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FDRE TECHNICAL & VOCATIONAL TRAINING INSTITUTE

FACULTY OF CIVIL TECHNOLGY, DEPARTMENT OF WOOD TECHNOLOGY MANAGEMENT.

M.Sc. Thesis on

Supply Chain Analysis of Small-Diameter *Eucalyptus globulus* Poles in Central Ethiopia.

Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Wood Technology Management.

BY

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Advisor Dr. Yashwant Singh Rawat

July 2026,

Addis- Ababa, Ethiopia

APPROVAL SHEET

This is certify that the thesis entitled, "Supply Chain Analysis of Small- Diameter *Eucalyptus globulus* Poles in Central Ethiopia." submitted in partial fulfillment of the requirements for the degree of Master of Science in Wood Technology of the graduate program of the Department of Wood Technology Management in the Federal Technical and Vocational Education and Training Institute meets the accepted standards with respect to originality and quality, under my supervision, and no part of the thesis has been submitted for any other degree of diploma. The assistance and help received during the course of this investigation have been duly acknowledged. Therefore, I recommend that it be accepted as fulfilling the thesis requirements.

Approved by:

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EVALUATION SHEET

We, the undersigned, members of the Board of examiners of the final open defense by Sisay Jemberu Ayano have read and evaluate his thesis entitled "Supply Chain Analysis of Small- Diameter *Eucalyptus globulus* Poles in Central Ethiopia.", and examined the candidate. This is therefore, to certify that the thesis has been accepted in partial fulfillment of the requirements for the degree of Master of Science in Wood Technology.

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DECLARATION

I hereby declare that the work which is being presented in this thesis entitled "Supply Chain Analysis of Small- Diameter *Eucalyptus globulus* Poles in Central Ethiopia." is my own original work carried out under the supervision of Dr. Yashwant Singh Rawat. All sources and references used for this thesis are properly acknowledged and thanked.

Sisay Jemberu Ayano **----------** **----------**

Candidate **Signature** **Date**

LIST OF ABBREVIATIONS AND ACRONYMS

Abbreviation	Full Term
ANOVA	Analysis of Variance
CSA	Central Statistical Agency
DBH	Diameter at Breast Height
EFD	Ethiopian Forestry Development
ETB	Ethiopian Birr
FAO	Food and Agriculture Organization of the United Nations
FDRE	Federal Democratic Republic of Ethiopia
FSC	Forest Stewardship Council
GPS	Global Positioning System
Ha	Hectare
IFAD	International Fund for Agricultural Development
ITTO	International Tropical Timber Organization
KII	Key Informant Interview
Km	Kilometer
MDF	Medium-Density Fiberboard
MOA	Ministry of Agriculture
NGO	Non-Governmental Organization
OECD	Organisation for Economic Co-operation and Development
SPSS	Statistical Package for the Social Sciences
TVET	Technical and Vocational Education and Training
UNIDO	United Nations Industrial Development Organization
VIF	Variance Inflation Factor

Title:-**Supply Chain Analysis of Small-Diameter *Eucalyptus globulus* Poles in Central Ethiopia**

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ABSTRACT

The small-diameter *Eucalyptus globulus* pole sector is an important source of rural income and a major supplier of construction materials in Central Ethiopia. Despite its economic contribution, the sector faces challenges related to limited value addition, weak market linkages, inadequate institutional support, and unequal distribution of benefits among supply chain actors. This study analyzed the supply chain of small-diameter *Eucalyptus globulus* poles in Central Ethiopia by mapping the supply chain, identifying key actors and their roles, examining product flow and value addition practices, and assessing the major constraints and opportunities affecting the sector. The study was conducted in Sodo Woreda of East Gurage Zone and Ezha Woreda of Gurage Zone, with Lemi Kura Sub-city of Addis Ababa serving as the principal destination market. A mixed-methods research approach was employed, integrating quantitative and qualitative data. Primary data were collected from 121 respondents using structured questionnaires, complemented by 10 key informant interviews, field observations, and secondary data obtained from relevant institutions. The data were analyzed using descriptive statistics, Pearson correlation, Chi-square tests, one-way analysis of variance (ANOVA), multiple linear regression, marketing margin analysis, supply chain mapping, and thematic analysis. The results showed that producers constitute the foundation of the supply chain, while brokers, transporters, wholesalers, retailers, and end users perform distinct marketing and distribution functions. Value addition was mainly limited to grading, sorting, and size selection, indicating limited upgrading practices. Marketing margin analysis revealed that wholesalers and retailers captured a larger share of the final market value than producers. Regression analysis further showed that land allocated to *Eucalyptus globulus* plantations was the only significant determinant of annual production volume. Major constraints included price fluctuations, poor rural road infrastructure, and broker dominance, high transportation costs, limited market information, inadequate extension services, and restricted access to credit. Nevertheless, increasing demand from the construction sector and opportunities for producer cooperation and improved value addition offer considerable potential for strengthening the supply chain. The study concludes that improving producer organizations, rural infrastructure, market information systems, value addition, and institutional support is essential for enhancing the efficiency, competitiveness, and sustainability of the small-diameter *Eucalyptus globulus* pole supply chain in Central Ethiopia.

Keywords: *Eucalyptus globulus*, supply chain analysis, value addition, marketing margin, smallholder producers, Central Ethiopia.

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CHAPTER-1: INTRODUCTION

1.1. Background of the Study

Forests are among the most important natural resources, providing ecological, economic, and social benefits that support sustainable development worldwide (Yi et al., 2025).They cover over 31 percent of the Earth's surface and are essential for biodiversity, climate regulation, and the livelihoods of billions of people worldwide (Food and Agriculture Organization of the United Nations [FAO], 2020). Forest ecosystems provide several goods and services, including fuel wood, lumber, carbon storage, non-wood forest products (NWFPs), soil conservation, and water control (Sinha, 2025). According to(Mills, 2025), forests serve as the economic backbone of many developing countries, especially for rural people who depend on wood-based products for daily energy needs and income.

Among the different forms in which *Eucalyptus globulus* is harvested, small-diameter poles typically collected between 4 and 7 years of age with a diameter at breast height (DBH) of less than 20 centimeters play a vital role in the local economy. These poles are particularly valued in the construction industry, where they are commonly used for scaffolding, temporary rafters, trusses, and fence supports. Their straightness, moderate mechanical properties, and widespread availability make them especially suitable for both informal and formal construction uses (Food and Agriculture Organization of the United Nations, 2005; Lemenih & Kassa, 2014; Worku, 2020).

Ethiopian forests occupy around 15.7% of the country's land area, and as natural forests continue to decline and the demand for wood products increases, plantation forestry has become more important (Urrutia, 2025). Since its introduction from Australia in the late 19th century, *Eucalyptus globulus* has become one of the most popular and economically significant plantation species. It has adapted well to Ethiopia's varied agro-ecological zones and is currently grown extensively by smallholder farmers, private investors, and government institutions (Ayen et al., 2025). It is selected for its rapid growth, coppicing ability, tolerance of poor soils, and diverse end-use applications, which include pulpwood, construction materials, poles, and fuel wood(Mandal & Nicodemus, 2025).

In recent years, Ethiopia has seen a rapid expansion in the cultivation of *Eucalyptus globulus*, particularly across the highland and midland regions of Central Ethiopia. The species is favored by both smallholder farmers and commercial growers due to its fast growth rate, strong coppicing

ability, and high economic return. These attributes make it an ideal choice for woodlot development in areas where land and resources are limited (Lemenih & Teketay, 2005).

The small-diameter *Eucalyptus globulus*, typically harvested when young (4–8 years), is a major supplier of energy, fencing materials, and construction poles in both rural and urban settings (Mills, 2024). It contributes significantly to wood production in Central Ethiopia, where it is widely grown in areas such as East Gurage Zone (Butajira) and Gurage Zone (Welkite) (Deribe, 2024). The increasing infrastructure development and urbanization in these areas have increased the demand for *Eucalyptus*-derived products (Kindu et al., 2013). However, the supply chain for small-diameter *Eucalyptus globulus* is still poorly understood, and stakeholders from producers to end users frequently face challenges related to market accessibility, value addition, and transportation, despite the market's growth (Woo, 2020).

Supply chain analysis provides a framework for examining the flow of capital, information, and goods through the stages of production, processing, distribution, and consumption. A robust supply chain ensures efficient product delivery to the market, value addition at every stage, and fair benefits for all stakeholders (Zivhave and Kornienko, 2024) .In forestry, supply chain analysis is crucial for understanding the harvesting, processing, marketing, and consumption of forest products. It also makes clear the inefficiencies, institutional flaws, and financial leakage that prevent sustainable development (Bongomin and Nziu, 2022).

Ethiopia, the small-diameter *Eucalyptus globulus* supply chain is typically unstructured and unofficial(Martin & Cossalter, 1975). Most producers who sell standing trees to brokers or merchants are smallholder farmers who lack a comprehensive understanding of market prices or quality criteria. Because they usually have better access to market data and logistics, these intermediaries sell and deliver the wood to cities with high demand (Kareem et al., 2025). However, the absence of value-adding strategies, grading systems, and organized market links leads to inefficiencies across the chain and lower returns for producers (Achamyelh, 2025).

