

International Journal of Agriculture Extension and Social Development

Volume 8; Issue 10; October 2025; Page No. 438-447

Received: 26-08-2025
Accepted: 30-09-2025

Indexed Journal
Peer Reviewed Journal

Empowering women through agroforestry: Opportunities and barriers in India

Nishikant Krishan¹, Yamini Baghe², Amit Dixit³, Pushpraj Khare¹ and Roopa Dhumketu¹

¹ Silviculture and Agroforestry, College of Forestry & Research Station, Sankara, Patan, Durg, Chhattisgarh, India

² Assistant Professor, Silviculture and Agroforestry, College of Forestry & Research Station, Sankara, Patan, Durg, Chhattisgarh, India

³ Professor, Department of Vegetable Science, MGUVV, Sankara, Patan, Durg, Chhattisgarh, India

DOI: <https://www.doi.org/10.33545/26180723.2025.v8.i10g.2566>

Corresponding Author: Nishikant Krishan

Abstract

Agroforestry has long been a cornerstone of rural livelihoods in India, providing food, fuel, fodder, timber, and ecosystem services. Yet, the gendered dimensions of agroforestry remain insufficiently explored, even as women play critical roles in sustaining and innovating these systems. This review synthesizes literature published between 2005 and 2025 to examine the opportunities and barriers for women's empowerment through agroforestry in India. The findings reveal that women are deeply engaged in nursery management, seed selection, fuelwood and fodder collection, and the preservation of local agro-biodiversity, but their contributions are often invisible in policy and market frameworks. Opportunities for empowerment include income diversification through non-timber forest products and tree-based enterprises, enhanced leadership via self-help groups and farmer producer organizations, and strengthened ecological stewardship in climate-smart agriculture. However, persistent barriers such as patriarchal norms, insecure land tenure, gender-blind extension services, limited access to credit and markets, and weak institutional mechanisms constrain women's agency and benefits. Policy and program evidence suggests that capacity building, secure land and tree tenure, inclusive financing, women-led producer collectives, and gender-responsive policy design can significantly enhance outcomes. The review highlights future prospects in integrating agroforestry with climate-smart agriculture and carbon markets, while underscoring research gaps in longitudinal, sex-disaggregated data and intersectional analyses. Ultimately, promoting women's empowerment through agroforestry is not only essential for gender equity but also critical for sustainable rural development, climate resilience, and biodiversity conservation in India.

Keywords: Agroforestry, women's empowerment, gender equity, climate-smart agriculture, land tenure, non-timber forest products, self-help groups, farmer producer organizations, carbon sequestration, India

Introduction

Agroforestry defined as the intentional integration of trees and shrubs with crops and/or livestock on the same land unit has gained renewed policy and research attention in India because of its documented contributions to livelihood diversification, ecosystem services, and climate resilience (Government of India, 2014) ^[15]. Despite the clear multifunctional potential of agroforestry systems to increase on-farm income, sequester carbon, and improve soil and water conservation, uptake across Indian agricultural landscapes remains constrained by a complex mix of regulatory bottlenecks, fragmented policy support, and limited institutional coordination (Venn *et al.* 2024 ^[31], Datta, Behera, & Rahut, 2024) ^[9]. Within this broader context, women are central actors: empirical and review evidence shows that women perform a large share of on-farm and household forestry tasks (from nursery management and fodder collection to processing of non-timber forest products) and possess rich local knowledge about multipurpose trees, yet their contributions are often undervalued and inadequately captured by mainstream interventions (CIFOR-ICRAF editorial collective, 2015) ^[7]. Measuring and strengthening women's empowerment in agricultural and agroforestry settings has advanced

Methodologically e.g., the WEAI and related instruments but gaps persist in how programs translate measurement into gender-transformative programming that tackles structural constraints such as land tenure, access to credit and markets, and extension services tailored to women (Quisumbing *et al.* 2023) ^[23]. Recent case studies and program reviews in India and similar contexts indicate that agroecological transitions and targeted policy measures hold promise for expanding meaningful economic and decision-making spaces for women, provided interventions address socio-cultural norms, resource rights, and value-chain inclusion simultaneously (Behl, 2023 ^[3], Datta *et al.* 2024) ^[9]. This makes a focused review on women's empowerment through agroforestry in India timely: synthesizing evidence on pathways, measured outcomes, policy levers, and persistent barriers can help build a roadmap for gender-transformative agroforestry policy and practice. This review has three interlinked objectives. First, it aims to synthesize empirical and policy literature (2005-2025) on the roles and contributions of women in agroforestry systems in India, highlighting how gendered divisions of labor, knowledge, and access shape both on-farm practices and household wellbeing. Second, it seeks to critically evaluate pathways through which agroforestry interventions and policies can

contribute to women's economic and social empowerment, drawing on recent program evaluations, measurement advances (e.g., WEAI adaptations), and state-level policy analyses to identify what works, for whom, and under what conditions (Quisumbing *et al.* 2023^[23], Datta *et al.* 2024)^[9]. Third, the review will identify key barriers and institutional gaps including constraints in land and resource rights, extension and training reach, market access, and policy incoherence that limit women's meaningful participation and benefits from agroforestry, and then propose actionable research and policy priorities for gender-transformative agroforestry programming in India (Venn *et al.* 2024^[31], CIFOR-ICRAF, 2015)^[7]. Throughout, the review emphasizes evidence from peer-reviewed journals, major CGIAR/ICRAF outputs, and recent national policy analyses so that conclusions and recommendations are anchored in both rigorous evaluation and policy relevance.

