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Potential of agroforestry in water management and livelihood support

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Abstract

Agroforestry is as old as the origin of Agriculture. But the scientific approach to this system has been realized recently. Global warming, climate change and deforestation are major responsible for the fluctuation in spatial and temporal distribution of rainfall which finally leads to water deficit. So water stress in agroforestry can be minimized by developing the appropriate models in general and growing site specific species in particular. Agroforestry is a compromise between the growing of forest and field crops on the same land simultaneously. This tree crop provides shade to the field crop with making land productive and increase revenue. Agroforestry system provide a variety of products, some of which are consumed by the farming family or sold for cash, and a variety of services that benefit the crops, livestock or the landscape and thus it can transform the rural landscape, and also alleviates poverty and support farmers' livelihood. They make clean environment with full utilization of soil resources help in generation of employment and income of the people.

Keywords: Agroforestry, agriculture, global warming, productivity, livelihood etc.

Introduction

One of the growing global concerns is to increase the water productivity for meeting the water demand of the rising population. According to the estimates of the World Commission on Water, demand for water will increase by approximately 50% over the next 30 years, and about half of the world's population will live in conditions of severe water stress by 2025. Due to rapid degradation of water catchments and climate change there is a major threat in decreasing water supplies in many parts of the world. Agroforestry has the potential to improve water productivity in two ways. Trees can increase the quantity of water used on-farm for tree or crop transpiration and may also improve the productivity of the water that is used by increasing the biomass of trees or crops produced per unit of water used (Ong *et al.*, 2006) [1]. The rate of depletion of land and surface water in our country is indeed alarming. So the rational approach is required like by developing the suitable agroforestry model and/or integrating with the rain water harvesting unit for overcoming the water crisis in the country. Agroforestry, as a science and practice, has the potential to secure the growing food insecurity and deteriorating livelihood situations especially in rural areas. Since agroforestry provides various forms to offer multiple alternatives and opportunities to smallholders to enhance farm production and income, while protecting the agricultural environment. Agroforestry as a land use system that integrates trees, crops and animals in a way that is scientifically sound, ecologically desirable, practically feasible and socially acceptable to the farmers (Nair, 1979) [2]. While agroforestry clearly offers ecological and economical advantages, on the other side, due to the combination of different components in any agroforestry system there would be an interaction among the components which may be negative or positive. However, the competition can be minimized by adopting suitable management practices. So, agroforestry is the only viable option to meet the ever growing need of increasing population as there is least scope of horizontal expansion of agriculture and forestry.

Agroforestry Potential

Agroforestry has now been widely practiced all over the world especially in the developing countries. Records of experiences from agroforestry initiatives worldwide indicate that agroforestry has the following potentials:

- Being more complex than monoculture, agroforestry provides wide ranges of products available to farmers such as wood fuel, timber, poles, stakes, medicines, fodder, green manure or mulch, fruits or nuts, spices and resins.

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- Provide beneficial ecological services include wind speed reduction, soil temperature moderation, shade provision for certain crops and livestock.
- Helps in carbon sequestration mainly by woody components and thus reduces the environmental global warming.
- Watershed stabilization, soil erosion control and soil fertility improvement or maintenance.
- Minimizing soil and nutrient losses due to the deep rooting nature of the woody components, which enhances soil stability on sloping land, and uptake of nutrients from deeper soil layers.
- Helps in the microclimatic changes thus favouring the crop growth of crops.
- Better resistance in disease, insect, etc due to variety in crops in the systems.
- Beautifying the agricultural landscapes.
- Improving biodiversity conservation domesticating wild trees and shrubs of high value and growing them on farm.
- Integration of all resources available to farmers can generate more employment opportunities and income.

Water stress and its effects in agroforestry

Water stress in plant is developed during periods of water deficiency because plants are unable to absorb adequate water to match the transpiration rate. A water deficiency exists when the amount of rainfall is less than potential evapotranspiration. Water stress may be either due to water shortage or due to excess of water. Water deficit, one of the key limiting factor for plant growth, productivity and survival and often adversely affects agroforestry practices in arid and semi-arid areas (Sanchez-Coronado *et al.*, 2007) ^[3]. However, plants can normally acclimate to water stress through physiological and morphological responses (Coopman *et al.*, 2008) ^[4]. However critical water stress leads to death of plants.