The growing demand for small-diameter *Eucalyptus* poles reflects their importance in supporting rural livelihoods and supplying affordable materials for the construction sector, especially in rapidly urbanizing areas. This lack of structured supply chain analysis contributes to inefficiencies, price fluctuations, and missed opportunities for value addition (Alemayehu et al., 2024a).

Additionally, social and environmental concerns are associated with the expansion of *Eucalyptus* plantations (Belachew and Minale, 2025). Despite the species' economic benefits, it has been

linked to environmental issues such as conflicts over land use, lower agricultural yields in agroforestry systems, and loss of soil moisture (Daba, 2016).These impacts, however, are strongly influenced by site selection and management practices. In regions like Central Ethiopia, where land is scarce and population pressure is high, it is important to balance economic benefits with ecological sustainability.

The importance of commercial forestry, rural employment creation, and sustainable natural resource management has been emphasized in Ethiopia's recent policy changes. The National Forest Sector Development Program (NFSDP) and the Climate-Resilient Green Economy Strategy (CRGE) both highlight the need to integrate smallholder producers into formal markets and strengthen forest product value chains (Mekuanent, 2024). Nonetheless, there is still a significant shortage of data and empirical evidence relevant to policy, especially concerning the forestry industry's small-diameter wood sector.

Understanding the structure and functioning of the small-diameter *Eucalyptus globulus* supply chain is therefore critical. It provides insight into the roles of key actors, identifies operational bottlenecks, and highlights opportunities for upgrading both market and production systems. (Donovan et al., 2015). In doing so, it contributes not only to improving forest resource management and economic returns for smallholders, but also to strengthening the supply of sustainable materials for Ethiopia's growing construction sector (Tesfaw et al., 2021).

Previous studies in Ethiopia have mainly focused on the biological growth performance and environmental impacts of *Eucalyptus globulus*, while limited attention has been given to its supply chain dynamics, including institutional, economic, and logistical aspects. In Ethiopia, *Eucalyptus* biological growth performance and environmental effects have received more attention than the institutional, logistical, and commercial dynamics of the supply chain (Chanie Wubetie et al., 2025). This has created a lack of knowledge regarding the actors, relationships, transaction flows, and value addition in the supply chain of small-diameter *Eucalyptus globulus*. With a focus on identifying bottlenecks and upgrading opportunities, this study aims to bridge this gap by providing a comprehensive analysis of the supply chain in selected Central Ethiopian districts (Alemayehu et al., 2024b).

Through supply chain mapping, value-adding activity evaluation, and examination of challenges at each node, this research will help better understand the practical functioning of the small-diameter *Eucalyptus globulus* economy (Donovan et al., 2017). The findings will help explain how to

increase the efficiency, sustainability, and equity of the supply chain, which will benefit farmers, non-governmental organizations, policymakers, and wood dealers. This study explores the supply chain of small-diameter *Eucalyptus globulus* in Central Ethiopia as a key driver of regional and local development. A strong and well-organized supply chain not only connects producers with markets but also creates opportunities for sustainable forestry, improved rural-urban linkages, and the formalization of the informal wood sector. By identifying current challenges and gaps, the research aims to support a shift toward a more efficient, inclusive, and environmentally responsible wood supply system that benefits all stakeholders across the chain (Tshikovhi et al., 2023).

In many parts of Central Ethiopia, the supply chain for small-diameter *Eucalyptus globulus* remains fragmented and underdeveloped, particularly at the production, transportation, and marketing stages. Smallholder producers often face barriers such as limited market information, lack of standardized grading systems, and weak institutional support. These constraints not only reduce the economic benefits for upstream actors but also limit the availability of quality wood products for downstream users in the construction and energy sectors. Addressing these gaps through targeted supply chain improvements, such as better coordination among actors, investment in rural infrastructure, and digital tools for traceability, can enhance efficiency, reduce waste, and support more inclusive value distribution across the chain (Tshikovhi et al., 2023).

1.2. Statement of the Problem

Small-diameter *Eucalyptus globulus* poles play a crucial role in construction and energy production. However, the process of transporting these poles from farmers to end users is poorly organized. Smallholder farmers often sell standing trees for relatively low prices because they have limited knowledge of market conditions, which weakens their bargaining power.

The selling system is largely influenced by intermediaries, which results in an unequal distribution of benefits among actors in the supply chain. Farmers receive only a small share of the final market price, while brokers and traders capture a larger share of the profit. In addition, poor road access, limited market facilities, and weak efforts to add value to the product make transportation and marketing difficult.

Previous studies in Ethiopia have mainly focused on the growth performance and management of *Eucalyptus* trees. Little attention has been given to how producers and marketers of *Eucalyptus* poles generate income and interact within the supply chain. As a result, there is limited knowledge

about how *Eucalyptus* poles move from growers to end users, how transactions are managed, and how value is created along the chain.

Therefore, this study examines the supply chain of small-diameter *Eucalyptus globulus* poles in Central Ethiopia. It focuses on the relationships among supply chain actors, product flow from producers to users, value addition practices, and the challenges faced during marketing and transportation.

1.3. Objectives of the Study

1.3.1. General Objective

The main objective of this study is to analyze the supply chain of small-diameter *Eucalyptus globulus* poles in Central Ethiopia.

1.3.2. Specific Objectives

- To map the supply chain of small-diameter *Eucalyptus globulus* poles.
- To identify the key actors in the supply chain.
- To analyze the roles of the actors, product flow, and value addition at different nodes of the supply chain.
- To provide recommendations for improving supply chain efficiency and sustainability.

1.4. Research Questions

1. Who are the key actors involved in the supply chain of small-diameter *Eucalyptus globulus* in Central Ethiopia?
2. How does the product flow across different stages of the supply chain, and where is value added?
3. What are the major challenges and constraints faced by supply chain actors?
4. What opportunities exist to improve the efficiency and sustainability of the supply chain?

1.5. Significance of the Study

This study on the supply chain of small-diameter *Eucalyptus globulus* poles in Central Ethiopia is significant for a wide range of stakeholders, including policymakers, smallholder farmers, brokers, wholesalers, retailers, transporters, end-users such as construction and real estate developers, researchers, and development partners. It provides evidence based insights that can help improve the efficiency, fairness, and sustainability of the wood product value chain.

A major focus of the study is the role of brokers and intermediaries. By examining how farmers access markets, often through informal and unregulated channels, the study can help identify inefficiencies, pricing gaps, and power imbalances that reduce producer benefits.

The study also explores the potential for direct market linkages between farmers and major end-users, especially in the construction and real estate sectors. These sectors are the main consumers of small-diameter poles used for scaffolding, rafters, trusses, and bracing. Encouraging direct transactions can reduce dependence on intermediaries, increase farmer income, improve price transparency, and strengthen quality assurance for buyers.

In addition, the research examines the roles and challenges of wholesalers, retailers, and transporters, who are essential for moving products from rural production areas to urban construction sites. Identifying the logistical, financial, and regulatory barriers they face is important for improving supply chain coordination and performance.

The findings will help smallholder farmers by offering strategies to improve market access, obtain fairer prices, and strengthen their livelihoods. The study also offers practical recommendations such as forming cooperatives, improving product standards, and building stronger links with institutional buyers.

Moreover, the study serves as a useful resource for policymakers, NGOs, and development actors in designing targeted interventions such as capacity building, infrastructure investment, and policy reform. It also contributes to academic research in forestry, rural development, and value chain optimization.

Finally, by promoting sustainable harvesting and efficient wood utilization, the study supports Ethiopia's broader goals of green economic growth, poverty reduction, and sustainable forest resource management.

1.6. Scope of the Study

This research was conducted in Central Ethiopia to examine the supply of small-diameter *Eucalyptus globulus* poles. The study focused on two zones and one major city where these poles are commonly purchased and used, allowing the full process to be observed from tree cultivation to end use.

The study areas included the East Gurage Zone, specifically the Sodo area and the villages of Genet Maryam and Amawte, as well as the Ezha area and the villages of Wojebar and Gedeb in the Gurage Zone. These areas were selected because of their abundance of *Eucalyptus* trees, active

participation in the supply chain, and significant pole production. Lemi Kura Sub-city of Addis Ababa was also included because it is a major destination where many poles are used for construction.

The study concentrated on small-diameter *Eucalyptus globulus* poles used in construction for scaffolding, fencing, and temporary support structures. It examined the movement of poles from the farm to the buyer, including transportation, sale, and use. Timber sections and other *Eucalyptus* species were not included in the study.

The research covered key aspects of the supply chain, including tree cultivation, actors involved, transportation, value addition, and selling practices. However, it did not include experiments on tree growth or detailed economic calculations of potential income from selling *Eucalyptus globulus* poles.

