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Analysis of agroforestry system for improving rural livelihoods: A review

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Abstract
Agroforestry, which refers to the deliberate integration of trees with crops and/or livestockon the same land unit, is recognized as a sustainable land-use approach that provides both environmental and socio-economic benefits. This review assesses the role of agroforestry in enhancing rural livelihoods, particularly in resource-limited areas and those vulnerable to climate change. It explores how different agroforestry models- such as Agri-silviculture, Silvo-pastoral, Agri-horticulture, and Argo-silvo-pastoral systems-improve household income, food and nutritional security, generate employment opportunities, and promote ecological balance. There searchsynthesizes findings from various fields, highlighting the crucial role of agroforestry in improving soil health, protecting biodiversity, reducing land degradation, and enhancing resilience against climate change. It also presents successful case studies that demonstrate the profound impact of agroforestry on smallholder farming communities. However, the review identifies several obstacles to wider adoption, including uncertain land rights, lack of technical knowledge, limited market access, andlimited policy support. The study highlights the significance of incorporating agroforestry into national strategies for rural development and climate adaptation. It promotes participatory methods, skills development, and policy changes that support farmer engagement and guarantee fair advantages. Enhancing institutional structures, connections between research and extension services, and financial motivation are essential for expanding agroforestry practices.

Keywords: Agroforestry, agroforestry system, rural livelihood, sustainable land use, rural development, policy support.

Introduction
Agroforestry can be defined as sustainable land management approach that combines agricultural and forestry practices within the same area. Various authors, including Nair (1993) [27], describe agroforestry practices as the intentional integration of trees alongside agricultural crops and/or livestock, either simultaneously or sequentially on the same unit of land.
Agroforestry is a comprehensive term encompassing land-use systems where woody perennials like trees, shrubs, and bamboos are cultivated alongside herbaceous plants such as crops, pasture, and/or livestock (Bargah *et al.*,2024) [4].
According to the International Centre for Research in Agroforestry (ICRAF), agroforestry is "a dynamic, ecologically-based natural resource management approach that integrates trees into farmland and rangeland, enhancing and diversifying production for greater social, economic, and environmental advantages for land users across all levels." It is also described as "a land-use system where woody perennials (trees, shrubs, palms, and bamboos) are purposefully used in conjunction with agricultural crops (woody or not), animals, or both, in either a specific spatial arrangement or a temporal sequence." Leakey, 1996 [23].
In tropical areas like India, farmed species like Poplars (*Populus* spp.) and Eucalypts (Eucalyptus spp.) form a coherent and profitable enterprise known as agroforestry, which is a collective term for land use strategies and technology. Constitute a well-organized and lucrative endeavor. Fast-growing Poplars have become an essential part of woodlots and windbreaks on numerous farms across South Asia (Torquebiau,1992) [40]. The deterioration of natural resources, especially agricultural and forested areas, has emerged as a worldwide issue due to the significant populations that depend on them for their livelihood.

Currently, Indian agriculture is confronted with various challenges and limitations stemming from rising demographic pressure, escalating demands for food, feed, and fodder, degradation of natural resources, and the impacts of climate change (Dhyani *et al*., 2013) [15]. Therefore, a management system that can produce food from less productive agricultural land while simultaneously maintaining and improving the quality of the production environment must be developed (Dobriyal, 2014) [16]. Since it has the capacity to offer farmers and rural communities' options that are both economically and environmentally sustainable, agroforestry stands out as the only viable option. By expanding tree cover and providing lumber and other wood products, this strategy stabilizes ecosystems and reduces strain on forests while allowing for large-scale agricultural diversification that provides fuel, fodder, fruits, and fibers (Bijalwan, 2013) [9].

The term "Household livelihood security" describes having enough stable income and resources to meet essential needs such enough food, clean water, healthcare, education, housing, time spent in the community, and social integration. A livelihood might include a variety of off-farm and on-farm pursuits that, when combined, provide a range of methods for generating income and food. Non-timber forest products (NTFPs) include "all items for commercial, industrial, or subsistence use obtained from forests and their biomass." This category encompasses a diverse array of goods such as fruits, nuts, vegetables, fish, gums, medicinal plants, resins, essences, barks, and fibers like bamboo and rattan (Bargah *et al.*, 2024) [5]. Every household may therefore have several sources of entitlement that contribute to its overall income. The entitlements stem from the household's resources and its standing within the legal, political, and social structure of society. In the present situation concerning livelihoods, we have two options: one is to accept the conditions, while the other is to seek change. In this regard, while we are currently in the former stance, we must strive for the latter. A significant challenge that policymakers and decision-makers face in numerous developing nations regarding the assurance of livelihood is determining "how to enhance the welfare of impoverished populations in rural regions while ensuring environmental sustainability." Addressing this concern necessitates focused research into innovative seed technologies, considering the growing importance of this domain in the global crop protection markets, as emphasized by (Bargah *et al.*, 2025) [6]. The enhancement of farmers' livelihoods is frequently linked to strategies geared toward land-based economic development. (Tiwari,2017) [39].

