

AGROFORESTRY: SOLUTION TO ADDRESS FOOD SECURITY AND CLIMATE CHANGE

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Agroforestry, the cultivation of trees and shrubs along with agricultural crops and livestock simultaneously or sequentially, is a land-use system that has been a way of life and livelihood in many developing as well as developed countries for centuries to attempt assured interactions among the components with the objective of achieving a more environmentally diversified and socially productive output from land than is obtainable through traditional agriculture. It is a practically acceptable and minimal cost way out for implementing several aspects of integrated land management practices to reduce human interference on productive landholdings and contributing towards a green economy through encouragement of long term, sustainable, and renewable forest management, more specifically for small scale producers. Notwithstanding, the advanced conception of agroforestry became visible in the early 20th century, but the adoption of woody perennials in agrarian structure is quite antiquated, with documented descriptions of the principles and practice dating back to the ancient Roman era. Agroforestry has captivated the enthusiasm of researchers, scientists and developmental planners as it contributes a variety of products for fulfilling miscellaneous requirements of people, providing insurance coverage against risks and disturbances resulted by aberrant weather conditions, controlling erosion hazards due to water and wind effects and ensuring sustainable production of the intercrops (Nair, 2007). India has been at the cutting edge since standardized agroforestry research has commenced throughout the globe and progressed vigorous agroforestry science, innovative technologies and package of practices that are fascinating global interests.

What is agroforestry?

Agroforestry is defined as an integral component of productive agriculture and a flexible concept of management and integration of existing native forests and forests/trees established by small or marginal landholders, crops and/or livestock on the same plot or in

other words; it may be referred to as a collective term for land-use systems and technologies and an intensive land management practice in which the woody perennials such as trees, shrubs, palms, bamboos, etc. are deliberately cultivated on the same land management units in the spatial arrangement or temporal sequence optimizing the advantages from biological associations created between them. However, agroforestry is a dynamic, ecologically viable and economically cost-effective, natural resource management system that accommodates with the social and cultural characteristics of local people and diversifies and sustains production level for enhanced social, economic and environmental benefits for land users at all strata.

Benefits of agroforestry

1. Produces a diversified and sufficient supply of nutritious foods to meet the global demand and satisfy the requirements of the producers as well; provide food, fibre, fuel, fodder, fruits, flowers, timber and shelter for livestock and serve other commercial purposes also including the contribution of a wide range of useful and marketable products from fruits/nuts, medicines, wood products etc.
2. Ensures the protection of natural environment to provide resources and environmental services to meet the needs of present generations without endangering the resource base for future.
3. Fundamental for land regeneration to improve soil health; build up soil organic matter or soil carbon; ameliorate soil structure through constant addition of organic matter from decomposed litter; reduce soil erosion resulted from the action of wind and water on unprotected soils by canopy cover, roots and leaf litter of naturally growing grasses; stabilise the soil; utilise nitrogen-fixing plants *viz.* legumes to restore nitrogen fertility etc.
4. Sequesters carbon from the atmosphere or increase carbon stocks in soil and woody biomass.
5. Brings up water and nutrients from deep in the ground.
6. Provides a framework for increased above and below ground biodiversity to flourish or a more diverse habitat than a conventional agricultural system in which the tree component creates ecological niches for a wide range of organisms.
7. Helps in bioremediation, drought resistance and increased crop stability.

8. Obtains cleaner water through reduced nutrient and soil surface runoff by decreasing its velocity and increasing infiltration into the soil; higher nutrient uptake and reduced nutrient losses into streams; more efficient recycling of nutrients by deep-rooted trees; declined nutrient leaching; better protection of ecological systems; increment in soil nutrients through addition and decomposition of litterfall.
9. Results in odour, dust and noise reduction; green space and visual aesthetics; enhancement or maintenance of wildlife habitat.
10. As tree cover accounts for more than 75% of global carbon pool, it can significantly contribute to climate change mitigation along with adaptation benefits.
11. Additionally, the hedges serve as windbreaks to reduce wind velocity over and around crops thereby increasing yields through reduced drying of the crop or by preventing the crop from toppling in strong wind gusts.
12. Regulates or improves microclimates, such as lowering of soil surface temperature and evaporation through mulching and shading.
13. Innovates diversified farm enterprises, makes agricultural landscapes more resilient and enhances yields from staple food crops.
14. Reduction in incidence of total crop failure, increase in levels of farm income due to sustained productivity, improvement in rural living standards from employment generation and higher income, improvement in nutrition and health due to increased quality and diversity of food outputs, reduced poverty, stabilization of communities through elimination of the need to shift sites of farm activities are playing a vital role in promoting livelihood security.
15. It can check the development of soil toxicities like soil acidification, alkalinity/sodicity and salinity; can be employed in the reclamation of polluted soils, eroded and degraded lands and may augment soil water availability to land use systems.
16. They utilize solar energy more efficiently than monoculture systems; lead to reduced insect pests and associated diseases; reduce the need for toxic chemicals like insecticides, herbicides, etc.
17. Increased food security; improved human nutrition through more diverse farm outputs; reduced global warming and hunger risks by an increasing number of drought-resistant trees and the subsequent production of fruits, nuts and edible oils; reduced deforestation and pressure on woodlands by providing farm-grown fuelwood are other significant advantages.

