



HARMONY IN GROWTH: EXPLORING AGRO-FORESTRY'S ROLE IN SUSTAINABLE DEVELOPMENT AND ENVIRONMENTAL CONSERVATION IN INDIA

Haripada Paul

Assistant Professor, Department of Geography, Saheed Kshudiram College.

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-----ABSTRACT-----

This research explores the pivotal role of agro-forestry in fostering sustainable development and environmental conservation within the Indian context. Through an in-depth examination, it elucidates the intricate dynamics between agricultural practices and forestry interventions, emphasizing their collective potential in mitigating environmental degradation while enhancing rural livelihoods. The present paper focuses on the status of agro-forestry in India. The main objective of the present paper is to know the types of agro-forestry, need of agro-forestry and challenges of agro-forestry in India. This paper is basically a descriptive analysis based on secondary data source. India is a vast country with huge population pressure. Majority of the people are dependent on agriculture. Hence India needs large geographical area under agriculture. To maintain the healthy and sustainable environment India needs to increase forest cover area. The present paper finds that it is not possible to increase forest cover due to huge population pressure, but the country has the maximum scope to exhilarate greenery through agro-forestry method. This paper also finds that agro-forestry in India is running in a scattered way which is not enough as per the needs. Hence some constructive steps should be taken from the government side.

KEYWORDS: *Agro-forestry, Environment, Sustainable, Livelihood, Challenges.*-----

INTRODUCTION

Agro-forestry stands at the intersection of agricultural practices and forestry management, offering a holistic approach to land use that integrates trees and shrubs into farming systems. In the context of India, a country characterized by diverse ecological landscapes and significant agricultural activity, agro-forestry emerges as a promising strategy for achieving sustainable development goals while addressing environmental challenges. This introduction provides a comprehensive overview of the role of agro-forestry in promoting sustainable development and environmental conservation in India, drawing on empirical evidence and scholarly insights to elucidate its significance. Agro-forestry practices in India have a rich historical legacy, deeply intertwined with traditional agricultural systems and indigenous knowledge. Historical records attest to the prevalence of agro-forestry practices in various regions of the country, where farmers integrated trees and shrubs into their agricultural landscapes to enhance soil fertility, mitigate erosion, and provide additional sources of income (Kumar & Nair, 2011). These indigenous practices laid the foundation for contemporary agro-forestry initiatives, which have gained renewed attention in the face of escalating environmental degradation and the need for sustainable land management strategies. The multifunctional benefits of agro-forestry in India encompass both socioeconomic and environmental dimensions. From a socioeconomic perspective, agro-forestry offers a means of diversifying rural livelihoods and enhancing the resilience of farming communities against climate variability (Saha et al., 2018). By integrating tree crops with traditional agricultural crops, farmers can generate additional income streams through the sale of timber, fruits, nuts, and other forest products (Nair, 2012). Furthermore, agro-forestry systems contribute to food security by improving soil fertility, enhancing water retention, and providing shade and shelter for crops and livestock (Nair, 2014).

Environmental conservation lies at the heart of agro-forestry's value proposition, offering a nature-based solution to mitigate deforestation, soil erosion, and biodiversity loss. Trees and shrubs integrated into agricultural landscapes serve as carbon sinks, sequestering atmospheric carbon dioxide and mitigating the impacts of climate change (Jose, 2009). Moreover, agro-forestry promotes biodiversity conservation by creating habitat corridors and ecological niches



for diverse plant and animal species (Montagnini & Nair, 2004). By fostering ecological resilience and enhancing ecosystem services, agro-forestry contributes to the conservation of natural resources and the preservation of biodiversity hotspots in India (Saha et al., 2020). In light of these multifaceted benefits, agro-forestry has emerged as a cornerstone of sustainable land management strategies in India, garnering attention from policymakers, researchers, and practitioners alike. However, despite its potential, agro-forestry faces numerous challenges, including land tenure issues, policy constraints, and knowledge gaps among farmers (Kumar & Gupta, 2015). Addressing these challenges requires a concerted effort to promote awareness, provide technical support, and develop enabling policy frameworks that incentivize agro-forestry adoption at scale. India is a vast country. It has diversity in terms of topography, climate, and nature of soil and population density. Due to such diversity forest cover in different states of India are not same. Area-wise, Madhya Pradesh has the largest forest cover in the country followed by Arunachal Pradesh, Chhattisgarh, Odisha and Maharashtra. In terms of forest cover as percentage of total geographical area, the top five States are Mizoram (84.53 per cent), Arunachal Pradesh (79.33 %), Meghalaya (76.00%), Manipur (74.34 %) and Nagaland (73.90 %) (ISFR.2021). North Eastern states of India occupy small geographical area of India and also lowest population density. Forest cover percentage is lowest in the bigger states interns of area and population. States like Uttar Pradesh, Bihar, Gujarat, Karnataka, West Bengal, Maharashtra, Rajasthan, Tamilnadu, Punjab and Haryana has the lowest forest cover due population pressure, agricultural and industrial activities. Agro- forestry is essential in the states or area where lowest forest cover remains. According to Indian State Forest Report, 2019 of the Forest Survey of India, the extent of trees outside the forest area is 29.38 M ha, i.e. 9.5 M ha of tree cover and 19.88 M ha of forests outside the Reserved Forest area. Thus, the agro- forestry area estimate includes 9.8 M ha tree cover.