The selected study areas represent the supply chain system because they link production areas in Central Ethiopia with major urban markets. This made it possible to examine in detail how small-diameter *Eucalyptus* poles are transported and sold. These locations are therefore suitable for understanding the supply chain system of small-diameter *Eucalyptus* poles.

1.7. Research Gap

Several studies have been conducted on *Eucalyptus* farms in Ethiopia, mainly focusing on the environmental and economic impacts of *Eucalyptus* trees. Many of these studies address forestry in general rather than the specific issues related to small-diameter *Eucalyptus globulus* poles, which are widely used in the construction industry.

Very few studies have examined how these poles move from growers to users. Little attention has been given to how the actors in the supply chain operate, how poles are traded in informal markets, and how value is added along the chain. The relationships among actors in informal market structures and the methods used to improve value addition have not been adequately examined.

There is still limited understanding of the bargaining power of smallholder farmers when selling their poles and how intermediaries control pricing. In addition, the transportation challenges involved in moving poles from one location to another, including poor roads that pass through farms and the conflicts they create, have not been sufficiently studied in areas such as Ezha Woreda and surrounding localities.

This research aims to address these gaps by examining the supply chain of small-diameter *Eucalyptus globulus* poles in Ethiopia. It focuses on the actors involved, the transportation of poles, value addition practices, existing challenges, and ways to improve the supply chain.

1.8. Limitation of the Study

This research encountered several challenges during data collection and analysis. A major problem was the difficulty of accessing some areas because of poor road conditions. This made it hard to contact some individuals and gather all the required information.

Some respondents were initially reluctant to share information because they believed the study was connected to tax collection or government monitoring. Although this concern was clarified during fieldwork, it may have affected how openly some respondents responded.

Another limitation was that the supply chain for *Eucalyptus* poles is largely informal. This made it difficult to obtain exact figures on prices, sales volume, and transactions. As a result, some findings are based on estimates and the views of key informants.

The study was also limited to selected areas of Central Ethiopia, including Sodo, Ezha, and Lemi Kura Sub-city of Addis Ababa. Therefore, the findings may not be fully applicable to areas with different environmental and market conditions.

Despite these limitations, every effort was made to ensure the reliability of the study. The sample was selected carefully, and multiple sources of information were used, combining both quantitative and qualitative data to obtain a comprehensive understanding of the *Eucalyptus* pole supply chain.

CHAPTER-2: RELATED LITERATURE REVIEW

2.1. Overview of *Eucalyptus globulus*

Eucalyptus globulus, also known as blue gum, is one of the most widely planted tree species in the world and is a dominant fast-growing plantation species in Ethiopia (Shala and Gururani, 2021). Although it is native to Tasmania and southeastern Australia, it has adapted well to a range of ecological zones worldwide, including East Africa (Águas et al., 2022). The species was introduced to Ethiopia in the late nineteenth century, mainly in the central highlands near Addis Ababa, to help address wood scarcity and environmental degradation (Teketay et al., 2010).

Eucalyptus globulus is highly valued for its rapid growth, short rotation period, strong coppicing ability, and high biomass production (Wongprom et al., 2025). It is particularly suitable for smallholder and commercial plantations because it tolerates poor soils, resists browsing, and can provide financial returns within 4–8 years (Nair et al., 2022). As a result, it is commonly found in woodlots, homesteads, agricultural borders, and degraded areas, where it contributes to rural livelihoods and land rehabilitation.

The stems of *Eucalyptus globulus* are straight and cylindrical, which makes the species suitable for poles, building materials, and fuel wood. In Ethiopia, small-diameter *Eucalyptus globulus* poles, typically harvested at a diameter of 6 to 12 cm, are widely used for fuel wood, fencing, scaffolding, wall frames, and other wood-based businesses (Lowell et al., 2014). Because of its short rotation cycle, the species also serves as an important cash crop for smallholder farmers who depend on regular income.

From an ecological perspective, *Eucalyptus globulus* has received both praise and criticism. It is recognized for its ability to stabilize soil on degraded land, store carbon, and support reforestation efforts (Forrester & Bauhus, 2016). At the same time, it has been criticized for its allopathic effects, high water consumption, and possible negative impacts on biodiversity when grown in monocultures (Alemayehu and Melka, 2022). These effects are strongly influenced by management practices, species selection, and site conditions.

Eucalyptus globulus is a major part of Ethiopia's wood economy in both rural and urban areas. It supports different actors along the supply chain, including growers, end users, brokers, transporters, and nurseries. Because of its steady demand, reliable pricing, and accessible markets, especially in metropolitan areas, it is one of the most commercially important tree species in the coun-

try. In recent years, demand for small-diameter poles has increased because of rural housing, urbanization, and infrastructure development (Biswas and Biswas, 2021). However, the supply chain for small-diameter *Eucalyptus globulus* remains largely informal and underdeveloped despite its wide use (Sunder, 1993). At the farm gate, farmers often sell standing trees to brokers without full knowledge of market conditions or value addition opportunities. Traders and transporters therefore play a major role in price formation and product movement. This raises concerns about sustainability, market efficiency, and equity, particularly in high-production areas such as Central Ethiopia (Tegegne et al., 2018)

As plantation forestry continues to expand, policymakers, researchers, and development practitioners are increasingly interested in understanding the dynamics of *Eucalyptus globulus* supply chains (Ayana et al., 2018). Better supply chain management, efficient resource use, and fair benefit distribution are essential for maximizing the species' socioeconomic and environmental contributions to national development goals (Hiloidhari et al., 2023).

2.2. Characteristics of *Eucalyptus globulus*

The fast-growing evergreen *Eucalyptus globulus*, commonly known as blue gum, is native to southeastern Australia and has been widely introduced into temperate and subtropical regions, including Ethiopia (Khan et al., 2020). Its main characteristics include smooth bark that sheds in strips, a straight cylindrical bole, and juvenile leaves that are lance-shaped and later develop into long, glossy green foliage. Although the species can grow in a range of soil types, it performs best in loamy, well-drained soils with annual rainfall of 700–1,200 mm (Nair et al., 2022) .Because it tolerates livestock browsing and adapts well to degraded land, it is highly valued in Ethiopia and grows between 1,500 and 2,800 meters above sea level (Kalinganire et al., 2021).

One of the most notable features of *Eucalyptus globulus* is its rapid growth and strong coppicing capacity, which allow it to regenerate effectively after harvest. Since small-diameter poles can reach harvestable size in 5 to 8 years, the species is well suited to short-rotation forestry. Its wood is commonly used for fuelwood, charcoal, poles, and construction materials because it is strong and relatively heavy, with an average density of 850 kg/m³ at 12% moisture content (Zerga et al., 2021b). The species is also known for its essential oil content, especially cineole, which is extracted from the leaves for pharmaceutical and industrial purposes in addition to its wood uses. These ecological and economic traits make it one of the most important species in Ethiopia's smallholder forestry sector.

However, *Eucalyptus globulus* also has some challenges. The volatile compounds it produces can increase fire risk in dry areas. Its wood is also prone to shrinkage during drying, which may cause warping and cracking if not properly controlled. In addition, because it is introduced in non-native environments, there are concerns about its ecological effects, including competition with native species and possible changes in local water tables (Barbosa et al., 2016).

2.3. Supply and Demand of Small-Diameter *Eucalyptus globulus* Poles in Ethiopia

In Ethiopia, *Eucalyptus globulus* is widely used for lumber and pole production because of its fast growth rate (F- Belay et al., 2025). It is commonly planted for both environmental and commercial purposes, and small-diameter poles are frequently available in plantations and woodlands because of the species' wide cultivation. These poles are usually harvested from trees that have not yet reached full maturity but are large enough for fence posts, building supports, and other structural uses. The supply of small-diameter poles in Ethiopia is influenced by plantation management practices, local harvesting regulations, and the amount of land available for large-scale *Eucalyptus globulus* growth (Indjikian and Siegel, 2005).

Despite this potential, several factors constrain supply. Competition for land, especially in rural areas, reduces the space available for tree plantations. In addition, water availability, land tenure issues, and environmental degradation can limit the expansion of *Eucalyptus globulus* plantations. Even so, small-diameter *Eucalyptus globulus* poles remain an important product in Ethiopia's wood industry, particularly in areas with established commercial timber plantations (Zeleke & Vidal, 2020).

The demand for small-diameter *Eucalyptus globulus* poles has increased because of their use in construction, fencing, scaffolding, and temporary support structures. This demand is especially strong in growing urban and per urban areas, where construction activity continues to expand. However, the supply chain remains largely informal, and this affects pricing, product movement, and market efficiency. As a result, producers often have limited bargaining power, while intermediaries and traders play a central role in linking production areas with consumers. This makes supply and demand analysis important for understanding not only the flow of poles, but also the distribution of value along the chain.

2.3.2 Demand for Small-Diameter *Eucalyptus globulus* Poles

The primary users of small-diameter *Eucalyptus globulus* poles in Ethiopia are the construction, agricultural, and furniture sectors. Temporary structures like housing poles and fences are commonly erected in rural areas utilizing small-diameter poles. Additionally, the agricultural sector needs the poles to hold crops, especially as stakes for climbing plants like beans and tomatoes. According to (Melsew Nibret, 2021). Urbanization is also driving up demand for affordable building materials, which in turn raises demand for *Eucalyptus globulus* poles in both rural and urban regions.