2. Agroforestry in India: An Overview

2.1 Historical context and evolution: Agroforestry in the Indian subcontinent is rooted in millennia-old agroecological traditions from home gardens and sacred groves to taungya and pastoral silvopastoral arrangements and these deeply embedded practices formed the historical substrate for modern agroforestry science and policy (Pandey, 2007)^[22]. Scientific attention to agroforestry grew markedly from the 1970s onward as researchers recognized tree-crop interactions for livelihood support, soil and water conservation, and biodiversity conservation, by the early 2000s this translated into systematic documentation and synthesis of indigenous systems and their ecosystem services (Dagar, Singh, & Arunachalam, 2014)^[8]. Over the past two decades scholars and national institutes have further refined classification of Indian agroforestry types (home gardens, boundary plantations, silvopasture, alley cropping, and agrosilvicultural mosaics) while quantifying their multifunctional benefits, such as fuelwood and fodder provisioning, timber production, microclimate regulation and carbon sequestration (Pandey, 2007^[22], Dagar *et al.* 2014)^[8]. Importantly, historical land-use legacies colonial forest laws, post-independence forest sector priorities, and agrarian policies that separated forestry from agriculture constrained formal recognition of trees outside forests for many decades, only in the 2010s did a policy and research convergence begin to mainstream agroforestry as an agricultural as well as forestry strategy (Government of India, 2014)^[15]. This evolution from customary practice to formal policy and institutional attention sets the stage for evaluating how agroforestry can now be mobilized for livelihoods, climate resilience, and inclusive development.

2.2 Current status and practices

Despite longstanding practice and policy interest, the on-ground expansion and formal integration of agroforestry remain uneven: India's India State of Forest Report (ISFR) 2023 documents modest increases in forest and tree cover and highlights a sizeable area of Trees-Outside-Forest (TOF), signalling important agroforestry potential, but national estimates indicate that the proportion of total land under active agroforestry remains limited relative to the country's agricultural area (Forest Survey of India, 2023)

^[13]. Empirical analyses and policy-think tank reviews show that while certain states and districts exhibit dense clusters of innovative, species-rich home gardens and farm forestry (for example in parts of Karnataka, Kerala, and the northeast), large tracts of arable lands still lack systematic tree integration because of tenure uncertainty, market bottlenecks and institutional fragmentation (Council on Energy, Environment and Water [CEEW], 2023)^[6]. On the practice side, contemporary Indian agroforestry blends traditional models (home gardens, taungya, boundary planting) with modern approaches (silvopasture, alley cropping, fruit-tree intercropping and integrated tree-crop-livestock systems) tailored to local ecologies and value chains, studies increasingly emphasise design elements that boost productivity while maintaining farmer incomes for instance species selection that complements seasonal cropping and fodder needs (Datta, Behera, & Rahut, 2024)^[9]. At the same time, several evaluations find that increases in national tree cover reported by remote sensing do not automatically translate into livelihood benefits unless supported by market linkages, processing infrastructure and clear legal/regulatory frameworks that facilitate harvest and sale (CEEW, 2023, Forest Survey of India, 2023)^[13, 6].

2.3 Policy support and institutional framework

Policy recognition for agroforestry has advanced substantially in the last decade: India's National Agroforestry Policy (2014)^[15] was a pivotal milestone that for the first time articulated an inter-sectoral approach to integrate trees into agricultural landscapes, recommend institutional coordination mechanisms, and propose measures to relax barriers such as onerous timber felling rules on private lands (Government of India, 2014)^[15]. Following the policy, the government launched the Sub-Mission on Agroforestry (SMAF) under the National Mission for Sustainable Agriculture (NMSA) (operationalised from 2016-17) to incentivize on-farm tree planting, provide planting material and training, and catalyse state-level action (Department of Agriculture & Farmers Welfare, 2016)^[10]. Complementing these central measures, research and extension institutions such as the Central Agroforestry Research Institute, state agricultural universities, and international research bodies have played critical roles in varietal trials, farmer training, and knowledge exchange (Dagar *et al.* 2014)^[8]. Yet recent policy reviews and working papers highlight persistent institutional gaps: fragmentation across agriculture, forestry and rural development departments, inconsistent state-level regulations (especially regarding tree-felling and timber commerce on farmland), and limited long-term financing and market development remain major bottlenecks to scaling agroforestry (Sanyal, 2024^[28], Datta *et al.* 2024)^[9]. The policy trajectory is promising a formal national policy, mission-level incentives and growing technical capacity but experts underscore that scaling agroforestry equitably (including benefits to women and smallholders) requires clearer subnational rule harmonisation, stronger value-chain support and sustained investments in planting material, extension and farmer organization (Government of India, 2014, Department of Agriculture & Farmers Welfare, 2016, Sanyal, 2024)^[28, 15, 10].

3. Methodology

This review article employed a systematic literature synthesis approach to examine the opportunities and barriers to women's empowerment through agroforestry in India. Relevant academic publications, policy documents, and project reports published between 2005 and 2025 were identified through searches on Google Scholar, ResearchGate, Scopus, and Web of Science using keywords such as “*women in agroforestry*,” “*gender and agroforestry India*,” “*women empowerment rural forestry*,” “*gender and climate-smart agriculture*,” and “*gender equity in land tenure and agroforestry*.” To ensure comprehensive coverage, both peer-reviewed journal articles and authoritative grey literature (such as FAO, CIFOR-ICRAF, NABARD, World Bank, and government reports) were included. Only publications directly addressing gender roles, women's participation, empowerment outcomes, or barriers in agroforestry systems were selected. Preference was given to recent studies (2015-2025) to capture the latest policy interventions, while earlier foundational works (2005-2014) were used for historical context and conceptual framing.

The collected literature was analyzed using a thematic synthesis approach, grouping evidence under five core dimensions: (1) women's traditional roles in agroforestry, (2) opportunities for economic, social, and ecological empowerment, (3) barriers to participation, (4) strategies and policy interventions, and (5) future prospects and research gaps. Each selected study was critically reviewed for methodological rigor, geographical coverage, and relevance to the Indian context, and its findings were coded into thematic categories. To avoid bias, references were drawn from a diverse set of authors and institutions, ensuring no single source was disproportionately represented. The synthesized evidence was then interpreted to construct a balanced narrative that integrates empirical findings, policy analysis, and case study insights.

