woody perennials are grown in association with herbaceous plants or livestock in a spatial arrangement, a rotation or both". It has both productive and services function. Among the productive function 3Fs (fuelwood, fodder and fruit) are the most important besides construction wood, gums, resins, medicines, fibres and a host of other economic base and greater food security*.

Agroforestry is a combination of agricultural and forestry technologies to create combined, diverse and productive land-use systems (Garrett et al. 2000). A broader field is that of soil and water conservation is reduction in water loss through runoff is an integral part of soil conservation. In turn, soil and water conservation aim is the conservation of natural resources which covers also the conservation of other resources including vegetation (forests, pastures) and wildlife.

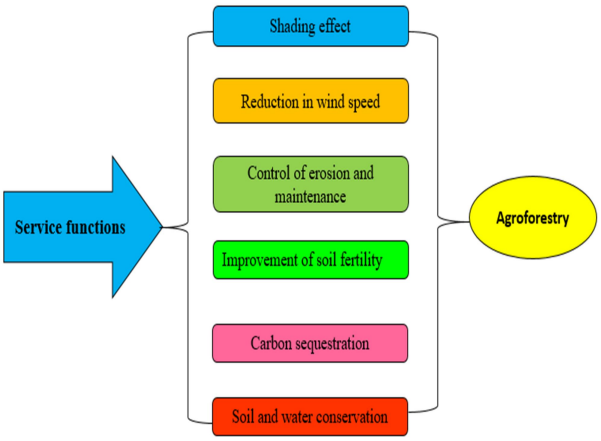

Fig. 1. Service functions of Agroforestry

Concept of soil and water conservation

Soil conservation is described as soil fertility maintenance through control of erosion, maintenance of organic matter, soil physical properties, nutrients and avoidance of toxicities (Young, 1989). Soil and water are conserved through reduction in soil loss from runoff and increasing of infiltration rate. The only crop is not enough to lower the velocity of runoff. When trees are grown with crops gives much strength to the soil through the permeability of water, as a result, water is also conserved. Trees with deep root system improve groundwater quality through trapping of nutrient, metals which are deposited in surface and subsurface of soil. As a result, soil fertility become enriched (Dury, 1991).

Positive effects of agroforestry on soil and water

Based on various experimental facts, beneficial effects of agroforestry on soil, such as:-

- Reduction in loss of soil as well as nutrients through reduction of run-off
- Addition of carbon and its transformation through leaf, twig and bark fall etc.
- Nitrogen improvement by fixation of nitrogen-fixing trees, shrubs etc.
- Enhancement of physical conditions of soil such as permeability, water holding capacity, and drainage etc.
- Release and reutilizing nutrients by moving biochemical nutrient cycling
- More microbial associations and addition of more root biomass
- Moderately effect on extreme conditions of alkalinity & soil acidity
- Lowering effect of the water table in areas where the water table is high

Agroforestry for erosion control

Alley cropping or hedgerow cultivation is very effective in controlling soil erosion in the hilly area. Hill Tract Development Board of Bangladesh recognized five nitrogen-fixing trees species like:

- *Leucaena leucocephala*
- *Gliricidia sepium*
- *Indigofera tysmani*
- *Fleminigia spp. And*
- *Desmodium rensonii*

Two grass species for controlling runoff and erosion in the hilly area (Khisa et al., 2002)

- *Vetiver zizanoides* and
- *Thysanolaena maxima*

It was found that runoff and soil loss significantly reduced when small watersheds with agriculture were replaced either by trees and grasses (silvipasture) or with mechanical measures (Singh et al., 1990).

Agroforestry for improving soil fertility

The effects of long-term cultivation of crops under different agroforestry systems as compared to crops alone as:

- The total content of N was higher in soil tree crop stand as compared to crop systems in topsoil (0-15 cm).
- The C: N ratio was narrow in tree species system as compared to sole crop stand.

Nitrogen fixation and nutrient cycling

- Nitrogen-fixing trees can make substantial nitrogen and extensively increase nitrogen inputs to agroforestry systems.
- *Sesbania rostrata* in wetland rice systems can also achieve 500 kg N per ha per year.
- Increase in nutrient use efficiency through agroforestry can be achieved by increasing the cycling of nutrients from tree litter, which reduce, by leaching and erosion losses.
- The deep rooting system of trees help in absorbing nutrients from the deep soil that crop roots cannot reach and recycle them to the surface 15 cm soil layers through the addition of litter (Jadhav et al., 2006) and have a potential to capture and recycle a larger amount of nutrients.
- It is observed that woody species in Alley cropping provide higher amount of nutrients than other species in shade system and infertile soil with Alley cropping system.

Agroforestry Systems as carbon Sink for soil fertility

- In India, average sequestration potential in agroforestry has been estimated to be 25 ton C ha-1 over 96 mha, but there is a considerable variation in different regions depending upon the biomass production.
- Effect on soil physicochemical properties

A. Changes in chemical properties of the soil

- The Nitrogen content is increase with *L. leucocephala* as alley crop. Addition of organic matter through nitrogen fixation, significantly increase N in soil and other chemical properties like CEC, organic carbon, pH and nutrients availability.
- Miah et al. (1997) reported higher soil pH and organic C in alley cropping system with *G. sepium* and higher leaf N content CEC was also advanced in the alley cropping treatments associated to control and early soils. Increased

top-soil CEC in alley cropping of the recent study is proven by De Costa et al. (2005).

B. Changes in physical properties of the soil

- Trees can improve the physical properties by adding organic matter like soil structure, porosity, and water holding capacity etc.; modify the temperature by shading; and litter cover and tree species enrich the soil by adding both above and below-ground biomass into the soil system.
- A study was conducted at ICAR Research Complex for NEH Region at Umiam, Meghalaya for suitable agroforestry systems different multipurpose trees species. The effect of tree species on bulk density (BD), organic carbon (OC) and porosity of the soil was reported significant. The water-stable aggregates (> 0.25 mm) increased significantly under the different multipurpose tree species as well as Soil erodibility decreased considerably as compared to control (Saha et al., 2007).

Water conservation through Agroforestry

- Tree species improve moisture retention capacity of the soil and hydraulic conductivity as well as moisture storage in both dry season and the rainy season than control.

Agroforestry system in improving soil water quality

- Agroforestry practices such as windbreaks and shelterbelts reduce wind velocity and thus limiting wind erosion.
- Excess fertilizer is washed away from agricultural fields via surface runoff or leached into the subsurface as a result contamination of water sources and deterioration of water quality (Cassman, 1999).
- Agroforestry system help clean runoff water by reducing the velocity of runoff by promoting infiltration, sediment deposition, nutrient retention and improve groundwater quality by capturing nutrients.

Conclusion

Thus it is concluded that soil conservation is the maintenance of soil fertility which requires control of erosion, maintenance of organic matter, soil physical properties, nutrients and water is also stored through reducing the erosive force of rainfall as well as enhancing infiltration rate. Effects of different multipurpose trees on soil physical properties, soil water retention and nutrient availability of soil were superior as well as organic carbon was higher in different agroforestry system than sole cropping system. Therefore, the article revealed that agroforestry is a sustainable land-use system that has the potentiality to conserve soil and water for the production practice.

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