The demand for small-diameter poles is also impacted by the local availability of alternative materials. The market for these smaller poles may be impacted by the availability of other materials including concrete, metal, and larger-diameter timber goods, even if *Eucalyptus globulus* poles are a cost-effective option for many. However, *Eucalyptus globulus* poles remain a staple material due to their accessibility, rapid growth cycle, and relatively low production costs when compared to other timber species(Sori et al., 2023).

2.3.1. Factors Affecting the Supply and Demand Balance

The balance between supply and demand for small-diameter *Eucalyptus globulus* poles in Ethiopia is influenced by several factors (Taziwa, 2023). Climate conditions like droughts can affect the growth rates of *Eucalyptus globulus* trees by lowering the number of accessible poles. Demand-side economic factors, such as changes in local income levels and the availability of alternative building materials, might affect the quantity of *Eucalyptus globulus* poles needed. Moreover, government regulations concerning land use and forestry projects can have a substantial impact on supply and demand by encouraging or forbidding the production of *Eucalyptus globulus* (Alemayehu & Melka, 2022).

The supply-demand balance is also impacted by market trends, such as the rising demand for environmentally friendly building materials and techniques (DebRoy & Elmer, 2024). Depending on how the species is viewed in terms of sustainability, demand for *Eucalyptus globulus* poles may increase or decrease in reaction to a movement in consumer preferences toward more ecologically friendly items. Additionally, demand trends may shift from raw materials to more finished items as a result of the ongoing development of wood products with added value, such as furniture and processed timber (Alemayehu et al., 2024a).

2.4. Supply Chain Concepts and Their Application to Forestry

2.4.1. Overview of Supply Chain Concepts

A supply chain refers to the entire process of production and distribution, from the extraction of raw materials to the final delivery of a product to the customer. It includes all individuals, groups, resources, activities, and information involved in moving goods from suppliers to customers (Christopher, 2022). The main components of a supply chain include raw material procurement, production, processing, distribution, storage, and transportation. Effective supply chain management helps ensure the timely delivery of high-quality products at competitive prices while reducing costs and improving efficiency (Juhara, 2024).

Supply chain principles can also be applied in forestry to ensure that wood and other forest products are collected, processed, and distributed efficiently to meet the needs of different markets. Several actors are usually involved in forestry supply chains, including sawmill owners, retailers, traders, and loggers. According to Al Mahmud et al.,(2025),these actors need to coordinate their activities to improve product flow, reduce costs, and meet customer demand. Effective supply chain management is therefore essential for the responsible and efficient use of forest resources and for maintaining sustainable forestry practices.

2.4.2. Key Components of the Forestry Supply Chain

The forestry supply chain has several stages, and each one must be properly planned and coordinated to achieve good results. Harvesting is the first stage, where trees are cut and logs are collected. This stage is influenced by labor availability, equipment, regulations, and forest management practices. The wood is then transported to processing facilities, such as sawmills or wood-processing plants, where it is cut, shaped, and prepared for use in products such as lumber, paper, and furniture (Elias, 2024).

The processed wood products are then distributed to merchants, wholesalers, or end users depending on market demand. Logistics play a major role throughout the supply chain because they help ensure that products are delivered on time and at reasonable cost. Storage and transportation facilities are especially important in rural areas where infrastructure may be limited. In addition, inventory control, demand forecasting, and cooperation among supply chain actors are essential for reducing waste and improving profitability in the forestry supply chain (Simard et al., 2024).

2.4.3. Application of Supply Chain Management in Sustainable Forestry

Sustainability has become a major concern in the forestry sector, and effective supply chain management can make an important contribution to the responsible use of natural resources. According to (Agarwalla, 2024),sustainable forestry supply chains aim to reduce environmental impacts such as deforestation, soil degradation, and biodiversity loss while maintaining economic viability and social responsibility. Forestry companies can improve their environmental performance and respond to consumer demand for eco-friendly products by adopting responsible sourcing, certification systems, and traceability mechanisms.

One important tool in sustainable forestry supply chain management is certification, such as the Forest Stewardship Council (FSC), which helps ensure that timber comes from sustainably managed forests. These certifications improve supply chain transparency and increase consumer trust in forestry products. Better forest management practices, such as selective logging and replanting, also help maintain ecological balance and ensure a steady supply of timber for the industry (Wang et al., 2025). Through effective supply chain management, the forestry sector can respond to market demand while protecting the long-term health of forest ecosystems.

2.4.4. Challenges in Managing the Forestry Supply Chain

Managing a sustainable forestry supply chain involves several challenges, many of which are specific to the sector. One major challenge is the variability of forest resources caused by weather, pests, and diseases, which can affect the supply of raw materials. According to(Barreto Riaño et al., 2022), geopolitical factors such as trade regulations and export restrictions can also disrupt supply chains and cause timber prices to fluctuate.

Another challenge is the lack of infrastructure in remote forest areas, which can make transportation of timber and finished products expensive and inefficient. Poor roads, limited storage facilities, and labor shortages further complicate supply chain management. To overcome these challenges and improve overall efficiency, companies need to invest in infrastructure, build partnerships with local actors, and use new technologies such as digital platforms for tracking and managing supply chains (Chang et al., 2020).

2.5. Actors in the Supply Chain of Small-Diameter *Eucalyptus globulus* in Ethiopia

2.5.1. Overview of Supply Chain Actors

In Ethiopia, the production, delivery, and processing of timber depend on the participation of all actors in the small-diameter *Eucalyptus globulus* supply chain. These actors include primary producers such as farmers and plantation owners, intermediaries such as traders and processors, and end users such as furniture manufacturers and construction companies. Their interactions are essential for delivering *Eucalyptus globulus* poles and related products to the intended markets (Yirga et al., 2024a).

The involvement of each actor affects how well the supply chain functions and how effectively it meets demand for timber products. In the timber supply chain, collaboration and coordination among these actors help ensure cost-effectiveness, timely delivery, and product quality (G. Gebremedhin, 2015). Understanding the roles of these actors is important for identifying problems and for developing strategies to improve the efficiency and sustainability of the supply chain.

2.5.2. Key Actors in the Supply Chain of Small-Diameter *Eucalyptus globulus*

The small-diameter *Eucalyptus globulus* supply chain in Ethiopia involves several important actors who contribute to production, handling, processing, and distribution. At the beginning of the chain are farmers and plantation owners who manage *Eucalyptus globulus* plantations. These producers plant and tend the trees, thinning them when necessary to produce marketable poles. In Ethiopia, much of this activity is carried out by smallholder farmers, especially in rural areas where large plantations are limited. By selling poles in local markets or using them for construction, fencing, or fuel, these smallholders contribute significantly to household income and rural livelihoods (Woredas, 2018).

When the trees become mature enough for harvesting, loggers and harvesting contractors take over. They are responsible for cutting the timber and transporting it, sometimes directly to markets or processing facilities. This stage may require specialized equipment to handle small-diameter poles without causing damage. In many rural and remote areas, loggers face challenges related to poor infrastructure, high transport costs, and the need for manual labor because of limited mechanization (Jembere et al., 2023).

After harvest, timber traders and middlemen play a key role in connecting farmers with markets and processors. These actors purchase poles from loggers and farmers, arrange transportation, and

facilitate sales to distributors, sawmills, and end users. Some intermediaries operate locally, while others are part of wider networks. Their ability to balance supply and demand affects pricing and market availability (Sheppard et al., 2020).

At the next stage, sawmills and processing mills convert raw poles into value-added products such as sawn timber, wood chips, and construction materials. Depending on the quantity and quality of the timber, these facilities use different strategies to reduce waste and maximize output. Processing small-diameter poles can be challenging, so careful handling is required to maintain product quality. Whether large industrial operations or small local enterprises, sawmills are important for supplying processed timber to the construction and furniture industries (Scarascia-Mugnozza et al., 2023).

Finally, the processed wood products are delivered to manufacturers and end users, including homeowners, farmers, construction companies, and furniture producers. *Eucalyptus globulus* is important for a range of uses, including fencing, firewood, and building materials. Ethiopia's urbanization and infrastructure development have increased demand for affordable and accessible construction materials, which has raised the demand for small-diameter poles (Sori et al., 2023). These actors represent the final stage of the supply chain, completing the *Eucalyptus globulus* journey from tree to finished product.

2.5.3. Challenges Faced by Actors in the Supply Chain

Actors in the *Eucalyptus globulus* supply chain face several challenges. Farmers and plantation owners commonly deal with land tenure issues, limited access to quality seedlings, and insufficient technical knowledge of sustainable plantation management. Loggers also face difficulties, especially in remote areas with poor mobility and weak transport infrastructure. Timber dealers may experience price volatility due to changes in supply and demand (Favero et al., 2021).

