# Commodity Value Chains in Agroforestry: A Comprehensive Scientific Review

# Abstract

Agroforestry combines agricultural and forestry practices to optimize land use, increase productivity and promote environmental sustainability. Agroforestry products Value chains provide significant chances for native farmers to boost their output and revenue, which makes them crucial in emerging nations. This paper investigates the commodity value chains of agroforestry in South Asia, with a specific focus on India and Bangladesh. It explores structural barriers, market inefficiencies and institutional gaps through case studies and regional analyses. By examining current marketing practices, identifying constraints and proposing innovations such as contract farming, cooperative models and digital integration, the study provides a framework for enhancing the value of agroforestry value chains.

# Keywords

Agroforestry, Value Chains, Marketing Systems, Contract Farming, Institutional Support and Rural Livelihoods

# 1. Introduction

Agroforestry is a land use strategy that purposefully places trees alongside crops and livestock on the same piece of land. Agroforestry has long been performed in India as subsistence farming, but it is gradually being appreciated from an economic aspect, in addition to its excellent contribution to the wood-based industrial sector, which is relatively new (Jose *et al.,* 2021). A total mismatch between supply and demand has resulted from reduced forest cover, low productivity and legal restrictions, as well as increased demand for wood and wood products driven by population growth, industry and policy changes. This has prompted more attention to agroforestry (Dhyani, 2018). Agroforestry supplies 60% of paper pulp, 9–11% of feed, 65% of small timber and more than 70% of plywood in India (Dev *et al*., 2019). However, the need to acquire wood from agroforestry systems has increased due to legal limits on forest harvesting and rising demand. India’s forests produce only 0.7 m³/ha/year (Parthiban *et al*., 2016), while timber demand is projected to rise to 153 million m³ by 2020 (Anonymous, 2009). This imbalance necessitates efficient agroforestry value chains that can supply wood-based industries such as pulp, paper, plywood, and matchwood. Despite policy frameworks like the National Forest Policy (1988), farmers often remain price takers due to poor market linkages.

Commodity value chains are the complete series of steps required to take an item or service from its inception through all of the stages of manufacturing, transformation and conveyance to final consumers, followed by disposal following use(van Noordwijk, 2021). To better understand how each strategic component affects cost and value as a framework for firm-level research, the value chain must be divided into its constituent parts and the competitive advantages and disadvantages at the industry level. Due to their intrinsic complexity, agroforestry market system links are less well-established or noticeable than those in value chains for individual main crops. As direct initiatives that carry the risk of further upsetting the market system, a flexible market systems approach can be utilised to expand market access, connect smallholder producers and agribusinesses and provide value-added services (Ripley and Nippard, 2014).

India is one of the few tropical nations where the amount of forest cover has steadily increased over the past 20 years (Estoque *et al*., 2022). Agroforestry has drawn a lot of interest as a feasible land-use strategy for meeting household and industrial wood needs. However, there is now a large gap between the supply and demand of wood and wood products due to the growing need for wood and legal obstacles to collecting wood from government-owned forests. A "value chain model" must now be used in order to solve this problem and guarantee sustainability in the production and supply of industrial wood. Agroforestry markets and marketing in India cover the flow of goods and services from producers to final consumers. The market hubs for agroforestry
on the trade of livestock, agricultural and forest products in particular areas. Agroforestry marketing differs significantly from agriculture marketing, despite certain parallels. For example, agroforestry marketing lacks market data, standardised quality grades and established marketing organisations (Parthiban *et al*., 2020).

# 2. Methodology

This study synthesizes secondary data from academic literature, government reports and case studies in Haryana, Punjab, Tamil Nadu, Uttar Pradesh and Bangladesh.

The analysis includes
-Value chain mapping
- Case-based comparison of marketing channels
- Identification of barriers and enabling conditions
- Documentation of institutional innovations

This study employs a qualitative synthesis of secondary data, drawing from peer-reviewed literature, government reports, case studies and development agency publications. A comparative regional analysis framework was used to understand the diversity and complexity of agroforestry value chains in South Asia. Five regions were selected for in-depth analysis: Punjab, Haryana, Tamil Nadu, Uttar Pradesh (India) and Bangladesh. These regions represent a range of agroecological zones and market maturity levels.

The methodology includes value chain mapping, stakeholder analysis, and examination of policy frameworks supporting agroforestry markets. Particular attention was given to structural bottlenecks, transaction costs, and actors' power dynamics within marketing systems. Existing marketing channels were documented through previously published field studies, and institutional innovations were benchmarked against global best practices. The analysis also incorporates gender and equity considerations to understand who benefits and who is marginalized within the chains.