4. Women and Agroforestry: A Gendered Perspective

4.1 Traditional Roles of Women in Agroforestry

In India and comparable agroforestry contexts, women have long been assigned discrete, gendered roles in tree cultivation, management, and related tasks, often shaped by socio-cultural norms and labor divisions. In studies of home-garden agroforestry in the Kumaun Himalayas, Bargali (2015) [12] observed that women undertake nearly all tasks except ploughing including planting, weeding, harvesting, nursery care, and composting, often working independently in hill zones (Bargali, 2015) [12]. In broader South Asian and global contexts, Ramirez-Santos *et al.* (2023) [26] highlight that women are disproportionately responsible for routine tasks such as nursery management, pruning, seed collection, and caring for seedlings, tasks portrayed as “less physical” than heavy land preparation but essential to system functioning (Ramirez-Santos *et al.* 2023) [26]. A gendered analysis of traditional agroecological knowledge also emphasizes how women's workloads in agroforestry are shaped by overlapping responsibilities: domestic chores, child care, water/fuelwood collection constrain time available for formal training or extension (Ramirez-Santos *et al.* 2023) [26]. In India's policy discourse, agroforestry is sometimes positioned as “close to home”

land use to reduce drudgery: the CEEW reports that women prefer agroforestry systems that provide fuelwood, fodder or food species near homesteads, reducing walking time and supplementing livelihoods (Council on Energy, Environment and Water [CEEW], 2023) [6]. These traditional roles remain undervalued and often invisible in formal programs, which tend to focus on male-dominated land allocation, timber species, and commercial tree planting, further reinforcing gendered patterns of task allocation.

4.2 Women's Knowledge Systems and Local Practices

Women possess rich local and gendered knowledge of multipurpose trees, species combinations, phenology, seed selection, and microclimatic interactions knowledge that often goes unrecognized in mainstream agroforestry research and extension. Ramirez-Santos *et al.* (2023) [26] document in their systematic review the growing literature on traditional agroecological knowledge (TAeK), which shows that women are central to conserving and transmitting seed systems, medicinal species, understory species, and niche species combinations tailored to micro-niches. They note that publications linking gender and TAeK in agroforestry systems are on the rise, although geographic and system coverage remain uneven (Ramirez-Santos *et al.* 2023) [26]. In India specifically, Datta, Behera, and Rahut (2024) [9] identify that agroforestry systems frequently build on indigenous practices of intercropping trees with fodder shrubs or nitrogen-fixing species practices that are often initiated or stewarded by women farmers based on generational experience. Moreover, a World Agroforestry “User Guide to Gender Analysis in Agroforestry” outlines how women's knowledge networks (informal peer exchange, women's groups, maternal lineage networks) serve as conduits for local innovation, adaptation, and dissemination of agroforestry practices (World Agroforestry, 2017) [32]. However, women's adaptive practices and experimentation are frequently marginalized in extension systems: because training and demonstration plots are often male-oriented, they may not reflect women's priorities (e.g. lower-height trees, fodder species, multipurpose shrubs) or suit their time constraints, limiting uptake of improved agroforestry models (Galudra *et al.* / Tropenbos, 2022) [14].

4.3 Contribution of Women to Household Livelihoods

Women's contributions in agroforestry systems extend well beyond labor they generate tangible food, fodder, fuel, income streams, nutritional security, and ecosystem services, which underpin household resilience. Studies show that women account for a large share of collection and processing of non-timber forest products (NTFPs): for example, in many agroforestry and forestry projects, up to 60-70% of fuelwood, fodder, and NTFP collection is carried out by women (Biswas *et al.* / Nandeha *et al.* 2025) [4] (see also *Women's Contributions to Community Forestry and Agroforestry Systems*). Women's income dependence on agroforestry is evident: some analyses report that over half of a forest-dependent household's annual income may derive from tree and NTFP activities managed or collected by women, compared with roughly a third for men (Biswas *et al.* / Nandeha *et al.* 2025) [4]. Nguyen, North, Duong, and

Nguyen (2021) ^[21] in their assessment of exemplar agroforestry landscapes (outside India, but instructive) find that women perceive and derive multiple benefits improved knowledge and skills, social status, networking, and incremental income from participation in tree planting, soil conservation and agroforestry interventions (Nguyen *et al.* 2021) ^[21]. Their data show that in project areas where women had stronger engagement, household food security improved via home gardens and tree cropping, and women gained new small sale opportunities. In the Indian context, Datta *et al.* (2024) ^[9] emphasize that agroforestry interventions often enhance dietary diversity and fodder availability (reducing livestock feed costs) while opening extra income avenues, especially when value chains for tree crops or NTFPs are strengthened. Thus, women's contributions in agroforestry generate both subsistence value and earned income, playing a critical role in cushioning households against agrarian shocks, diversifying livelihoods, and strengthening resilience to climate variability.

5. Opportunities for Women's Empowerment through Agroforestry

5.1 Economic Opportunities (income generation, market access): Agroforestry presents substantial economic opportunities for rural women by diversifying household income streams, expanding on-farm value addition, and opening pathways into organized markets and producer groups, when design and market linkages are intentionally gender-responsive, these opportunities can translate into measurable gains in women's earnings and autonomy. Empirical compendia of women's enterprises in India demonstrate that women's groups and producer organizations that aggregate tree-crop produce (fruits, honey, value-added non-timber forest products) reduce transaction costs, improve price realization and enable women to capture a larger share of value chains compared with isolated producers (Livelihoods India, 2023) ^[19]. Policy and program reviews emphasize that agroforestry interventions that combine planting material, technical training, and explicit market development (buyer linkages, branding, and small-scale processing) are more effective at generating sustained incomes for women than stand-alone planting subsidies (Council on Energy, Environment and Water [CEEW], 2023) ^[6]. Microdata and impact evaluations further show that coupling women's collective institutions (SHGs/FPOs) with financial inclusion and market facilitation can produce rapid income effects: documented projects in which women organized around fruit orchards, honey, or value-added NTFPs report earlier and steadier cash flows and reinvestment in household welfare (Kumar, 2021) ^[18]. Crucially, the income potential is mediated by gendered constraints women's restricted mobility, limited control over sale decisions, and lack of access to larger contracts which means program design must deliberately address market information asymmetries, transport and storage bottlenecks, and business skills targeted to female entrepreneurs. When these constraints are reduced (for example through aggregation, contract farming models oriented to smallholders, and local processing hubs), agroforestry can shift from subsistence provisioning to a credible pathway for women's micro-enterprise and economic empowerment (Livelihoods India, 2023, CEEW, 2023) ^[6, 19].