Processing mills often struggle to control the quantity and quality of timber, especially when handling small-diameter poles, and they may face capacity limitations. End users may experience shortages during periods of high demand, which can delay construction and manufacturing activities. To overcome these problems, supply chain actors need stronger collaboration, improved infrastructure, and greater investment in sustainable practices to ensure a stable and reliable supply of small-diameter *Eucalyptus globulus* poles (World Agroforestry, 2022).

2.6. Value Addition and Product Flow in the Supply Chain of Small-Diameter *Eucalyptus globulus*

2.6.1. Introduction to Value Addition in Forestry Supply Chains

Value addition refers to the process of increasing the economic value of raw materials by transforming them into more valuable products. According to (Taziwa, 2023), value-adding activities in Ethiopia's small-diameter *Eucalyptus globulus* supply chain include harvesting, sorting, debarking, drying, treating, cutting, and converting poles into construction materials, furniture components, or fuel wood. These activities improve the market value and usefulness of *Eucalyptus globulus* products and contribute to a more profitable and sustainable supply chain.

2.6.2. Product Flow in the *Eucalyptus globulus* Supply Chain

The flow of small-diameter *Eucalyptus globulus* products in Ethiopia usually begins at the production stage, when farmers or plantation owners plant, tend, and harvest the trees (Yirga et al., 2024b). After harvesting, loggers or local harvesters cut, sort, and bundle the wood for transport. This is the primary handling stage. The next stage involves transportation and trade, where the wood is moved from rural production areas to urban markets or processing centers. This work is usually handled by local dealers, brokers, and transporters who serve as intermediaries in the supply chain.

When the poles reach processing facilities, they may be treated and processed into usable products such as poles, timber, or wood chips by sawmills or other specialized units. Depending on the final use, the wood may also undergo drying or chemical preservation to improve durability and market value. The products then move through distribution and retail stages, where wholesalers and merchants manage stock and supply the finished products to different end users (A. Tesfaw et al., 2021a).

The final stage is end use, where different consumers use the wood for fuel wood, fencing, support poles, furniture, and building materials. At each stage, value may be added depending on infrastructure, market access, and technical capacity. These stages show a structured flow that supports efficient resource use and creates income opportunities for supply chain (Kilelu et al., 2017).

2.6.3. Types of Value Addition across the Supply Chain

Value addition occurs at several stages of the small-diameter *Eucalyptus globulus* supply chain, from the farm level to final use (Strandgard et al., 2021). At the farm level, farmers may increase value through air drying, selective harvesting, and bundling poles according to size and straightness to meet market demand. In some cases, smallholders improve the market value of poles through activities such as grading, sorting, and quality selection before marketing, although advanced treatments such as preservation are less common among small-scale producers (Tefera et al., 2023). Although these practices are simple, they can significantly increase selling price and reduce post-harvest losses.

Value is also added during handling and transport by reducing damage, delays, and deterioration in pole quality. The use of locally adapted vehicles or animal-drawn carts can improve efficiency and help maintain product integrity until it reaches market centers in Ethiopia, where rural infrastructure is often limited (Mmutlana, 2017). Efficient logistics help reduce costs and improve delivery, which increases overall value.

Further technical value is added at processing and treatment facilities. These facilities carry out preservative pressure treatment, debarking, seasoning, and cutting poles into consistent dimensions. The resulting products may include scaffolding, utility poles, construction grade timber, and furniture components. Because treated poles are more durable and resistant to rot and pests, this is an important stage in value addition (Fritz & Garay, 2025).

Value is also added in wholesale and retail markets through grading, bundling, and storage practices that support steady supply and better accessibility. Wholesalers and retailers often move large quantities from rural areas to urban or peri-urban markets. Through product standardization and distribution, they connect producers with customer segments that small-scale producers may not reach directly (Meinhold & Darr, 2019).

Finally, end users such as craftsmen and small-scale furniture producers may trim, sand, assemble, or finish the products. These final adjustments improve both functionality and appearance, which increases market value. For example, an unprocessed fencing pole may have a low price, but once it is transformed into a chair or table component, it can fetch a much higher price (Hailemariam et al., 2021). Together, these value-adding stages improve the sustainability and viability of Ethiopia's *Eucalyptus globulus* supply chain.

2.6.4. Challenges in Value Addition and Product Flow

Despite these opportunities, several barriers limit value addition in Ethiopia's *Eucalyptus globulus* supply chain. These include limited access to processing technologies, weak market infrastructure, inconsistent quality standards, and inadequate training (Akinbowale et al., 2025). Product flow is also constrained by poor logistics and unstable market connections, while smallholders often lack the resources needed to engage in high-value processing activities.

2.7. Challenges in the Supply Chain of Small-Diameter *Eucalyptus globulus*

Several logistical, financial, and systemic problems reduce the efficiency, profitability, and sustainability of Ethiopia's small-diameter *Eucalyptus globulus* supply chain (Rawat et al., 2023). These challenges affect actors from production to end use and limit the sector's ability to support livelihoods and industrial development.

2.7.1. Inadequate Infrastructure and Transportation Barriers

One of the major challenges in the *Eucalyptus globulus* supply chain is the lack of adequate road and transport infrastructure. Because these trees are commonly produced in rural and highland areas, moving harvested poles to markets or processing centers is difficult due to poor roads. This leads to product losses and higher logistics costs (G. G. Gebremedhin et al., 2025). In addition, the lack of automated loading and unloading can cause physical damage and reduce efficiency.

2.7.2. Limited Processing and Value Addition Capacity

Many smallholder producers do not have access to modern processing and preservation technologies such as kiln drying or chemical treatment. This reduces the value of poles and makes them more vulnerable to pests, decay, and structural failure, especially when used in construction (Zscheischler et al., 2022). The lack of sawmills or treatment facilities in remote areas also forces producers to sell raw or semi-processed poles at lower prices, limiting their income potential.

2.7.3. Market Information and Price Volatility

The absence of organized market systems and reliable market information creates unequal power relations, price volatility, and intermediary exploitation. Small producers often accept low prices from brokers or merchants because they have little bargaining power (Alemayehu et al., 2024a). Seasonal demand, especially from the construction and energy sectors, also contributes to unpredictable income and unstable market conditions.

2.7.4. Weak Institutional Support and Policy Gaps

The forestry sector in Ethiopia, including *Eucalyptus globulus* supply chains, faces weak policy implementation and limited institutional coordination. Extension services often do not provide enough support for sustainable harvesting, better plantation management, and business training. Conflicts over land ownership and illegal harvesting are also linked to unclear or weakly enforced forestry and land-use policies (Abebe et al., 2021).

2.7.5. Environmental Concerns and Community Resistance

Although *Eucalyptus globulus* is valued for its fast growth and economic returns, it has also been associated with environmental concerns such as soil nutrient depletion and declining water tables. In some areas, local communities have resisted plantation expansion because it conflicts with biodiversity conservation and agricultural land use (Katila et al., 2014). Balancing commercial demand with environmental sustainability remains a major challenge.

2.7.6. Lack of Standardization and Quality Control

Most grading standards and quality assurance systems are absent from the *Eucalyptus* pole trade. This affects supply consistency and weakens buyer-seller trust. In the absence of clear standards and inspection systems, end users may receive low-quality products, while producers who maintain better quality may not receive higher prices in return (Arvola et al., 2019).

2.8. Opportunities for Supply Chain Improvement

Despite several challenges, the supply chain of small-diameter *Eucalyptus globulus* in Ethiopia offers many opportunities for improvement (Bekele, 2015). If properly supported, these opportunities can improve efficiency, sustainability, and profitability while also contributing to environmental conservation and rural livelihoods.

2.8.1. Adoption of Modern Processing and Treatment Technologies

One of the most important opportunities is the introduction of affordable and decentralized processing technologies. Portable sawmills, solar drying kilns, and low-cost treatment equipment can help small-scale producers improve the quality, durability, and market value of(Palander, 2025). Promoting such technologies through private-public partnerships or government support can significantly increase value addition at the community level.

2.8.2. Infrastructure and Transport Improvements

Improving rural roads and transport facilities can reduce post-harvest losses, speed up delivery, and improve market access. This is especially important because *Eucalyptus globulus* plantations

are common in highland and remote areas (Alemayehu & Melka, 2022). Shared transportation systems and better logistics arrangements can also help smallholders reduce costs.

2.8.3. Market Linkages and Cooperative Formation

Organizing producers into groups or cooperatives can strengthen bargaining power, reduce transaction costs, and improve collective marketing. According to (H. A. Kassa, 2018), cooperatives can help standardize production, aggregate supply, and build direct relationships with large buyers such as construction companies and urban wood markets. They can also provide a platform for knowledge sharing, access to finance, and capacity building.

2.8.4. Strengthening Policy Support and Extension Services

There is also a strong opportunity to improve supply chain performance through better policy support, land tenure security, and technical extension services. Well-designed regulations that encourage sustainable harvesting, forest certification, and investment incentives for processing enterprises can support supply chain development (Yirdaw, 2024). Strengthening forestry extension services can also raise awareness and promote the adoption of better management practices.