Certain trees that are integrated into agricultural systems can increase the efficiency of water use, while plantations of fast-growing trees can exacerbate water shortages. For most plants, the immediate responses to water deficit are leaf water potential declines, leading to stomatal closure and reduced photosynthesis. Furthermore, prolonged drought can limit plant growth and biomass production, and alter the allocation pattern of biomass, and even cause plant death. Water-use efficiency (WUE) is a functional character related to plant growth and performance under drought conditions. Thus, when trees are planted in arid locations, both productivity and WUE should be considered as important indicators.

Plants respond to stress in several different ways

Stress escape: Plant can escape the injury of water stress by regulating its life cycle. E.g. like ephemeral plants found in desert which can germinate, grow and flower very quickly following seasonal rains and so complete their life cycle during a period of adequate moisture and form dormant seeds before the onset of dry season.

Stress avoidance: Plants avoid the injury of stress by building up a barrier to prevent stress factors entering the plant. E.g. Alfalfa survive dry habitats by sending down deep root systems that penetrate the water table. Salt-secretion by halophytes secretes the salts out from the leaf thus reduce salt content in the leaf.

Stress tolerance: Plants can tolerate the water stress by regulating their metabolism and repair the damage which was caused during the water stress. E.g. highly salt tolerant halophytes such as *Suaeda salsa* survive salty habitat by many strategies such as high ROS scavenging ability, high osmotic adjustment ability, high ion compartmentalization ability and so on.

Agroforestry for high production in drought condition

The reasons for higher production of agro forestry under drought conditions are:

- Greater efficiency of perennial crops for photosynthesis
- Tapping of nutrients and water from deeper layers by perennial crops and
- Better environmental conditions

Minimizing water stress in agroforestry

Water stress in agroforestry can be minimized by adopting the following several steps:

- Planting of deciduous tree species which can shed their leaves during summer season.
- In water-scarce areas avoid the use of fast growing, evergreen species, such as pines and Eucalyptus.
- Practicing root and shoot pruning to decrease below-ground competition.
- Avoiding rotational woodlots with frequent harvesting.
- Reducing water losses from evaporation and excessive transpiration by using the practices of mulching, weed control, shading, windbreaks, etc.
- Use of drought-resistant and drought-escaping crops and varieties like sorghum, pearl millet, pigeon pea (crops) etc and tree species like Acacias, *Hardwickia binmata*, etc.
- Increase crop water use efficiency by selecting water-efficient crops like C₄ crops.
- Adjusting plant population to expected rainfall.
- Temporary closure of grazing lands and subsequent protection.
- Increasing the period for infiltration by detaining runoff with physical structures like contour cultivation, permeable cross-slope barriers, bench-type terraces, etc.
- Early planting.
- Introducing deep-rooting crops.

Transforming lives through agroforestry

Agroforestry can improve the livelihoods of smallholder farmers as by providing various production services like fuel wood, timber, medicine, fodder for livestock, green fertilizers, assets that can be sold in times of need and additional / diversified income (WAC, 2010) ^[5].

Policy and development interventions of agroforestry

- Price policy
- Infrastructure facilities
- Credit availability
- Rationalizing the tree felling and transit norms/rules
- Relaxation in land leasing rules by the state government for agroforestry
- Marketing information
- Value addition

Future Strategy

For further judicious and scientific use of land and water resource under agroforestry it is required to conduct research work under the following heads:

- Interaction between trees and crops
- Development of tree based nutritional garden
- Establishment of agroforestry and forestry nursery
- Introduction of multipurpose trees species
- Introduction of N-fixing trees in alley cropping
- Development of other accessory system like aquaforestry, multipurpose wood lots, etc.
- Development of appropriate agroforestry models
- Selection of agroforestry based entrepreneurship

Conclusion

Agroforestry has the potential to improve water productivity, able to manage water stress by various ways and has the potential to secure the growing food needs and livelihood by providing various timber and NTFPs to rural people and reduce poverty. Therefore, agroforestry will play a very effective role in sustainable crop production and socio-economic upliftments with livelihood and health security and employment and income generation.

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