18. Trees may help to lower water tables, act as pumps to take up water from soil and then evaporate it into the atmosphere, thereby reducing soil salinity by this declined water tables.
19. Through water removal, established trees can substantially reduce waterlogging in their immediate area, which may result in improved land uses, *e.g.* pasture or crops.

Challenges/Barriers

1. Lack of developed markets, equipment, financial assistance as well as demonstration sites
2. Unfamiliarity with technologies and alternative marketing approaches
3. Lack of awareness, training or expertise, technical assistance and apparent profit potential
4. Competition between trees, crops and animals
5. Expense of additional management
6. Lack of knowledge about where to market products
7. Adoption/start-up costs, including costs of time
8. Unavailability of information about agroforestry
9. Apparent inconvenience and lack of scientific research
10. Lack of infrastructures such as buildings and sufficient land and unavailability of quality seed/seedling sources

Key Traits

To be termed as agroforestry, a land-use practice must satisfy the following four criteria:

1. **Intentional:** The integration of trees, crops and animals are intentionally designed and administered as a complete unit instead of considering it as an individual element.
2. **Intensive:** The system should be intensively controlled to sustain their productive and protective functions.
3. **Interactive:** It must manipulate the biological and physical associations between trees, crops and animals to increase the production along with providing conservation functions such as control of water pollution or maintenance of wildlife habitat.
4. **Integrated:** All the essential components should be structurally and functionally aggregated into a single and horizontal or vertical (above or below ground) integrated

management unit thereby balancing the economic production in addition to natural resource preservation.

Types of agroforestry systems

1. Structural basis

- a) **Agri silviculture:** Agricultural crops are intercropped with tree crops
- b) **Silvi pasture:** Production of woody plants along with pasture
- c) **Agri silvi pasture:** Production of woody perennials with annual crops and pastures

2. Functional basis

- a) **Productive functions:** Provides food, fibre, fuel, fodder, timber, fruits, and flowers, spices, shelter, medicines, non timber forest products or NTFPs etc.
- b) **Protective functions:** It acts as windbreaks and shelterbelts, helps in soil improvement and conservation

3. Socio-economic basis

- a) **Commercial:** The scale of the production is the major aim
- b) **Intermediate:** It prevails between commercial and subsistence systems
- c) **Subsistence:** The use of land is directed towards satisfying the basic needs and is managed mostly by the owner and his family

4. Ecological basis

- a) **Agroforestry in humid/sub-humid lowlands:** Home gardens, trees on rangelands and pastures, improved fallow in shifting cultivation and multipurpose woodlots
- b) **Agroforestry in semiarid and arid lands:** Various forms of silvopastoral systems, windbreaks and shelterbelts
- c) **Agroforestry in tropical high lands:** Plantation crops like coffee, tea, use of woody perennials in soil conservation and improved fallow etc.

Conclusion/Way forward

Agroforestry is obligated to perform a huge responsibility in distant future, not only for its significance in food and livelihood security but also for its vital role in combating the ecological constraints. It can possess a fundamental consequence in furnishing a widely accepted solution to global warming, climate change, enhancement of per unit productivity of land and conversion of degraded and marginal lands into productive ones. The National Agroforestry Policy formulated various recommendations which will go an extended route in

motivating large scale embracement of agroforestry system by the peasants and provide the indispensable raw materials to wood oriented industries as well as play a huge role in energy and environmental security. The major concentration of investigation in the forthcoming years will be imposed upon the development of agroforestry techniques for crucial domains such as arid and semi-arid regions and other frangible ecosystems like Himalayan and Coastal areas to endure those tracts of lands areas for obtaining higher productivity and natural resource management.

Reference

Nair, P. K. R. (2007). The coming of age of agroforestry. *J Science Food Agriculture*, **87**: 1613-1619.