5.2 Social Empowerment (decision-making, leadership, self-help groups): Beyond cash earnings, agroforestry can be a vector for social empowerment by opening new decision-making spaces for women at the household and community level, building leadership capacity through collective action, and strengthening social capital via self-help groups (SHGs) and producer federations. Rigorous panel studies using pro-WEAI and similar indices find that sustained engagement with women's groups combined with targeted agricultural information reduces gender gaps in empowerment, increases women's participation in agricultural decisions, and enlarges the set of domains (crop choices, sale decisions, input procurement) where women have meaningful voice (Kumar, 2021 ^[18], Raghunathan, 2018) ^[24]. Program evaluations from India show that SHGs that combine savings/credit functions with enterprise development and training in agroforestry-linked livelihoods (e.g., orchard management, NTFP processing, nursery enterprises) produce larger empowerment effects than groups focused solely on micro-credit, because they create both economic returns and social learning spaces where women assume new leadership roles and public identities (Raghunathan, 2018) ^[24]. Qualitative studies of natural-farming and agroecology initiatives in northern India further indicate that women's active participation in group-based agroforestry interventions often leads to increased mobility, negotiation power within the household, and participation in local governance forums although these gains are uneven and dependent on pre-existing social norms and intra-household bargaining dynamics (Behl, 2023) ^[3]. Therefore, while agroforestry is not a panacea, when combined with consciously gendered facilitation, capacity building, and institutional supports (training timed to women's schedules, women-led demonstration plots, and recognition of women's knowledge), it creates durable routes for social empowerment and leadership.

5.3 Environmental Stewardship and Conservation Roles

Women are frequently frontline stewards of biodiversity and ecosystem services within agroforestry landscapes, and their traditional management practices, species knowledge and daily resource-use routines contribute substantially to conservation outcomes and climate resilience. Multiple practitioner guides and thematic reviews emphasize women's role in seed selection, maintenance of multipurpose home gardens, preservation of medicinal and understory species, and micro-watershed care activities that sustain in situ agrobiodiversity and improve household adaptation capacity (World Agroforestry, 2017, Tropenbos, 2022) ^[32]. Case syntheses and policy briefs for India illustrate that women's management of homestead agroforests and community tree resources reduces drudgery (shorter fuelwood/fodder collection distances), stabilizes local microclimates, and supports soil and water conservation measures that benefit both crops and livestock (Rizvi *et al.* 2024) ^[27]. Moreover, evidence from climate-smart agriculture and agroforestry projects shows that when women are included in participatory planning and monitoring, the selection of locally adapted, multi-purpose species increases, enhancing both carbon sequestration potential and household resilience to climatic shocks (Tropenbos, 2022). However, achieving these outcomes at

scale requires that women's ecological knowledge be legitimized and integrated into formal extension and landscape-level planning, and that tenure/harvest rights protect women's ability to steward and benefit from tree resources, absent secure use-rights, women's stewardship may not translate into long-term conservation incentives or equitable benefit sharing (World Agroforestry, 2017, Rizvi *et al.* 2024) ^[27, 32].

5.4 Case Studies / Best Practices in India

A number of Indian case studies demonstrate how well-designed agroforestry initiatives, especially those that prioritize women's agency and market linkages, can deliver both livelihoods and empowerment outcomes. The Palash branding and market aggregation initiative in Jharkhand which brought together hundreds of SHGs to process and market agricultural and NTFP products under a single brand has been documented as a scalable model for converting women's home-based production into formal market income, enhancing bargaining power and group leadership (Livelihoods India, 2023, Times of India, 2025) ^[19, 29]. In Bokaro district, women's collectives converted degraded land into a remunerative mango orchard by leveraging government schemes, technical training and a producer company structure, women reported significant cash earnings and improved decision-making in household affairs following the enterprise's success (Times of India, 2025) ^[29]. In Himachal Pradesh, documented natural-farming and agroecology projects show that women's central role in home gardens and on-farm tree management improved dietary diversity, decreased reliance on purchased fodder and increased women's visibility in local value chains an outcome traced to explicit gender-sensitive facilitation and training (Behl, 2023) ^[3]. These real-world examples illustrate recurring design features of successful interventions: (1) deliberate inclusion of women in planning and leadership, (2) bundling of technical inputs with business development and market access, (3) formation or strengthening of collectivities (SHGs / FPOs) for aggregation, and (4) linkages to safety-net or subsidy schemes that lower initial adoption risk. Collectively, these practices point to scalable pathways where agroforestry can be both an ecological strategy and an engine of women's economic and social empowerment in India.

6. Barriers to Women's Participation in Agroforestry

6.1 Socio-cultural Constraints (patriarchy, gender norms): Deeply entrenched socio-cultural norms and patriarchal structures remain some of the most persistent barriers limiting women's full participation in agroforestry. In many parts of rural India, women's agricultural work is regarded as "subsidiary" to men's farming roles, despite women performing a disproportionate share of labor in nursery raising, weeding, fodder and fuelwood collection (Bargali, 2015) ^[2]. Social expectations about women's domestic responsibilities restrict their time for training, group meetings, or participation in decision-making fora (Raghubathan, 2018) ^[24]. Additionally, gender norms often exclude women from discussions over species selection, land allocation for tree planting, and marketing, effectively marginalizing them from higher-value segments of agroforestry systems (Kiptot & Franzel, 2012) ^[17]. In many

communities, cultural taboos further discourage women from taking leadership in producer groups or handling cash from tree-product sales, which perpetuates male dominance in income control (Nguyen *et al.* 2021) ^[21]. These socio-cultural constraints contribute to the invisibility of women's contributions, reinforcing a gendered labor hierarchy that undervalues the ecological and livelihood roles women play in sustaining agroforestry systems.

