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Agroforestry and ecosystem services

for risk management in rainfed areas

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Agroforestry is a land-use system based on integration of trees, crops and/or livestock on the same piece of land to enhance productivity as well as resilience of farmlands and to deliver various vital ecological services. Based on this, it can act as a promising and potential land-based transformation solution with several co-benefits. Adoption of agroforestry can enhance farmers' income, increase green cover, besides natural resource conservation, production of forest based raw-materials, rural development and scalability - all at the same time from same land areas with different degrees. Agroforestry is an ideal option to restore most of the degraded and wastelands in the country. The potential of agroforestry is more important for rainfed areas due to various vulnerable factors associated with predominant sole cropping systems.

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INDIA is the first country in the world to formulate and announce the National Agroforestry Policy (in 2014), focusing on enhancing productivity, profitability, diversity and ecosystem sustainability through promotion of agroforestry. Agroforestry can simultaneously address many ecological challenges of the current era viz. food, nutrition, energy, employment, natural resources and environmental security. It includes both traditional and modern land use systems. The characteristic features of agroforestry through integration and optimisation of the interactions of the components of agroforestry can lead to improvements in the soil quality, greater vegetation and tree cover, and also address the mitigation and adaptation needs of managing climate change, along with many social and economic gains in the long term. The research efforts of ICAR-Central Agroforestry Research Institute (CAFRI) and All India Coordinated Research Project (AICRP) on Agroforestry have successfully developed and demonstrated various suitable agroforestry models. The farmers are being encouraged to adopt these models and technologies suitable for reducing environmental impacts without negatively affecting the profitability and productivity. These successful agroforestry models provided numerous evidences regarding socio-economic benefits and ecological outcomes of agroforestry interventions, specifically for restoring degraded and wastelands as well as for supporting livelihood of small and marginal farmers.

India targeted to achieve carbon neutrality by 2070 as per the COP26 climate crisis summit 2021 held at Glasgow. India emitting only 5% of total greenhouse gases, accounted as lowest per capita emissions among world's major economies. Agroforestry particularly through small farm holdings can not only take a lead towards carbon neutrality but can also create additional revenue for farmers besides generating employment avenues through wood based industries; nurseries and plantation activities. Agroforestry due to presence of woody perennials enhances the sustainability of a farming system. The upper Indo-Gangetic plain region of India comprising of Punjab and Haryana is an example that in spite of negligible natural forest cover, agroforestry turned the region into one of the hotspots for wood based industries based on raw material availability from trees outside forests.

Agroforestry provides a range of ecosystem services that are vital for risk management in agriculture particularly in rainfed areas.

Soil health and erosion control: Tree roots enhance soil structure, promoting better aeration and water infiltration; vegetative cover from trees and shrubs stabilizes soil, reducing erosion from wind and water as well as contribute organic matter through leaf litter, improving soil fertility and microbial activity.


Ailanthus and teak based agroforestry system

Integration of trees in crop lands helps in improving soil bio-physico-chemical processes. Trees generally have their roots well below the crop zone, use nutrients from the lower soil layers, resulting in increased nutrient- and water-use efficiency with least competition with crops. The agroforestry practices of residue retention, zero tillage increase SOM in the top soil which in turn, impact soil physical properties and processes that reduce erosion and runoff. Accordingly, it leads to improved N-use efficiencies and fewer N losses to the environment. Reducing runoff and water erosion with conservation agriculture in agroforestry result in lower transport of sediments, nutrients and pesticides/ herbicides and higher water quality.

Water management: Agroforestry systems improve soil moisture retention which is very helpful for mitigating drought impacts and protecting intercrops in arid and semi-arid regions; trees component also acts as buffers, filtering pollutants and reducing runoff into water bodies, promote rainfall infiltration and reduce surface runoff through tree canopies. Agroforestry creates the soil conditions that would result in reduced erosion and runoff besides improved water quality compared to conventional practices. Likewise, water-holding capacity and storage are enhanced by providing some buffer to crop production during drought conditions.

Biodiversity enhancement: Due to multi component nature, agroforestry creates diverse habitats for various species and increases biodiversity which in turn attract pollinators and enhances crop yields and resilience. The enhanced biodiversity has additional advantage as it naturally regulates pest populations and reducing dependence on chemical pesticides in farm lands. The enhanced biodiversity of flora and fauna under agroforestry system promotes endophytic microorganisms and contributes towards control of pest and diseases.

Climate regulation: Globally, climate negotiations have highlighted the importance of land-use systems in mitigating the climate change. Agroforestry has the huge potential as a mitigating strategy to the changing climate because of its potential to sequester carbon in its multiple plant species. Trees are the most significant component of agroforestry due to their biomass and important sink for atmospheric carbon, since 50% of their standing biomass is carbon itself. Trees capture and store carbon dioxide, helping mitigate climate change impacts. Due to huge potential of tree species for carbon storage in farm lands, a focused and dedicated programme on their promotion can definitely lead to carbon farming. Even small and marginal farm holdings can play an important role in this endeavour by promoting tree plantation on farm boundaries and earning extra income for the farmers. Agroforestry helps in climate regulation by enhancing tree cover, adopting conservation agroforestry practices (minimum or no tillage practices) and substituting bio-based fuels and products for fossil fuels. Additionally, in arid and semi-arid regions during hot summers, the soil temperature goes very high and under such circumstances, tree canopies regulate the microclimate by providing shade and reduce temperature extremes which ultimately benefits crop and livestock and increase the productivity. The wind break and shelterbelt system of agroforestry is also very beneficial through their role as wind barriers, reducing wind damage to crops and livestock.

Enhanced productivity: Since agroforestry systems provide multiple products depending upon the components integrated in the system, it reduces the economic risk for farmers due to market fluctuations, climatic factors etc. The farmers practicing agroforestry are assured about the returns from the system even

Hardwikia based agroforestry system

during failure of crop component due to extreme events like drought or flood. Further, the complementary interactions between trees and crops enhances the overall productivity through improved soil and microclimate conditions. Since the harvesting of tree component in agroforestry can be adjusted, it helps the farmers to overcome the challenges of market fluctuations.

Aesthetic, cultural and social benefits: Agroforestry landscapes with diverse nature improves the aesthetic and cultural values, and has better social impact on communities. It also helps by strengthening community bonding through shared management and resource use. Further, by incorporating traditional knowledge based on the experience of the local farmers, agroforestry enhances resilience and sustainability.

SUMMARY

Agroforestry has multiple benefits. There is a need to upscale proven agroforestry technologies for enhancing income from farmlands through diversification. If adopted and promoted in totality and supported by appropriate policies and programmes, agroforestry can surely lead to a path of carbon neutrality. The large scale adoption of agroforestry will enhance resilience against various risks, including environmental, economic, and social challenges. The potential ecosystem services through agroforestry will not only contribute towards sustainable farming but also ensure building a stronger, more resilient small and marginal farmer communities depending upon rainfed agriculture. Adoption of successful agroforestry systems in rainfed areas on a large scale can play a definite role in sustainable development and achieving Nationally Determined Commitments (NDCs) in the face of climate change and other global challenges.

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