# 4. Results and Discussion

Agroforestry commodity chains in South Asia, while promising in potential, remain constrained by multiple systemic issues. These include weak infrastructure, fragmented supply chains, low access to finance, poor market intelligence and institutional ambiguity. Market participation remains skewed, often benefiting middlemen and processors at the cost of primary producers. This section explores these constraints in detail, along with regional dynamics and successful models that offer replicable lessons.

Underdeveloped markets are the primary challenge for agroforestry value chains and market systems to achieve sustainability and success. Most agroforestry products lack connections to markets due to poorly developed policies that tend to focus on conventional agricultural methods, such as monocropping systems. Adequate farming techniques exist but are in many cases not accessible for the farmers. To provide sufficient income to farmers, agroforestry value chains and market systems need to become more efficient and profitable; by supporting smallholder farmers to organize themselves in cooperatives. Smallholders – especially women – need access to finance and advisory services, as agroforestry farming systems require investments in technical skills, and skills for marketing of products (Jung, D.R. and Vendrametto, O., 2025). There is generally inadequate awareness among decision makers about these barriers within market systems and a lack of coordination between stakeholders/value chain nodes. Institutional mandates are frequently ambiguous and split between agricultural and forestry ministries because agroforestry include a variety of stakeholders and value chains from both industries. Poor ownership for agroforestry system support may result from this. Agroforestry can empower women and underprivileged people and provide a range of economic, environmental, and social advantages if these obstacles are removed (Anonymous, 2020). This necessitates increasing funding for initiatives and groups working to create inclusive, equitable, and sustainable agroforestry market systems.

## 4.1 Barriers in Agroforestry Value Chains:

Despite policy efforts to promote agroforestry, several structural and institutional factors hinder effective value realization. These include weak regulatory frameworks, non-harmonized trade laws across states and insufficient market-based incentives for producers. Main systemic constraints that hinder value realization in agroforestry systems are given in Table 1.

Table 1 summarizes the main systemic constraints that hinder value realization in agroforestry systems.

|  |  |
| --- | --- |
| Barrier Type | Description |
| Market Access | Fragmented supply chains and the absence of organized markets. |
| Institutional Gaps | Overlapping mandates and weak coordination between the forestry and agriculture departments. |
| Credit & Finance | Limited access to institutional credit and absence of insurance mechanisms. |
| Information Asymmetry | Farmers lack real-time pricing, demand, and grading knowledge. |

## 4.2 Regional Value Chain Comparisons

### 4.2.1 Punjab: Eucalyptus Marketing

Farmers in Punjab frequently sell eucalyptus pre-harvest without yield estimation, exposing them to exploitation. Middlemen dominate transactions, while government support mechanisms offer limited compensation. It was revealed that most of the producers, while affecting pre-harvest sales, did not have any estimate of the quantity of wood of their plantations. They arbitrarily struck the bargains. Thus, they were badly exploited by the traders who had sufficient knowledge about the quantity and quality of the wood and the price to be fetched in the market. Eucalyptus Marketing Dynamics in Punjab: Agroforestry farmers, particularly those cultivating eucalyptus, often enter pre-harvest contracts without formal yield estimation or advisory support. These early agreements, dominated by middlemen, result in undervaluation of the produce. Studies indicate that many producers accept arbitrary deals without proper assessment of plantation volume or timber quality. Consequently, traders—armed with better market intelligence—gain disproportionate margins. The absence of government price support mechanisms further deepens this inequity.

Figure 1 illustrates a typical marketing channel

Channel- I



Channel -II



Channel- III



Channel -IV

**Fig. 1: Marketing channels of Eucalyptus in Punjab**

**4.2.2 Haryana: Timber Mandis**

Haryana's agroforestry value chains involve contractors, local saw-millers, and wholesale mandis. Key hubs include Yamunanagar and Ambala. Farmers seldom directly access industries due to logistical and informational barriers.

. The tree growers generally harvest the trees and bring the timber to the mandis for sale. In these mandis the wholesalers, commission agents and puccaarhatiya plays important roles in the sale of produce. The produce is generally purchased from farmers through brokers. In Haryana, Ambala and Yanmunanagar have developed into bigger markets for purchase of farm grown timber. Popular, eucalyptus, sissoo and *Acacia nilotica* from adjoining states like Utter Pradesh, Uttaranchal and Punjab are also brought to these markets for sale. Popular is being marketed in the form of round logs as well as sawn timber.