6.2 Limited Land Tenure and Resource Rights

A central structural barrier to women's empowerment in agroforestry is insecure land tenure and unequal resource rights. In India, women own less than 14% of operational holdings, and even where they do, plots are typically smaller, more fragmented, and less fertile than men's land (Agarwal, 2018) ^[1]. Without secure land titles, women lack both collateral for credit and the authority to plant, manage, or harvest trees on farmland. Studies have shown that insecure tenure discourages investment in long-gestation tree crops, which constrains women's ability to diversify livelihoods through agroforestry (FAO, 2019) ^[12]. Community forestry regimes can also marginalize women if governance structures allocate decision-making power primarily to male heads of households, limiting women's influence over species choice or benefit-sharing (Colfer *et al.* 2015) ^[7]. Even where laws provide for joint titling, implementation remains patchy and often undermined by local customs (Agarwal, 2018) ^[1]. Thus, addressing tenure inequities is critical: without secure rights over land and tree resources, women's participation in agroforestry remains precarious and conditional.

6.3 Knowledge Gaps, Training, and Extension

Limitations: Knowledge and capacity barriers significantly limit women's ability to adopt and benefit from agroforestry innovations. Extension services in India have historically been male-centric, with training sessions, demonstration plots, and technical advisories predominantly targeted at male farmers (Datta, Behera, & Rahut, 2024) ^[9]. Women farmers often have limited access to formal information channels, relying instead on informal peer networks, which constrains their exposure to new agroforestry technologies, improved tree germplasm, and market opportunities (World Agroforestry, 2017) ^[32]. Time poverty, illiteracy, and mobility restrictions further exacerbate the knowledge gap. A systematic review on gendered traditional agroecological knowledge found that while women hold significant knowledge of local species, soil fertility practices, and seed conservation, this knowledge is rarely integrated into formal extension systems (Ramirez-Santos *et al.* 2023) ^[26]. Without targeted capacity building, women risk being locked into low-value, subsistence-oriented practices while men capture more lucrative opportunities associated with commercial agroforestry.

6.4 Market and Financial Constraints

Market access and financial capital are critical determinants of agroforestry adoption, yet women face compounded barriers in both domains. Women frequently lack direct access to markets due to mobility restrictions, lower bargaining power, and exclusion from producer cooperatives that control aggregation and sales (Livelihoods

India, 2023)^[19]. Even when women produce marketable surplus (e.g., fruits, NTFPs, timber), male household members often control marketing and income, limiting women's financial autonomy (Kumar, 2021)^[18]. Credit access is another challenge: collateral requirements tied to land ownership systematically exclude women, and microfinance loans while more accessible are often insufficient to support long-term agroforestry investments (Quisumbing *et al.* 2023)^[23]. Studies also highlight that women's enterprises face difficulties in scaling up due to limited access to cold storage, transport, and processing facilities, which reduces profitability (CEEW, 2023)^[6]. These constraints prevent women from fully leveraging agroforestry's potential as a pathway to economic empowerment.

6.5 Institutional and Policy Challenges

Despite progressive initiatives such as the National Agroforestry Policy (2014)^[15] and the Sub-Mission on Agroforestry (SMAF), gender integration in India's agroforestry policy and institutional frameworks remains weak. Policies often adopt gender-neutral language that fails to account for the differentiated needs, roles, and constraints of women farmers (Rizvi *et al.* 2024)^[27]. Implementation bottlenecks such as lack of gender-sensitive indicators, poor coordination between agriculture and forestry departments, and inadequate funding for women-focused programs further constrain women's inclusion (Sanyal, 2024)^[28]. International reviews also emphasize that institutional fragmentation and rigid regulatory frameworks around tree felling, timber transit, and benefit sharing disproportionately disadvantage women, who often have less political voice to navigate bureaucratic processes (Venn *et al.* 2024)^[31]. Moreover, while NGOs and donor-funded projects sometimes create women-centered agroforestry models, these are rarely institutionalized at scale in government programs. Without deliberate mainstreaming of gender concerns into national and state-level policy design, women's empowerment through agroforestry will remain piecemeal rather than systemic.

7. Strategies and Policy Interventions for Promoting Gender Equity

7.1 Capacity Building and Skill Development

Effective capacity-building for women in agroforestry requires more than one-off trainings, it demands sustained, context-sensitive, and women-friendly approaches that combine technical skills (silviculture, nursery management, pest/disease management), business skills (post-harvest handling, value-addition, bookkeeping), and leadership/organizational training. Evidence from India and comparable contexts shows that participatory training methods farmer field schools, women-led demonstration plots, and video-based peer learning improve adoption rates and are better aligned to women's time constraints when sessions are scheduled locally and use visual or oral methods (Digital Green case studies, Reach Alliance, 2019)^[11]. Scaling such approaches benefits from layering interventions: short technical modules should be paired with longer mentorship, seasonal refresher sessions, and linkages to extension agents who are gender-sensitive or women extension workers where possible (World Bank, 2023)^[33].

Capacity building should also explicitly include climate-resilience topics (species selection for drought tolerance, mixed cropping designs that reduce risk) and enterprise development modules so women can convert agroforestry products into marketable goods. Programs that invest in training women as para-extension agents or community nurserypersons create multiplier effects they build local capacity while increasing women's status and mobility (Bohra, 2023)^[5]. Finally, monitoring and evaluation must measure not only technical uptake but changes in decision-making, time allocation, and income control to ensure capacity building translates into genuine empowerment (Quisumbing *et al.* 2023)^[23].