OBJECTIVES

The objectives of the present paper are as follows:

1. To assess the current status of agro-forestry adoption and its contribution to forest cover expansion in India.
2. To identify the key challenges and barriers hindering the widespread implementation of agro-forestry practices in India.
3. To explore the socioeconomic and environmental benefits of agro-forestry and its potential to promote sustainable development in India.
4. To propose actionable strategies and policy recommendations to promote the adoption of agro-forestry and overcome barriers to its implementation in India.

DATA SOURCE AND METHODOLOGY

For this research, secondary data sources were utilized, comprising scholarly articles, reports, government publications, and relevant literature on agro-forestry, sustainable development, and environmental conservation in India. The selection process involved systematic literature review and database searches in academic databases like PubMed, Scopus, Web of Science, and Google Scholar. Additionally, reports from government agencies and international organizations were consulted. The methodology consisted of a comprehensive review and synthesis of secondary data to analyze the role of agro-forestry in sustainable development and environmental conservation in India. Qualitative and quantitative techniques, such as content analysis, thematic coding, and descriptive statistics, were employed to identify key trends, patterns, and challenges associated with agro-forestry practices. Overall, this approach facilitated a nuanced understanding of the subject and informed policy interventions aimed at promoting sustainable land management practices in India.

RESULT AND DISCUSSION

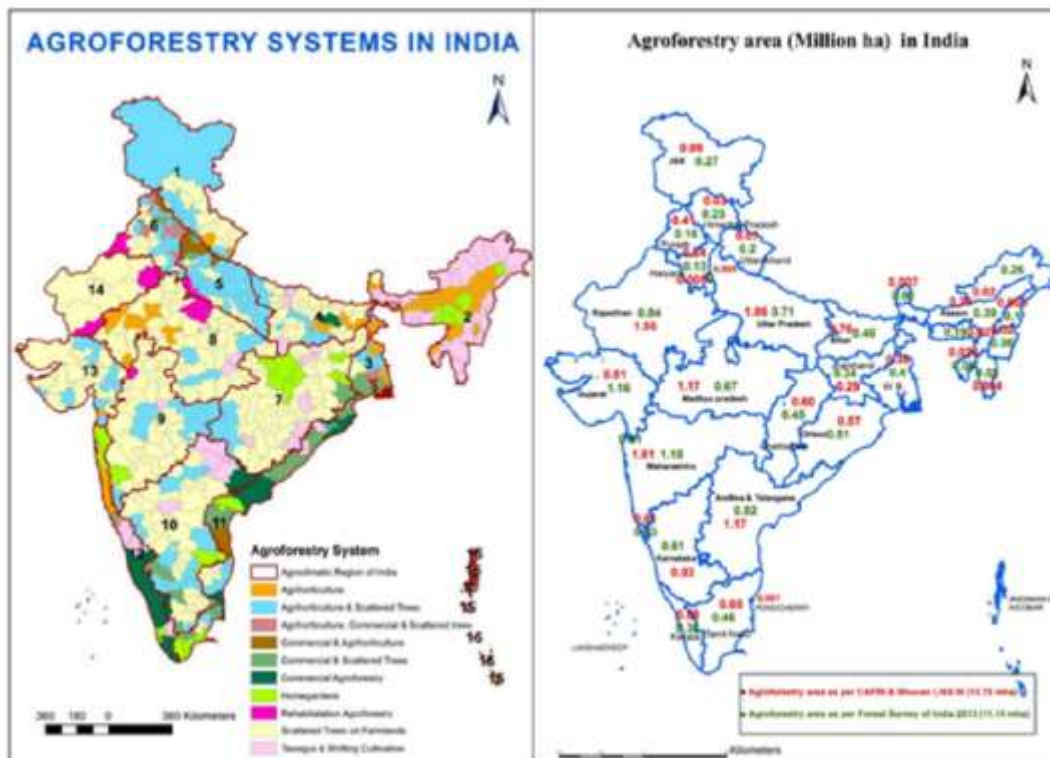
India, the second most populous country globally, is experiencing rapid economic growth and significant changes in lifestyle, leading to a surge in industrialization and transportation. This growth has resulted in a substantial increase in the number of factories, vehicles, and electricity demand. Currently, a significant portion of India's electricity is generated through coal burning, contributing to escalating fuel consumption and greenhouse gas emissions, including carbon dioxide. This surge in fossil fuel burning poses a considerable environmental challenge, exacerbating global climate change. Recognizing the urgent need to address these environmental issues, India has implemented various initiatives to promote tree-based farming, particularly through agro-forestry practices. Agro-forestry has been endorsed under initiatives such as the Green India Mission of 2001, six missions under the National Action Plan on Climate Change (NAPCC), and the National Agro-forestry and Bamboo Mission (NABM) of 2017. These long-term endeavors by the Government of India have significantly expanded the area under agro-forestry to approximately 13.75 million hectares. According to research conducted by the Central Agro-forestry Research Institute in Jhansi, agro-forestry has demonstrated substantial carbon sequestration potential, with approximately 11.35 tonnes of carbon per hectare sequestered. Additionally, the estimated carbon sequestration potential at the national level is 0.35 tonnes