Strategies for land-based rural development, including agroforestry and enhanced extension services, are thought to enhance the livelihoods of rural farming families. A investigates the enhancement of livelihoods through agroforestry in contrast to traditional farming methods and reveals a varied impact on five capital types: human, physical, natural, financial, and social. (Ahmed *et al*.,2021) [1].

Classification of Agroforestry Systems:

1. Agrosilvicultural Systems

Agro-silvicultural systems are agroforestry practices that combine woody perennials (Trees or Shrubs) with agricultural crops on the same unit of land. This integration enhances productivity, improves soil health, and diversifies farm outputs, thereby contributing significantly to sustainable rural livelihoods. (Nair.,1993) [27]

2. Hortisilviculture System

The Horti-silviculture system is an agroforestry practices that combine fruit trees (Horticultural crops) with forest trees (Silviculture) on the same piece of land.The objective of this system is to make optimal use of land by combining the economic benefits of fruit production with timber or other forest products, thus enhancing both farm income and environmental sustainability. (Nair,1993) [27].

3. Silvopastoral Systems

Silvo-pastoral systems are agroforestry practices that integrate trees or shrubs with pasture grasses and livestock on a single piece of land. These systems are particularly relevant in arid, semi-arid, and marginal areas where conventional agriculture is risky or unsustainable. (Kumar,2006) [22].

4. Agrosilvopastoral Systems

Agro-silvo-pastoral systems are complex, integrated land-use systems that combine Agriculture, Forestry (silviculture), and pastoralism(livestock) on the same unit of land. This tri-component structure enhances ecological sustainability and livelihood resilience, particularly for smallholders and rural communities in diverse Agroclimatic zones. (Singh,2011) [36].

5. Home Gardens

Home gardens (or kitchen gardens) are small-scale, intensively managed multi-strata agroforestry systems around homesteads. These systems are known for their high species diversity, vertical structure, and continuous food and fodder production throughout the year. (Nair,1993) [27].

6.Alley Cropping

Alley cropping is a form of hedgerow intercropping in which annual crops are grown between rows of leguminous or multipurpose trees/shrubs. It is a widely promoted system for soil fertility enhancement, erosion control, and sustainable intensification of marginal lands. (Young,1989) [44].

Components of Agroforestry Systems

Component	Examples
Trees	*Acacia, Populusdeltoides, Eucalyptus, Gliricidia, Leucaena, Azadirachta indica,Terminalia arjuna, Artocarpus heterophyllus.*
Crops	Wheat, maize, pulses, vegetables, millets, tubers.
Livestock	Cattle, goats, poultry, buffalo.

(Dhyani, 2013) [15]

Dimensions of Rural Livelihoods

The UK Department for International Development (DFID) created the Sustainable Livelihood Framework (SLF), a popular method for evaluating how people and communities maintain their living standards in various social, economic, and environmental circumstances. It emphasizes five key "capital assets"- human, natural, financial, physical, and social- that interact with institutional processes and vulnerability contexts, shaping livelihood outcomes (DFID, 1999) [14].