7.2 Access to Credit, Technology, and Markets

Access to finance, appropriate technologies and market infrastructure is central to turning agroforestry into a sustainable pathway for women's economic empowerment. Financial products must reflect agroforestry's long time horizons (tree crops often require multi-year investments) and women's constrained collateral options, blended finance models combining small grants or subsidies for establishment with low-interest longer-term credit, delivered through SHGs or women-FPOs have shown promise in India's FPO experiments (NABARD FPO case studies, 2022)^[20]. Technology and rural infrastructure improvements (mobile market information, local processing units, community cold-chains, and small mechanization suitable for women's labor) raise returns and reduce drudgery, helping women move up value chains (CEEW, 2023)^[6]. Producer collectivization women's SHGs, women-led FPOs or producer companies is repeatedly identified as a robust pathway to reduce transaction costs, negotiate better prices, and enable access to bulk buyers and government procurement schemes, recent exploratory studies of women FPOs show improved market linkages when accompanied by business development support (Rai, 2024, NABARD, 2022)^[20]. Digital platforms (for aggregation, price discovery, and traceability) can be inclusive if combined with local facilitation to overcome literacy and connectivity barriers otherwise they risk privileging better-connected male actors (Digital Green, World Bank, 2023)^[33]. To be effective, market and finance interventions must be co-designed with women to match seasonal cashflow patterns, mobility limits, and household responsibilities.

7.3 Strengthening Women's Land and Resource Rights

Securing women's land and tree tenure is arguably the single most important structural policy reform to enable long-term investment in agroforestry. Empirical work in India shows persistent gender gaps in land ownership, with very low percentages of land titles in women's names and widespread prevalence of customary practices that favour male control, which together reduce women's access to credit and authority to plant long-term trees (Jain, 2023^[16], NCAER land-rights brief, 2023). Policy options that have empirical support include promoting joint titling, simplifying procedures for women to obtain pattas/land records, targeted distribution of homestead plots to women, and public campaigns to ensure social recognition of women's ownership (Kelkar & others, World Bank policy note). At the community level, reforms in local forest and

land governance that formally entrench women's representation on user committees, and legal recognition of women's rights over NTFPs and on-farm trees, improve both stewardship incentives and benefit sharing (Colfer *et al.* 2015) ^[7]. Implementation matters: several state-level land titling drives in India that included public joint-title ceremonies and simplified documentation saw better uptake by women when local administration proactively facilitated outcomes (policy briefs and program reviews). Securing use-rights for women over homestead trees and community groves and linking those rights to access to planting material and market supports creates the necessary economic and social incentives for women to undertake long-term agroforestry investments.

7.4 Role of NGOs, Cooperatives, and Community-based Organizations: NGOs, cooperatives and community-based organizations have been catalytic in demonstrating gender-transformative agroforestry models and bridging gaps between women and formal institutions. Successful interventions typically combine technical training with institutional development (help forming SHGs/FPOs, governance training, and market linkages) and deliberate gender norms change components (dialogues with men, flexible meeting times, and women's leadership pathways) (Tropenbos gender practice guide, 2022). Case evidence from India's civil society projects (for example, local cooperatives converting degraded lands into community orchards, women's groups running processing units, and NGO-led value chain incubation) shows that these organizations can pilot gender-responsive innovations at scale and then seed government uptake (Livelihoods India, SRIJAN example in Madhya Pradesh). Cooperatives and FPOs that prioritize women's membership and leadership, and that receive targeted capacity building and business advisory services, tend to deliver stronger empowerment outcomes than those that treat gender as an afterthought (NABARD FPO study, 2022, Rai, 2024) ^[20]. Importantly, NGOs can play a mediating role supporting documentation for land claims, facilitating women's participation in local fora, and demonstrating business models attractive to private sector buyers but long-term sustainability requires institutionalizing these gains through policy and public finance channels.

7.5 Integrating Gender into Agroforestry Policies

Mainstreaming gender into agroforestry policy requires explicit targets, gender-sensitive indicators, and budgetary allocations that prioritize women's needs across all stages of policy design and implementation. Recent policy reviews of India's agroforestry trajectory argue that while the National Agroforestry Policy (2014) ^[15] and subsequent mission activities provided an enabling architecture, they often lacked clear gender disaggregation in beneficiary targeting, monitoring frameworks and incentives (Rizvi *et al.* 2024) ^[27]. Best practice policy integration includes: mandatory gender analyses at the design stage, sex-disaggregated targets for subsidies and planting material distribution, support for women-led FPOs in procurement preferences, and institutional mandates for gender focal points across agriculture and forestry departments to coordinate actions (Venn *et al.* 2024) ^[31]. Monitoring frameworks should

capture empowerment outcomes (decision-making, income control, time use) in addition to biophysical indicators, this will allow adaptive management and course corrections where initiatives fail to reach women. Finally, integrating gender across finance, land, extension and market policies rather than treating it as a stand-alone add-on is essential to address the multi-dimensional barriers women face in agroforestry adoption and benefit realization.

8. Future Prospects and Research Gaps

8.1 Emerging Opportunities in Climate-smart Agriculture: Agroforestry is increasingly positioned as a cornerstone of climate-smart agriculture (CSA) in India, offering multiple co-benefits of productivity, adaptation, and mitigation. Integrating trees into agricultural landscapes can help buffer smallholder farmers against climate variability, improve soil fertility and water regulation, and contribute to national climate commitments through enhanced carbon sinks (Datta, Behera, & Rahut, 2024) ^[9]. Women, as key managers of home gardens, fodder systems, and fuelwood resources, are uniquely placed to benefit from and drive CSA-oriented agroforestry practices if institutional support targets their roles. The National Action Plan on Climate Change (NAPCC) and several State Climate Action Plans highlight agroforestry as a mitigation strategy, but most do not yet systematically integrate gender-sensitive approaches (Rizvi *et al.* 2024) ^[27]. Looking forward, embedding agroforestry within CSA frameworks offers opportunities to enhance women's adaptive capacities while also contributing to climate resilience at the landscape scale provided that future programs explicitly recognize women as both agents and beneficiaries of CSA transitions.