of carbon per hectare per year. Leveraging agro-forestry systems, India aims to further mitigate greenhouse gas emissions, projecting a reduction of 2.5-3 billion tonnes of carbon dioxide by expanding tree cover. Agro-forestry is poised to play a pivotal role in achieving this expanded tree cover, with estimates suggesting its integration over 75.8 million hectares of land. The Forest Survey of India's technical series highlights the feasibility and effectiveness of agro-forestry as a sustainable land management practice, capable of withstanding minimal inputs while contributing significantly to environmental conservation and carbon sequestration efforts.

Agro-forestry activity in India

In 2014, India made history by becoming the first country to adopt a dedicated agro-forestry policy, the National Agro-forestry Policy (NAP), aimed at fostering employment, increasing output, and promoting environmental protection. As part of this initiative, a scheme was launched under the NAP in 2016 with an initial allocation of approximately ₹1,000 crore, marking a significant step towards transforming agro-forestry into a nationwide endeavor. The scheme, known as the Sub-Mission on Agro-forestry (Har Medh Par Ped), sought to incentivize tree plantation on agricultural land alongside crops or cropping systems, with the goal of enabling farmers to generate additional income and enhance the resilience of their farming systems to climate variability. The Sub-Mission on Agro-forestry (Har Medh Par Ped) Scheme was rolled out during the 2016-17 period and implemented across 20 states and 2 union territories in India. These states included Andhra Pradesh, Bihar, Chhattisgarh, Gujarat, Haryana, Himachal Pradesh, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh, Mizoram, Meghalaya, and Nagaland. The funding pattern for the scheme varied between states, with a central-state government contribution ratio of 60:40 in most states, 90:10 in northeastern and hilly states, and 100% funding for union territories and national-level agencies. In the 2022-23 Union Budget, the Finance Minister of India announced continued support for agro-forestry initiatives. However, it's noteworthy that the Ministry of Agriculture and Farmers' Welfare later integrated the Sub-Mission on Agro-forestry (Har Medh Par Ped) Scheme with the Rashtriya Krishi Vikas Yojana. This amalgamation raised concerns within the agro-forestry sector as it deprived the sector of its dedicated flagship implementation mechanism. Overall, these policy initiatives and funding schemes underscore the government's recognition of the importance of agro-forestry in addressing socioeconomic and environmental challenges while promoting sustainable land management practices in India.

Map No -1: Agro-forestry system & Agro-forestry area in India



Source: ICAR-Central Agro-forestry Research Institute



Problems related to adopting Agro-forestry in India: While agro-forestry holds significant potential for addressing environmental and socioeconomic challenges in India, several obstacles hinder its widespread adoption and implementation. Understanding these challenges is crucial for devising effective strategies to promote agro-forestry practices. Some key problems related to adopting agro-forestry in India include:

I- Land Tenure Issues: In many parts of India, unclear land tenure systems and insecure land rights pose barriers to agro-forestry adoption. Farmers may hesitate to invest in tree planting on land they do not own outright or fear losing access to land due to unclear property rights.

II- Lack of Awareness and Technical Knowledge: Limited awareness among farmers about the benefits and techniques of agro-forestry inhibits its adoption. Many farmers may lack the technical knowledge and skills required to implement agro-forestry systems effectively, including appropriate tree species selection, planting methods, and management practices.

III- Access to Finance and Resources: Adequate financial resources are essential for establishing and maintaining agro-forestry systems. However, many farmers, particularly smallholders and marginalized communities, face challenges in accessing credit, subsidies, and other financial support mechanisms for investing in agro-forestry activities.