2.8.5. Promoting Environmental Sustainability and Agroforestry

Promoting agroforestry systems that combine *Eucalyptus globulus* with food crops or livestock can help reduce environmental problems and improve land-use efficiency. These systems can improve soil health, increase biodiversity, and allow smallholders to diversify their income sources, thereby supporting more sustainable livelihoods (Solomon Mulu , Zebene Asfaw, 2022).

2.8.6. Digital Tools and Information Access

Digital platforms can give producers access to weather forecasts, market demand, and price information, helping them make better decisions. Mobile applications and digital extension services can also improve transparency, reduce intermediary exploitation, and close the information gap between rural producers and urban markets (Seixas Pereira and Duarte, 2025).

2.9. Empirical Studies on *Eucalyptus* Supply Chain in Ethiopia and Other Countries

2.9.1. Empirical Studies in Ethiopia

Several studies in Ethiopia have examined the ecological and economic importance of *Eucalyptus globulus* in smallholder woodlots. For example, Alemayehu & Melka, (2022) found that *Eucalyptus* functions as an important cash crop and a safety net during crop failure when studying plantation income among rural households in the Ethiopian highlands. (Mekonnen et al., 2014), who

studied wood flow and marketing patterns in central Ethiopia, also highlighted the dominance of informal markets and the limited level of value addition by small producers. (Zerga et al., 2021b) conducted a supply and demand study of small-diameter poles and found that limited transport access and weak crop management contribute to fluctuations in supply, even as demand rises rapidly, especially in urban construction. Their study also showed that better organization of the value chain and stronger institutional support could create employment opportunities.

According to (Sori et al., 2023), middlemen and brokers often capture a disproportionate share of earnings, which shows how unequal market benefits can be. The study recommended stronger producer cooperatives and improved access to market information to create a fairer distribution of benefits along the chain.

2.9.2. Empirical Studies in Other Countries

Studies from other countries also show the importance of efficient *Eucalyptus* supply chains. (Mena-Reyes et al., 2024), for instance, examined the industrial *Eucalyptus* wood supply chain in Brazil and found that logistics, inventory management, and transport efficiency are major factors in competitiveness. They also showed that geographic information systems and real-time monitoring can reduce costs and improve delivery efficiency.

(McEwan et al., 2020), studied how smallholder *Eucalyptus* plantings were integrated into India's pulp and paper sector. Their study found that contract farming arrangements helped balance supply and demand, benefiting both processors and farmers. In these arrangements, industries provided planting materials, market guarantees, and training.

The quality issues in South African plantations of *Eucalyptus grandis* were also studied by(Ramantswana, 2012). The study found that genetic improvement programs and silvicultural practices strongly affected product acceptability for sawmilling and pole production, showing the importance of improving production practices to meet market standards.

2.10. Conceptual Framework of the Study

The conceptual framework of this study is based on a supply chain systems approach. It shows how small-diameter *Eucalyptus globulus* poles move from production areas in Sodo and Ezha Woredas to end users in urban construction markets such as Addis Ababa.

The framework identifies key actors, including farmers, traders, transporters, wholesalers, retailers, and construction users. These actors are connected through supply chain activities such as production, collection, transportation, storage, and marketing. Transportation and loading points

play a central role in linking rural supply areas with urban demand centers. At each stage of the chain, value is added through handling, aggregation, transport, and market distribution.

However, the performance of the supply chain is affected by constraints such as the lack of official records, price fluctuations, weak coordination among actors, and infrastructure limitations. Overall, the framework shows that supply chain efficiency and sustainability depend on the quality of interaction among actors and the smooth flow of products from producers to final consumers.

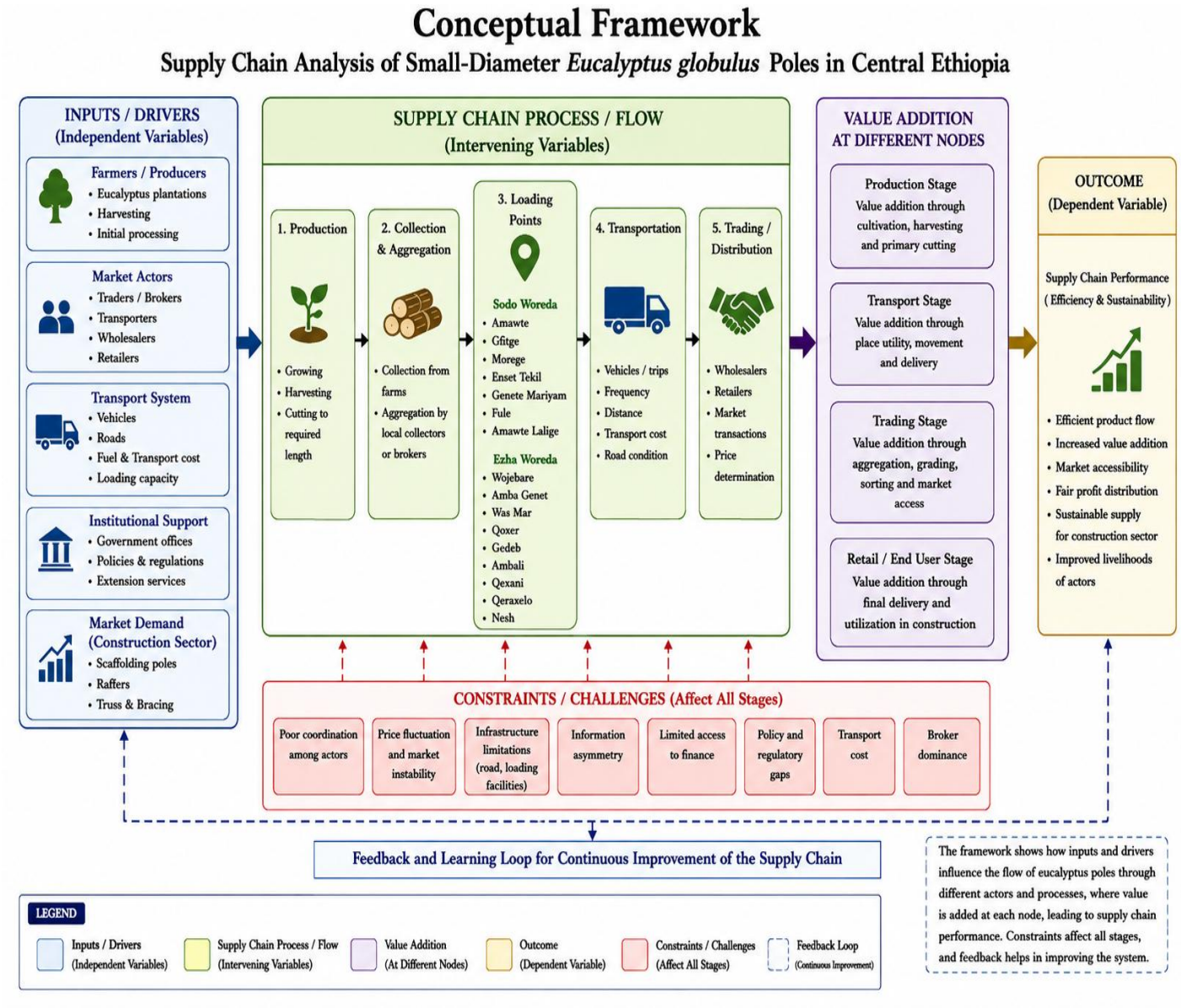


Figure 2.1: Conceptual Framework of the Study

CHAPTER-3: MATERIALS AND METHODS

3.1. Description of the Study Area

The study was conducted in selected areas of Central Ethiopia, covering Sodo Woreda in the East Gurage Zone, Ezha Woreda in the Gurage Zone, and Lemi Kura Sub-city of Addis Ababa City Administration. These locations were deliberately selected because of their active involvement in the production, marketing, and consumption of small-diameter *Eucalyptus globulus* poles, as well as their importance within the broader supply chain network (Alemayehu et al., 2023; A. Tesfaw et al., 2021b).

Sodo and Ezha woredas are among the key *Eucalyptus*-producing areas where smallholder farmers integrate *Eucalyptus* woodlots into mixed farming systems as a source of income and construction materials. Within Sodo Woreda, Genet Maryam and Amawte kebeles were selected, while Wojebar and Gedeb kebeles were chosen from Ezha Woreda. These kebeles were identified based on their high level of *Eucalyptus* production, strong participation in market activities, and ease of access for field data collection.

Lemi Kura Sub-city of Addis Ababa was included in the study as a major consumption and distribution center for *Eucalyptus* poles, particularly those used in the construction sector. The area plays a key role in linking rural producers with urban demand, which continues to grow due to rapid urban expansion and construction activities (Bank, 2024a) .

Sodo Woreda is located about 102 km south of Addis Ababa, while Ezha Woreda lies approximately 203 km southwest of the capital. Both areas are well connected to major markets through road networks, which are essential for the movement of agricultural and forestry products along the supply chain.