In Haryana and Western Uttar Pradesh, marketing entails a number of middlemen who act as a bridge between producers and consumers, therefore reducing the product's value to the greatest extent possible. However, farmers may make the most money from their produce if they have direct connection to consumers and industry Singh *et al* (2023). The following market channels are prevalent in the area (Fig. 2)



**Fig. 2: Distribution channels for wood-based products in Haryana**

### 4.2.3 Tamil Nadu: Contract Farming and Industrial Supply

Tamil Nadu has established successful contract farming models for pulpwood species. Casuarina and Eucalyptus are cultivated under tripartite/quadripartite contracts involving industries, farmers, and service providers. An efficient and successful mechanism for the production and consumption of agriculture and related sectors is contract farming. In essence, it is an agreement between parties who are not on an equal footing, such as growers, processors, and consumers (Eatom, 1998). Currently wood-based industries have a multipartite model supply chain which is depicted in fig 3.

Villager traders

Pulpwood industries

Contract supplier

International contractual suppliers of pulpwood logs

Institutional suppliers from other states

 (Parthipan *et al*., 2012)

**Fig. 3 : Multipartite Supply chain of Pulpwood industries in Tamil Nadu**

### 4.2.4 Bangladesh: Informal and Multi-tiered Chains

In Bangladesh, multiple layers of intermediaries increase costs while minimizing producer profit. The dominant actors include phoria, beparis and arathdars. Bangladesh's marketing channels were lengthy and intricate due to the involvement of numerous intermediaries in the value chain analysis of agroforestry products. Some intermediaries' involvement frequently looks unnecessary; they only increase the consumer's cost and generate large marketing margins. Transporting the agroforestry products from farmer fields to retail locations accounted for the majority of the value chain's expenses. These transportation expenses significantly increased the worth of the merchandise. Furthermore, the farmers were viewed as a weaker actor in every network structure due to the absence of strong positive relationships among them. Therefore, it can be concluded from the study that while marketing, intermediary intervention, and value addition expenses were high, farmers' free and equitable access and rewards appeared to be very low in the current value chain. There are several policy possibilities that are anticipated to enhance the systems, despite the fact that the value chain analysis of agroforestry items in Bangladesh is beset by numerous issues. Establishing farmer cooperatives or a separate local organization is urgently needed, particularly to assist farmers in selling their goods and acquiring the materials they require. To gain the right and authority over strong middlemen who control and dominate the pricing of agroforestry products, these cooperatives can drastically cut out middlemen from network structures and integrate farmers horizontally (Islam *et al.,* 2014). A generalized product flow is depicted in Figure 4.



**Fig. 4: Agroforestry crops distribution channel in Bangladesh**

**5. Innovations and interventions**

 Through creative technological development, the highlighted research gaps as well as the related problems and limitations that existed in agroforestry can be addressed. Technological, organizational, and marketing tactics were among these advancements Overcoming research gaps, issues and constraints in agroforestry has been made possible in large part by the development of innovative technologies. This development included organizational, developments in marketing and technology. Due to their reliance on outdated genetic resources, traditional forestry and agroforestry techniques produced little and took a long time to harvest. A disjointed and multipartite supply chain was also the result of procedures that were founded on traditional knowledge (Buck, 1995). Traditionally, forestry and agroforestry developments relied on unimproved genetic resources, leading to low productivity and extended harvesting cycles. Likewise, management practices and agroforestry systems were largely based on traditional knowledge. The supply chain, in turn, has remained predominantly fragmented and highly unorganized.

These challenges can be effectively addressed by harnessing innovative technological solutions.

**5.1.1.Technological Innovations**

 Technological Innovations includes

1. Development and Deployment of High Yielding Short Rotation (HYSR) Clones.

 2. Miniclonal Technology.

 3. Design and Development of Multifunctional Agroforestry Model.

 4. Value addition Technology.

 5. Design and Development of Machineries for Agroforestry.

Mini clonal technology usage has also had a revolutionary impact. Agroforestry plantations have historically depended on seed-based offspring with inconsistent and variable yields. Large-scale multiplication and genetic uniformity have been made possible by the development of mini clonal technology, which offers a significant benefit over traditional mass multiplication techniques. A multifunctional agroforestry model that incorporates tree, agriculture, horticulture, and animal components has been designed in order to address the short size of agricultural holdings in India (Kumar *et al*., 2023). For farmers across a range of agroclimatic zones, this methodology guarantees sustainable revenue creation. Briquettes, a valuable industrial energy source, have been created from agroforestry wastes, such as plantation residues and agricultural crop leftovers, using value addition technology (Sharma *et al*., 2016).