Dimensions of Rural Livelihoods and Agroforestry Contributions

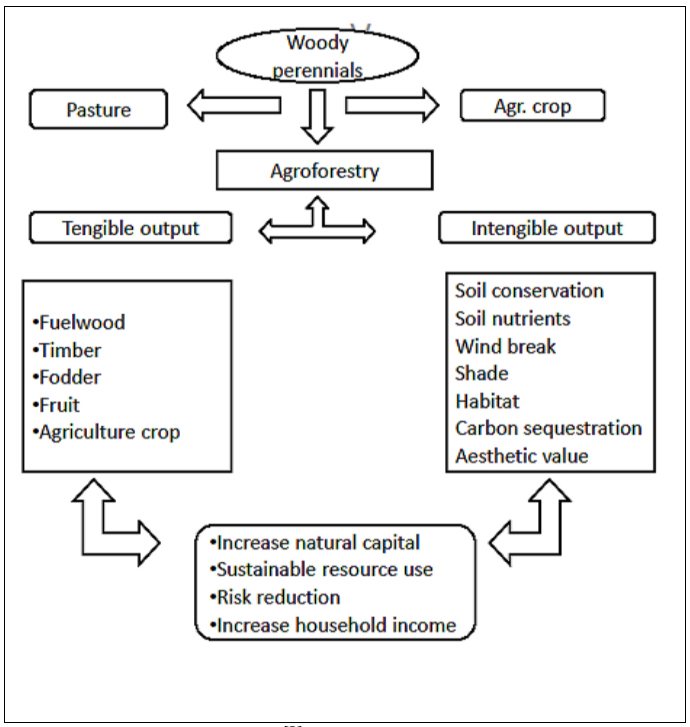
Livelihood Dimension	Components	Agroforestry Contributions
Economic	Income,employment, savings	Agroforestry provides diversified income sources (e.g., timber, fruits, NTFPs), enhances farm productivity, and creates rural jobs in planting, pruning, and marketing.
Social	Gender equity, social inclusion, education, and health	Engages marginalized groups (e.g., women in NTFP collection, youth in nurseries); builds community solidarity via cooperatives and forest groups.
Environmental	Natural resource sustainability, biodiversity, resilience	Trees improve soil fertility, retain moisture, reduce erosion, and buffer against climate shocks—making rural systems more sustainable and resilient.
Human Capital	Knowledge, skills, and labor health	Agroforestry builds technical and ecological knowledge (e.g., grafting, composting); improves health via better food diversity and nutritional security.
Physical Capital	Tools, infrastructure, basic services	Engages marginalized groups (e.g., women in NTFP collection, youth in nurseries); builds community solidarity via cooperatives and forest groups.

Source: Scoones, (1998) [35]

Contribution of agroforestry for livelihood improvement

India is notable for its considerable indigenous tree-planting expertise. Over ten years, small land plots, usually less than two hectares, that grow a combination of *Acacia* and *Oryza* (rice) species in a traditional agroforestry setup have shown an internal rate of return of 33% based on an annual discount rate of 12% and a benefit/cost ratio of 1.47 (Singh and Pandey, 2011) [37]. An Agri-horticultural system using *Psidium spp*. (guava) In Meghalaya in northeastern India, a system yielded almost three times the net return compared to a comparable system without trees (Bhattacharya and Mishra 2003) [8].

Agroforestry significantly enhances farmers' annual income. This income is generated from agricultural produce, timber, and livestock. Farmers primarily earn from crops like cocoa, coffee, cloves, rice, and fruits, as these plants yield quick returns and hold economic value, allowing farmers to secure a steady income for their daily needs. Common timber species cultivated in agroforestry include chrysolite, bayur, teak, sengon, medang, and hibiscus. Timber is mainly grown for long-term financial security, and households may harvest wood when a substantial amount of cash is required. Timber prices vary significantly based on the wood's species, maturity, size, and quality. Livestock farming is also viewed as a future investment by farmers. Many families raise cattle, sold or traded for cash and food, as part of their yearly routine. Cows and goats are the most frequently raised animals by farmers. Additionally, manure serves as a fertilizer for crops and a source of biogas fuel. The production costs in agroforestry management include expenses for fertilizers, pesticides, labor, and seeds. Land management practices are generally not intensive. (Chakrabarti *et al.*, 2025) [11].



Source: Bansal *et al.*, (2021) [3]

Fig 1: The contribution of agroforestry to the livelihood of thefarmers.

Challenges and Constraints in the Adoption of Agroforestry

The agroforestry approach is acknowledged as a valuable traditional method that significantly contributes to reducing vulnerability, improving the resilience of farming systems, and safeguarding households from climate-related risks (CAFRI, 2015) [10]. Nevertheless, in India, several challenges impede the realization of agroforestry's benefits. A primary concern is the scarcity of high-quality planting materials and enhanced seed varieties. (Verma *et al.*, 2017) [42].

Most planting supplies lack quality assurance, with only about 10% meeting high requirements. An over-reliance on a small number of species, such as Poplar, Eucalyptus, and Kadam,

results from a lack of research on agroforestry models suitable for the various Argo-climatic regions as well as for indigenous and multipurpose species (like Prosopis cineraria) (National Agroforestry Policy, 2014) [28]. The fact that most agroforestry research in India has been conducted in labs or at research stations on comparatively tiny plots is another worrying aspect. Most studies are relatively short-term, and little to no research has been done on the ecosystem or landscape level. (Puri and Nair, 2004) [33].