The agro-ecological conditions of the study areas are generally favorable for the growth of *Eucalyptus globulus*. Butajira, which is one of the nearby reference towns, is situated at an elevation of about 2,131 meters above sea level and experiences a subtropical highland climate with moderate rainfall and temperature conditions suitable for *Eucalyptus* plantations (Ethiopian Meteorological Institute, 2024). Similarly, Welkite, the administrative center of the Gurage Zone, lies between 1,910 and 1,935 meters above sea level and receives sufficient annual rainfall to support tree growth. Overall, both Sodo and Ezha woredas fall within midland (Woina Dega) and highland (Dega) agro-ecological zones, which are widely recognized as suitable environments for *Eucalyptus* production due to favorable moisture and temperature conditions (Zerga et al., 2021a).

In addition to rural production areas, Addis Ababa particularly Lemi Kura Sub-city represents a major urban market for *Eucalyptus* poles used in construction. The city is located between 8°55′ and 9°05′N latitude and 38°40′ and 38°50′E longitude, with elevations ranging from 2,200 to 3,000 meters above sea level. Rapid urbanization and infrastructure expansion have significantly increased the demand for *Eucalyptus* poles and related wood products (Creswell & Plano Clark, 2023).

Overall, the combination of Sodo Woreda (Genet Maryam and Amawte kebeles), Ezha Woreda (Wojebar and Gedeb kebeles), and Addis Ababa (Lemi Kura Sub-city) provides a comprehensive geographical representation of *Eucalyptus* pole production, marketing, and consumption systems. This spatial coverage is suitable for analyzing the structure and functioning of the *Eucalyptus globulus* supply chain in Central Ethiopia.

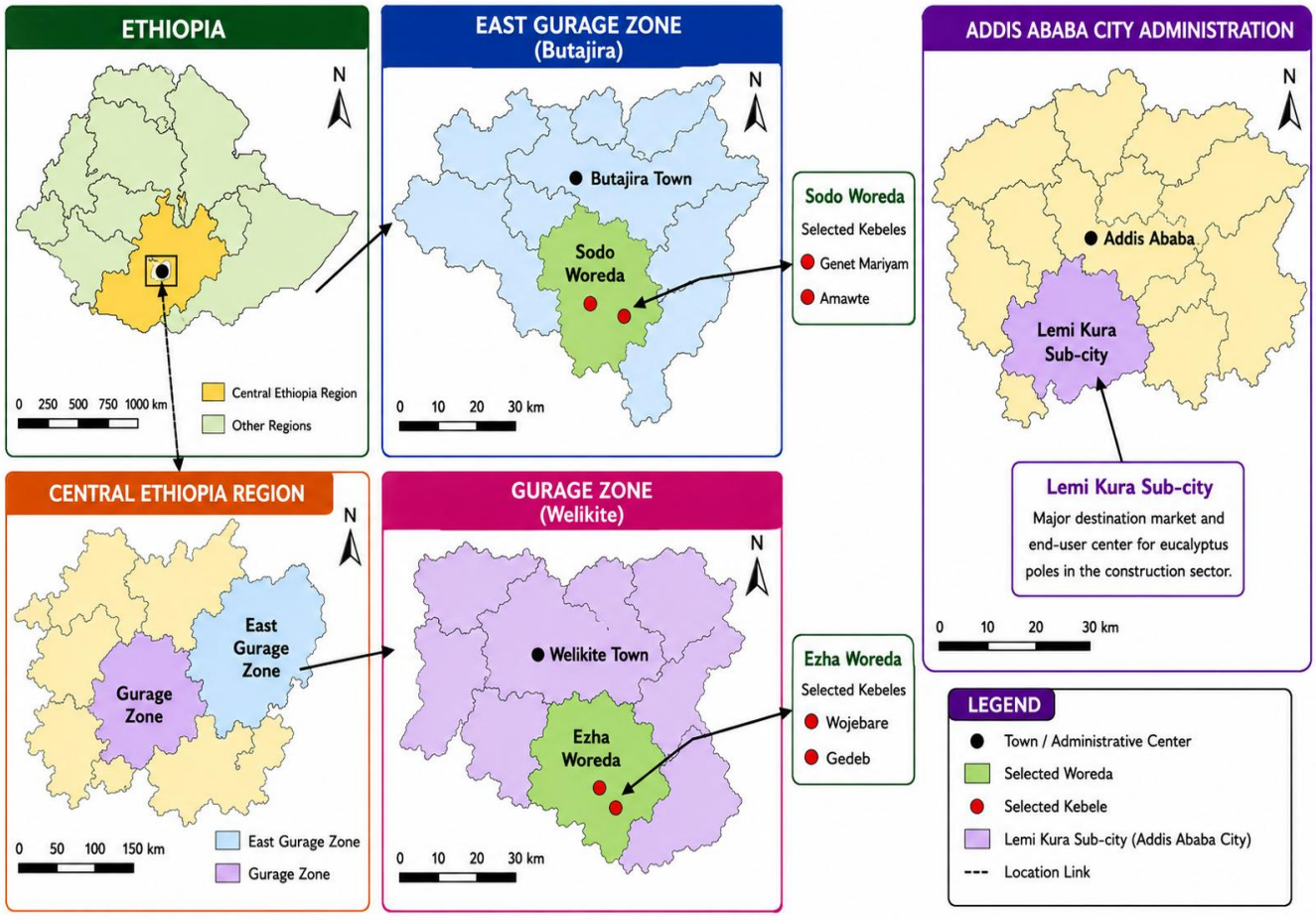


Figure 3.1: Location map of the study areas.



Figure 3.2: Field View of Small-Diameter *Eucalyptus globulus* Production Sites in the Study Area

3.2. Research Design

This study applied a mixed-methods research design that combined descriptive, exploratory, and analytical approaches to examine the supply chain of small-diameter *Eucalyptus globulus* poles among smallholder producers in Central Ethiopia. This combination was considered appropriate because the study aimed not only to describe how the supply chain operates but also to explore the underlying factors affecting its performance and to analyze relationships among key variables. By integrating both quantitative and qualitative evidence, the mixed-methods approach provides a more complete and reliable understanding of complex supply chain systems than using a single method alone (Creswell & Creswell, 2022).

The descriptive research design was used to clearly present the socioeconomic and institutional characteristics of the study participants as well as the overall structure and functioning of the supply chain. This design helped in identifying key supply chain actors, marketing channels, production and marketing practices, value addition activities, pricing mechanisms, and market linkages related to small-diameter *Eucalyptus globulus* poles. Descriptive design is widely used in studies where the aim is to accurately describe existing conditions without manipulating the research environment(Saunders et al., 2019).

The exploratory research design complemented the descriptive part by focusing on issues that are not yet fully understood within the *Eucalyptus* pole supply chain. It helped to identify production, marketing, transportation, institutional, and financial challenges, as well as possible opportunities for improving supply chain efficiency and performance. This design also allowed flexibility during

fieldwork to capture unexpected findings and better understand how different supply chain actors interact with one another in real market settings(Kaplinsky & Morris, 2001).

In addition, the study used an analytical research design to examine relationships among variables and address the analytical objectives of the research. Quantitative data were analyzed using descriptive statistics and econometric techniques, including multiple linear regression, to identify factors influencing supply chain performance and market outcomes. This analytical approach allowed the study to go beyond simple description and explain how socioeconomic, institutional, and market-related factors shape the performance of the *Eucalyptus* supply chain (Hair et al., 2021).

The study followed a convergent mixed-methods approach, where both qualitative and quantitative data were collected during the same phase of the research. The two types of data were analyzed separately and then combined during interpretation to draw comprehensive conclusions (Creswell & Plano Clark, 2023). Quantitative data were collected using structured questionnaires administered to selected smallholder producers and other market actors. These data provided measurable information on production levels, marketing practices, prices, costs, and supply chain performance.

On the other hand, qualitative data were gathered through key informant interviews, field observations, and document reviews. Key informants included agricultural experts, cooperative leaders, traders, transporters, and other stakeholders with direct experience in the *Eucalyptus* pole supply chain. These qualitative insights helped explain patterns observed in the quantitative results and provided a deeper understanding of institutional arrangements, market relationships, value addition practices, and operational (Donovan et al., 2015). Finally, the integration of both qualitative and quantitative findings improved the validity and reliability of the study through triangulation. Data collected from household surveys were cross-checked with interviews, observations, and secondary documents to ensure consistency and accuracy. Overall, this mixed research design provided a comprehensive and well-balanced understanding of the *Eucalyptus globulus* pole supply chain and supported the development of reliable conclusions and practical recommendations.

3.3. Sampling Techniques and Sample Size Determination

A multistage sampling technique was employed to select both study areas and respondents for this research. In the first stage, Sodo Woreda from the East Gurage Zone, Ezha Woreda from the Gurage Zone, and Addis Ababa City Administration were purposively selected. This selection was

based on the high concentration of small-diameter *Eucalyptus globulus* production, marketing activities, and the presence of active supply chain actors. Such purposive selection is frequently used in forest and tree product value chain studies to focus on locations with active production and marketing systems (Ingram et al., 2014).