8.2 Role of Women in Carbon Sequestration and Ecosystem Services: The contribution of agroforestry to carbon sequestration is well documented, yet women's role in this domain remains underexplored. Studies show that home gardens, boundary plantations, and mixed cropping systems, many of which are managed or co-managed by women, store significant above- and below-ground carbon while maintaining biodiversity (Behl, 2023 ^[3], Pandey, 2007) ^[22]. Women's daily management of tree-based systems including pruning, coppicing, mulching, and seedling care directly influences biomass accumulation and soil organic carbon, but these contributions are rarely captured in formal carbon accounting frameworks (Colfer *et al.* 2015) ^[7]. Moreover, women's indigenous knowledge about species diversity, medicinal plants, and understorey vegetation enhances ecosystem services such as pollination, nutrient cycling, and microclimate regulation (Ramirez-Santos *et al.* 2023) ^[26]. Future research must foreground women's ecological agency and explicitly link their practices to quantified ecosystem services, including carbon credits, to ensure equitable benefit-sharing under emerging carbon markets and nature-based solutions.

8.3 Areas Needing Further Research

Despite a growing body of evidence on gender and agroforestry, critical gaps persist. First, there is a lack of robust, sex-disaggregated longitudinal data capturing

women’s roles in agroforestry adoption, income generation, and ecological stewardship. Most studies rely on short-term surveys or qualitative accounts, limiting comparability across contexts (Quisumbing *et al.* 2023) ^[23]. Second, there is little evidence on how emerging technologies digital extension, climate information services, and carbon accounting platforms can be tailored to overcome women’s access and literacy constraints. Third, the intersection of gender with caste, class, and ethnicity in shaping access to land, credit, and markets remains underexplored in agroforestry research, despite its obvious importance in India (Agarwal, 2018) ^[1]. Finally, research must move beyond documenting women’s constraints to rigorously evaluate gender-transformative approaches such as joint titling, women-led FPOs, and policy incentives and assess their impacts on empowerment and sustainability outcomes. Addressing these gaps will require interdisciplinary collaborations that integrate social science, forestry, and climate policy research to build a comprehensive evidence base.

9. Conclusion: Agroforestry offers significant potential to advance women’s empowerment in India by combining livelihood security, ecological resilience, and social transformation. Women are central to the functioning of these systems, contributing to seed management, fuelwood and fodder collection, non-timber forest product processing, and biodiversity conservation. At the same time, they face structural challenges such as unequal land ownership, limited access to credit and markets, and socio-cultural norms that restrict their agency in decision-making. The review highlights that empowerment does not occur automatically through participation in agroforestry, but rather through intentional interventions that address gender-

specific barriers. Looking ahead, strategies that strengthen women’s land and resource rights, expand their role in farmer producer organizations and self-help groups, and ensure access to training, technology, and finance are vital for inclusive development. Embedding gender equity within national and state agroforestry policies, while creating opportunities in climate-smart agriculture and carbon markets, can further enhance women’s roles as both economic contributors and environmental stewards. By transforming existing challenges into opportunities, agroforestry can serve as a dual pathway promoting sustainable livelihoods and advancing gender equity-ultimately contributing to more resilient rural communities and a more balanced model of development.

10. Acknowledgment

The authors sincerely express their gratitude to the College of Forestry & Research Station, Sankara, Patan, Durg (C.G.), for providing academic guidance and institutional support during the preparation of this review. Special thanks are extended to the faculty members and colleagues of the Department of Silviculture and Agroforestry for their valuable suggestions and encouragement. The authors also acknowledge the contributions of various researchers, institutions, and organizations whose work has provided the foundation for this study.

11. Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this review article, “*Empowering Women through Agroforestry: Opportunities and Barriers in India.*”

Table 1: Traditional Roles of Women in Agroforestry in India

Role/Activity	Examples of Practices	Source(s)
Nursery management	Raising seedlings, watering, seed selection	Bargali (2015) ^[2]
Fuelwood and fodder collection	Daily gathering from home gardens, boundaries	CEEW (2023) ^[6]
NTFP collection & processing	Tendu leaves, Mahua flowers, medicinal plants	Colfer <i>et al.</i> (2015) ^[7]
Soil fertility management	Compost preparation, mulching, manure application	Ramirez-Santos <i>et al.</i> (2023) ^[26]

Table 2: Opportunities for Women’s Empowerment through Agroforestry

Dimension	Key Opportunities	Examples/Case Studies	Source(s)
Economic	Income generation, small enterprises, market access	Palash brand (Jharkhand SHGs)	Livelihoods India (2023) ^[19]
Social	Leadership in SHGs, decision-making, community mobilization	Women-led orchards in Bokaro	Times of India (2025) ^[29]
Environmental	Biodiversity stewardship, home garden conservation, CSA role	Himachal agroecology projects	Behl (2023) ^[3]
Policy-linked	SMAF incentives, women-FPOs support	NABARD FPO initiatives	NABARD (2022) ^[20]

Table 3: Barriers to Women’s Participation in Agroforestry

Barrier Type	Key Challenges	Source(s)
Socio-cultural	Patriarchy, gender norms, time poverty, mobility restrictions	Kiptot & Franzel (2012) ^[17]
Land tenure	Low land ownership, insecure rights, weak benefit-sharing	Agarwal (2018), FAO (2019) ^[1, 12]
Knowledge & extension	Male-centric extension, limited access to training and technology	Datta <i>et al.</i> (2024) ^[9]
Market & financial	Lack of credit, weak bargaining power, exclusion from cooperatives	Kumar (2021) ^[18] , CEEW (2023) ^[6]
Institutional & policy	Gender-neutral policies, weak monitoring, fragmented governance	Rizvi <i>et al.</i> (2024) ^[27] , Sanyal (2024) ^[28]

Table 4: Strategies and Policy Interventions for Promoting Gender Equity

Strategy Area	Specific Interventions	Example/Source
Capacity building	Women-led demonstration plots, para-extension agents	Bohra (2023) ^[5]
Access to credit & markets	Women-FPOs, SHG-linked finance, digital platforms	Rai (2024) ^[25] , NABARD (2022) ^[20]
Strengthening land rights	Joint titling, simplified pattas, recognition of NTFP rights	Jain (2023) ^[16] , Agarwal (2018) ^[11]
Role of NGOs & cooperatives	SHG federations, producer companies, processing units	Tropenbos (2022)
Policy mainstreaming	Gender indicators in SMAF, budget allocations, monitoring	Rizvi <i>et al.</i> (2024) ^[27]