Linkages Between Agroforestry and Rural Livelihood

Livelihood Linkage	Agroforestry Contribution
Income Diversification	Agroforestry provides multiple income streams from timber, fruits, fuelwood, fodder, and non-timber forest products (NTFPs). It reduces reliance on a single income source and improves financial stability. (Chavan *et al.*, 2015) [12], (ICRAF, 2020) [21]
Food and Nutritional Security	Inclusion of fruit trees, legumes, and leafy vegetables in agroforestry systems increases household dietary diversity and food availability year-round. (FAO, 2018) [17]
Employment Generation	Agroforestry creates on-farm employment (nursery work, planting, harvesting) and off-farm opportunities (processing, transport, marketing). (NRCAF, 2013) [31], (FAO, 2018) [17]
LivelihoodResilience and Climate Adaptation	Trees stabilize soils, conserve water, and offer protection against drought and floods. They reduce vulnerability to climate shocks and support long-term sustainability. (ICRAF, 2020) [21]
SkillDevelopment and Enterprise Creation	Promotes knowledge in tree cultivation, agroecological practices, and entrepreneurship (e.g., NTFP processing, nursery operations). Primarily benefits women and youth. (Chavan *et al.*, 2015) [12], (ICRAF, 2020) [21]

National Agroforestry Policy

The State Action Plan on Climate Change (SAPCC) finalization year and the relevant nodal entities responsible for its creation are introduced. Notably, 14 of the 28 SAPCCs were established between 2014 and 2015, a significant amount of time after the Prime Minister announced the SAPCC project at the Conference of State Environment Ministers on August 18, 2009. (Datta and others, 2024) [13].

In most states, the relevant departments in charge of the environment, forests, and/or climate change coordinated the efforts to establish SAPCCs, soliciting feedback from a range of related departments and agencies. Many of the benefits of agroforestry for adaptation and mitigation that are highlighted in the SAPCCs are consistent with the findings of other research. (Albrecht and Kandji, 2003; Muthuri *et al*., 2005; Nair *et al*., 2009; Tewari *et al*., 2014) [2, 26, 38].

The SAPCCs largely saw agroforestry as a way to increase tree cover outside forest regions and store carbon, therefore strengthening the carbon sink. This strategy might be related to India's goal of meeting the NDC aim of creating a carbon sink by 2030 through increased forest and tree cover. (Government of India, 2022) [19].

Case Studies on Agroforestry and Rural Livelihoods

Region / Country	Agroforestry Practices	Livelihood Outcomes	Challenges
India (Chhattisgarh)	Agri-silviculture, NTFP-based system. e.g. - Mahua, Tendu, Bamboo	Seasonal employment for tribal populations in NTFP collection, lac cultivation, and nursery raising	Market instability; lack ofvalue addition infrastructure. (Government of Chhattisgarh, 2020) [18], (TRIFED, 2021) [41]
India (Uttar Pradesh, Haryana)	Poplar and Eucalyptus-based Agri-silviculture	High seasonal income from timber; increased employment in intercropping and nurseries	Land fragmentation; policy gaps. (NRCAF, 2013) [31]
Africa (Kenya)	Farmer-Managed Natural Regeneration (FMNR), woodlots	Job creation in nursery, charcoal, and honey enterprises; improved soil fertility	Weak extension services. (Place *et al.* 2012) [32], (ICRAF, 2020) [21]
Southeast Asia (Indonesia, Vietnam)	Jungle rubber, multistory agroforests	Enhanced household income; reduced deforestation	Logging pressure; weak enforcement. (Roshetko*et al.* 2007) [34], (FAO, 2018) [17]
Asia (Philippines)	Sloping Agricultural Land Technology (SALT), home-gardens	Increased income from fruits, vegetables, and firewood; soil conservation	Limited access to capital and training (Murniati*et al.*,2001) [25]

Conclusions

Agroforestry systems provide opportunities for enhancing the livelihoods of impoverished individuals by ensuring economic and environmental stability. Nontimber forest products are considered vital assets for sustaining livelihoods and conserving ecosystems. In India, agroforestry holds significant potential for creating employment opportunities. The most tremendous potential has been observed in the production of tree-borne oil seeds, followed closely by Silvi-pasture systems.

Agroforestry represents a vital pathway toward prosperity for farmers and rural communities, facilitating job creation and revenue generation; ensuring food and nutritional security; fulfilling other essential human needs sustainably; and providing a buffer against the impacts of climate change. It fosters more integrated, diverse, productive, profitable, healthy, and sustainable land use systems and is the only viable option to increase the nation’s forest and tree cover to 33%. The advantages and opportunities of agroforestry can be realized only through significant investments and coordinated initiatives in research, education, extension services, and suitable national policies. The National Agroforestry Policy of 2014 [28] has initiated a substantial shift in the progress of agroforestry in India by tackling many challenges that farmers and rural communities face. Still, the primary hurdle remains translating the National Agroforestry Policy from documentation to practical implementation at the grassroots level.

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