**5.1.2. Organizational Innovations:**

The National Agroforestry Policy of India (2014) states that the
In order to accomplish policy goals in the forestry and agroforestry sectors, the consortium's formation was in line with technology-based agroforestry promotion (Kumar *et al*., 2021). The consortium implemented a number of organisational improvements, including the provision of superior seedlings, the establishment of plantation management facilities, the facilitation of different market outlets, loading, transportation, and falling. The Consortium of Industrial Agroforestry makes money through a variety of endeavours and functions as an independent organisation (Minz *et al*., 2021).

 1. Design and Deployment of Contract Tree Farming.

 2. Consortium of Industrial Agroforestry.

**5.1.3. Marketing strategies**

The implementation of technology-based value chain interventions has significantly addressed the challenges faced by farmers engaged in tree planting. One of the primary issues, the absence of a guaranteed buyback and price support, has been effectively handled through the creation of a market support structure and assurance of buyback by Consortium industries (Parthiban *et al.,* 2023). Over the past decade, the promotion of agroforestry has garnered increased trust from both industries and farmers due to the established and expanded price support system. Business innovation played a crucial role in advancing the forestry and agroforestry land use systems (Jacobi, 2024).’

Farmers and other value chain partners have benefited from the significant job opportunities created by agroforestry-related activities. Regarding the environment alleviation, agroforestry has been acknowledged for its role in microclimate control and carbon sequestration, aiding in the fight against environmental problems like climate change. Despite the advancements, the value chain still faces significant obstacles, such as the lack of sufficient raw materials, heavily farmed fields with subpar seed-based offspring, undeveloped markets, a lack of awareness, and a lack of machinery in silvicultural operations. Improving the supply chain's structure, fostering direct ties between farmers and business, and guaranteeing dependable buyback and support prices are all necessary to meet these issues. All things considered, the promotion of value chain-based industrial agroforestry has made great progress in overcoming obstacles, raising production, and generating socioeconomic and environmental advantages (Leakey, R. R., 2020).

****Such innovated technology and contract farming model implemented in Tamil Nadu are shown below in Fig. 5, 6 and 7 (Parthipan *et al.,* 2021).

**Fig 5: Quad-partite contract tree farming model**



**Fig.6: Tripartite contract tree farming model**



**Fig. 7: Support and services by the business incubato**

# 6. Policy and Strategic Recommendations

Through creative technological development, the highlighted research gaps as well as the related problems and limitations that existed in agroforestry can be addressed. Technological, organizational, and marketing techniques are some of these advancements. Historically, unimproved genetic resources were used to create forestry and agroforestry, which led to low yield and lengthy felling times. Agroforestry and management techniques were also practiced using indigenous knowledge. When it comes to supply chains, they are typically multipartite and quite disorganized. (Raj *et al*., 2013).

- Promote Farmer Producer Organizations (FPOs) to strengthen collective bargaining.
- Support contract farming with regulatory protection for smallholders.
- Establish state-level agroforestry marketing boards with digital platforms (Ezeomah, B. and Duncombe, R., 2019).
- Encourage public-private partnerships for processing, storage, and logistics infrastructure (White *et al*., 2006).
- Integrate agroforestry in national and state-level climate adaptation strategies.
- Provide crop insurance and credit-linked incentives for certified tree farming.
- Revise forest produce transit regulations to facilitate interstate wood movement.

# 7. Conclusion

Agroforestry presents an untapped opportunity to meet growing timber demands, enhance rural livelihoods, and achieve climate adaptation goals. However, its true potential remains under-realized due to market inefficiencies and institutional fragmentation. Through regional case analysis, this review highlights the importance of structured, inclusive, and technologically enabled value chains. Successful examples from Tamil Nadu and lessons from Bangladesh underline the need for cooperatives, policy coherence, and investment in rural market infrastructure. Strengthening these dimensions can transform agroforestry from a marginal land use to a mainstream development strategy. All of these problems can be fixed by utilizing cutting-edge technical strategies. The creation and implementation of High-Yielding Short Rotation (HYSR) clones, mini clonal technology, multifunctional agroforestry model design and development, value addition technology and agroforestry machinery design and development. However, innovative models like contract farming and farmer cooperatives demonstrate viable pathways for reform. A well-supported, integrated value chain can deliver sustainable livelihoods while preserving ecological integrity.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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