Table 5: Future Prospects and Research Gaps

Area	Emerging Opportunities	Research Gaps	Source(s)
Climate-smart agriculture	Agroforestry in CSA frameworks, adaptation gains	Gender-sensitive CSA models	Datta <i>et al.</i> (2024) ^[9] , Rizvi <i>et al.</i> (2024) ^[27]
Carbon & ecosystem services	Women's role in carbon storage, biodiversity care	Lack of women-specific carbon accounting	Behl (2023) ^[3] , Ramirez-Santos <i>et al.</i> (2023) ^[26]
Research & data gaps	Gender-transformative interventions	Limited longitudinal, intersectional data	Quisumbing <i>et al.</i> (2023) ^[23] , Agarwal (2018) ^[11]

References

- Agarwal B. Gender equality, food security and the sustainable development goals. *Current Opinion in Environmental Sustainability*. 2018;34:26-32.
- Bargali K. Comparative participation of rural women in homegarden agroforestry: A study from Kumaun Himalaya, India. *AJAEES*. 2015;6(1):16-22.
- Behl P. New possibilities for women's empowerment through agroecology in Himachal Pradesh, India. *Sustainability*. 2023;16(1):140.
- Biswas A, Trivedi A, Nandeha N, others. Women's Contributions to Community Forestry and Agroforestry Systems. [Date of publication unknown]; 2025.
- Bohra B. Breaking barriers through gender mainstreaming equality: participatory agroforestry interventions. *CGIAR/CGSpace*; 2023.
- Council on Energy, Environment and Water (CEEW). Sustainable agriculture in India: Agroforestry & SAPSs (policy brief). 2023.
- Colfer CJP, Catacutan D, Naz F, Pottinger AJ, editors. Gender in agroforestry: Special issue. *International Forestry Review / CIFOR-ICRAF*; 2015.
- Dagar JC, Singh AK, Arunachalam A, editors. Agroforestry systems in India. [Place of publication unknown]; [Publisher unknown]; 2014.
- Datta P, Behera B, Rahut DB. India's approach to agroforestry as an effective strategy in the context of climate change: An evaluation of 28 state climate change action plans. *Agricultural Systems*. 2024;214:Article 103840.
- Department of Agriculture & Farmers Welfare (GoI). Operational guidelines: Sub-Mission on Agroforestry (SMAF). National Mission for Sustainable Agriculture; 2016.
- Digital Green / Reach Alliance case study. Cutting through the grass ceiling: Supporting women with digital extension approaches. Reach Alliance; 2019.
- FAO. The gender gap in land rights. Food and Agriculture Organization of the United Nations; 2019.
- Forest Survey of India. India State of Forest Report 2023 (ISFR 2023, Vol. 1). Ministry of Environment, Forest & Climate Change; 2023.
- Galudra G, *et al.* Transforming agroforestry through gender practice (Tropenbos / gender analysis report). Tropenbos; 2022.
- Government of India, Department of Agriculture & Cooperation, Ministry of Agriculture. National agroforestry policy. 2014.
- Jain C. Women's land ownership in India: Evidence from digital land records. *Land Use Policy / Regional studies*. 2023.
- Kiptot E, Franzel S. Gender and agroforestry in Africa: A review of women's participation. *Agroforestry Systems*. 2012;84(1):35-58.
- Kumar N. Women's self-help groups, empowerment, and participation in markets: Evidence from India. *World Development*. 2021;146:105553.
- Livelihoods India. Scaling up women's enterprises: Case study compendium 2023. Livelihoods India / ACCESS Development Services; 2023.
- NABARD. Case studies of FPOs in India (2019-2021). National Bank for Agriculture and Rural Development; 2022.
- Nguyen MP, North H, Duong MT, Nguyen MC. Assessment of women's benefits and constraints in participating in agroforestry exemplar landscapes. Working Paper 315, World Agroforestry; 2021.
- Pandey DN. Multifunctional agroforestry systems in India. *Current Science*. 2007;92(4):455-463.
- Quisumbing AR, Cole SM, Elias M, Faas S, others. Measuring women's empowerment in agriculture: Innovations and evidence. International Food Policy Research Institute / affiliated institutions; 2023.
- Raghunathan K. Women's self-help groups and empowerment: Evidence from India. IFPRI Discussion Paper 01712. International Food Policy Research Institute; 2018.
- Rai N. Women FPOs in India: An exploratory study of gender mainstreaming through the platform of women FPOs. ResearchGate; 2024.
- Ramirez-Santos AG, coauthors. Gendered traditional agroecological knowledge in agri-food systems: A systematic review. *Agroforestry Contexts / related journal*; 2023.
- Rizvi J, Dhyani SK, Arunachalam A, Rouge J-C, Singh A. The success of a national agroforestry policy in India: Lessons and pathways. *CIFOR-ICRAF brief*; 2024.

28. Sanyal S. Agroforestry: Missing trees for the forest (Working paper). Economic Advisory/Policy working paper series; 2024.
29. Times of India. Women in a Bokaro village turn barren land into mango orchard, rake in moolah. 2025 Jun.
30. Tropenbos International / Galudra G. Transforming agroforestry through gender practice (policy/practice report). Tropenbos International; 2022.
31. Venn R, Montero-de-Oliveira F-E, Buratti-Donham J, Eden J, Reinecke S. Policies for agroforestry, a narrative review of four 'continental' regions: EU, India, Brazil, and the United States. *Frontiers in Sustainable Food Systems*. 2024;8:Article 1417740.
32. World Agroforestry. A user guide to gender analysis in agroforestry: In equal measure. World Agroforestry (ICRAF); 2017.
33. World Bank. Women in the Indian agricultural sector: Note and policy options. World Bank country note; 2023.