IV- Policy and Institutional Constraints: Inconsistent policies, bureaucratic hurdles, and inadequate institutional support often impede agro-forestry initiatives in India. Fragmented governance structures and overlapping mandates among different government departments can lead to coordination challenges and regulatory bottlenecks.

V- Market Access and Value Chains: Limited market opportunities and inadequate infrastructure for marketing agro-forestry products hinder farmers' ability to derive economic benefits from their investments. Weak value chains and lack of market linkages further discourage farmers from engaging in agro-forestry enterprises.

VI- Climate Change and Environmental Risks: Climate variability and extreme weather events pose risks to agro-forestry systems, affecting tree growth, crop yields, and overall productivity. Climate change-induced shifts in precipitation patterns, temperature extremes, and pest and disease outbreaks can undermine the resilience of agro-forestry systems and livelihoods dependent on them.

VII- Social and Cultural Factors: Socio-cultural factors, such as traditional farming practices, social norms, and gender dynamics, may influence farmers' willingness to adopt agro-forestry. Cultural preferences for certain crops or reluctance to change existing land use patterns can present barriers to the adoption of agro-forestry practices.

Suggestion to promote Agro-forestry in India: India, as the second most populous country globally, faces the challenge of increasing tree cover and the number of trees amidst continued population growth. However, expanding forest areas is limited due to land constraints. In order to ensure a healthy environment and sustainable development, agro-forestry emerges as the most viable solution. Despite its potential, agro-forestry in India encounters various challenges. To mitigate these challenges and promote agro-forestry, the following steps should be undertaken:

i) **Awareness and Capacity Building:** Launching comprehensive awareness campaigns and training programs to educate farmers about the benefits and techniques of agro-forestry is essential. These initiatives should focus on disseminating knowledge about suitable tree species, planting methods, and management practices, while also highlighting the socioeconomic and environmental advantages of agro-forestry.

ii) **Policy Support and Institutional Strengthening:** Formulating clear and supportive policies that incentivize agro-forestry adoption and provide institutional mechanisms for its implementation is crucial. Governments at both the national and state levels should streamline regulatory frameworks, enhance coordination among relevant departments, and allocate adequate resources for agro-forestry programs.

iii) **Financial Incentives and Access to Credit:** Providing financial incentives, subsidies, and credit facilities to support agro-forestry investments can encourage farmers to adopt these practices. Governments, financial institutions, and development agencies should collaborate to design innovative financing mechanisms tailored to the needs of smallholder farmers and marginalized communities.



iv) **Market Development and Value Addition:** Developing robust market linkages and value chains for agro-forestry products is essential for ensuring farmers receive fair prices for their produce. Governments can facilitate market access by improving infrastructure, promoting certification schemes for sustainable products, and fostering partnerships between farmers and agribusinesses.

v) **Research and Extension Services:** Investing in research and development initiatives to improve agro-forestry technologies and practices is vital. Collaborative research efforts involving agricultural universities, research institutions, and grassroots organizations can generate valuable knowledge and innovations to enhance the productivity and sustainability of agro-forestry systems. Extension services should disseminate research findings and provide technical support to farmers, facilitating the adoption of best practices.

vi) **Community Participation and Social Mobilization:** Engaging local communities, farmer groups, and civil society organizations in agro-forestry planning and implementation processes fosters ownership and sustainability. Participatory approaches that involve stakeholders in decision-making, project design, and monitoring can enhance the effectiveness and acceptance of agro-forestry interventions.

vii) **Climate Resilience and Adaptation:** Integrating climate-smart practices into agro-forestry systems can enhance their resilience to climate change and variability. This includes selecting drought-tolerant tree species, implementing water harvesting techniques, and adopting agro-forestry models that promote soil conservation and biodiversity conservation.

By implementing these suggestions in a coordinated manner, India can unlock the full potential of agro-forestry to address environmental challenges, enhance rural livelihoods, and promote sustainable development. Collaboration among stakeholders, sustained political commitment, and targeted interventions are essential for realizing the transformative impact of agro-forestry in India.

CONCLUSION

In conclusion, achieving a healthy environment and sustainable development requires a significant portion of land, approximately 33% of the geographical area, to be covered with forests. However, the extent of forest cover needed varies depending on the population pressure and economic activities in a region. India, with its dense population and extensive economic activities, is facing environmental challenges that necessitate an increase in forest cover and the number of trees. Agro-forestry presents a promising opportunity for India to expand its forest cover, especially across its vast agricultural landscapes. Despite this potential, various obstacles hinder the widespread implementation and promotion of agro-forestry in India. By introducing innovative strategies and initiatives, these barriers can be overcome, paving the way for India to achieve environmental sustainability while supporting its economic activities.

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