In the second stage, four kebeles were purposively selected from the two woredas. Accordingly, Genet Maryam and Amawte kebeles were selected from Sodo Woreda, while Wojebar and Gedeb kebeles were selected from Ezha Woreda. These kebeles were chosen because of their strong involvement in *Eucalyptus* production and market participation, making them highly relevant for supply chain analysis.

In addition, Lemi Kura Sub-city of Addis Ababa was included in the study as it serves as a major urban market center for *Eucalyptus* poles, particularly for construction purposes. This area plays a key role in linking rural producers with urban consumers, thereby strengthening the supply chain network (Kassahun et al., 2025).

In the third stage, respondents were selected in a way that ensured fair representation of all groups involved in the *Eucalyptus* value chain. This helped to capture diverse perspectives while maintaining representativeness of the study population. The selected respondent groups included producers, traders/brokers, transporters, wholesalers, retailers, and end users of *Eucalyptus globulus* products.

Key informants with extensive knowledge and experience in the *Eucalyptus* sector were also included. These individuals were selected purposively due to their expertise in production, marketing, forestry management, and construction-related use of *Eucalyptus* poles. Such informants provided valuable insights that complemented the survey data and improved understanding of supply chain dynamics (Nations, 2022).

The total sample size of the study was 121 respondents, which was considered adequate to capture the diversity of actors involved in production, marketing, transportation, and utilization of small-diameter *Eucalyptus globulus* poles. The combination of purposive and random sampling techniques ensured both relevance and representativeness of the data.

The sample was proportionally distributed across supply chain actors as follows:

- Producers/Farmers: 60
- Traders/Brokers: 13
- Transporters: 11

- Wholesalers: 11
- Retailers: 11
- End Users (Construction Sector): 15

This proportional allocation ensured balanced representation of all major actors in the *Eucalyptus* supply chain and improved the reliability of the findings.

Table 3.1: Distribution of Sampled Respondents

District	**Kebele**	**Producer**	**Trader/Broker**	**Transporter**	**Wholesaler**	**Retailer**	**End User**	**Total**
Sodo	Genet Maryam	15	3	3	3	3	4	31
Sodo	Amawte	15	3	3	2	3	3	29
Sub-total		30	6	6	5	6	7	60
Ezha	Wojebar	15	3	3	3	3	4	31
Ezha	Gedeb	15	4	2	3	2	4	30
Sub-total		30	7	5	6	5	8	61
Total		60	13	11	11	11	15	121

The sampling strategy adopted in this study ensured that both formal and informal actors within the *Eucalyptus globulus* supply chain were adequately represented. This enhances the reliability, validity, and generalizability of the findings, which can inform policy formulation, market development, and future research in the forestry sector.

To further ground the study in real market operations, the research also considered key construction applications of *Eucalyptus* poles, including:

- Scaffolding poles: Used as vertical and horizontal supports for construction platforms and formwork systems.
- Rafters: Used in temporary roofing structures and low-cost building frameworks.
- Truss members: Formed by assembling small-diameter poles into triangular structural systems for roofing.
- Bracing or tie supports: Used as diagonal reinforcements to stabilize scaffolding and roofing structures.

The table below summarizes the typical dimensions and functional uses of the small-diameter *Eucalyptus globulus* poles analyzed in this study.

Table 3.2: Typical Dimensions and Construction Applications of Small-Diameter *Eucalyptus globulus* Poles analyzed in the Study

Component	Diameter (cm)	Length (m)	Purpose
Scaffolding Poles (Fonte/Quami)	8–12	6–8	Vertical and horizontal support for working platforms
Rafters (Weraji)	10–14	6–9	Sloped roof support for permanent structures
Truss Members (Ye Qorqoro Mager)	8–10	5–8	Light roofing structural framework
Bracing/Tie Members (Chefeqa)	5–8	4–5	Lateral and diagonal stabilization

3.3.1. Sample Size Determination and Justification

A total of 121 respondents were included in this study from the major actors involved in the small-diameter *Eucalyptus globulus* pole supply chain, including producers, traders/brokers, transporters, wholesalers, retailers, and end users. Since the exact number of individuals participating in *Eucalyptus* pole production, marketing, transportation, and utilization was not formally documented, determining the sample size based on a complete population list was difficult. The informal nature of the *Eucalyptus* pole market, where many actors operate without official registration, was also considered during sample selection.

(Cochran, 1977) explained that when the size of the target population is unknown or difficult to determine, sample selection can be guided by the objectives of the study, the required level of precision, and practical considerations related to data collection. Based on this principle, the sample size for this study was determined by considering the need to adequately represent different supply chain actors and obtain reliable information relevant to the research objectives.

According to (Creswell & Creswell, 2023), sample size decisions in mixed-methods research should be consistent with the purpose of the study, research design, and the ability of participants to provide meaningful information for answering the research questions. Therefore, this study focused on achieving appropriate representation of all key supply chain actors rather than depending

only on a large sample size. The selected respondents provided adequate information to examine the structure of the supply chain, marketing channels, value addition practices, pricing mechanisms, and major challenges affecting the movement of small-diameter *Eucalyptus globulus* poles from producers to final users.

The respondents were selected through a combination of purposive and random sampling techniques. Supply chain actors were included based on their direct involvement and relevance to the production, marketing, transportation, and utilization of *Eucalyptus* poles. This approach helped capture different perspectives and provided a comprehensive understanding of the relationships and activities among actors within the supply chain.

In addition to the quantitative survey, ten key informants were purposively selected from stakeholders with practical knowledge and experience in the *Eucalyptus* pole sector. These included forestry experts, cooperative leaders, traders, transport operators, and construction sector representatives. The number of key informants was determined based on the principle of information saturation, where additional interviews no longer produced substantially new information. (Guest et al., 2020) emphasized that qualitative sample adequacy depends on the depth and richness of information obtained rather than statistical representation. Similarly, (Hennink & Kaiser, 2022) noted that qualitative studies with focused objectives can achieve saturation with a relatively small number of participants when the selected informants have relevant knowledge and experience.

Therefore, the combination of 121 survey respondents and 10 key informants was considered appropriate for generating reliable quantitative and qualitative information needed to analyze the supply chain structure, identify existing challenges, and develop practical recommendations for improving the efficiency and sustainability of the small-diameter *Eucalyptus globulus* pole supply chain in Central Ethiopia.

3.4. Data Collection Methods

Both primary and secondary data sources were employed to achieve the objectives of the study.

Primary Data

Several techniques were used to gather primary data in order to guarantee thorough coverage of the study's goals. 121 chosen respondents from various types of supply chain participants engaged in the manufacturing, marketing, shipping, and use of small-diameter *Eucalyptus globulus* poles were given a structured questionnaire. Respondents' socioeconomic characteristics, production methods, marketing channels, expenses and value-adding activities, and supply chain obstacles

were all covered in the questionnaire. Inquiries about consumption trends and the needs of the building industry for *Eucalyptus* poles were also included.

The individuals in charge also consulted with several experts familiar with the *Eucalyptus* supply chain and forestry.

They intentionally selected 10 individuals due to their extensive experience in this field.

These individuals comprised specialists from the agriculture and forestry department, cooperative leaders, *Eucalyptus* traders, and employees from construction firms, such as engineers and managers.

These discussions provided them with extensive insights regarding the assistance the *Eucalyptus* supply chain receives, issues with regulations and policies, current market situations, and significant challenges that impact the efficiency of the *Eucalyptus* supply chain from production to utilization.

Additionally, direct field observations were conducted at several supply chain locations, such as construction sites, roadside markets, storage facilities, loading stations, checkpoints, and production sites. The harvesting, grading, handling, transportation, and use of *Eucalyptus* poles were all documented using a standardized observation checklist. This supported and validated the data gathered from surveys and interviews.

(a) *Eucalyptus* pole harvesting at farm level, Sorting and grading of poles after harvesting.





Figure 3.3: Field Observation of Small-Diameter *Eucalyptus globulus* Pole Supply Chain Activities

(b) Loading and transportation of *Eucalyptus* poles



(c) Roadside *Eucalyptus* pole market



(d) Construction application of *Eucalyptus* poles



Figure 3.4: Construction Uses of Small-Diameter *Eucalyptus globulus* Poles Identified During Field Observation in Lemi Kura Sub-city, Addis Ababa (2026).

Secondary Data

To complement and triangulate the original data, secondary data was gathered from reliable web resources as well as published sources. The Ethiopian Forestry Development (EFD) and other pertinent government agencies' reports and data bulletins were among them. Academic papers, books, and earlier research on forestry production, marketing, and other timber products were also examined. These resources strengthened and contextualized the interpretation of the study's findings and offered crucial background information.

Secondary data on the movement of vehicles transporting small-diameter *Eucalyptus globulus* poles were obtained from the Forestry and Natural Resources Offices of Ezha and Sodo woredas. The offices provided official administrative records on the average daily, weekly, monthly, and annual number of vehicles transporting *Eucalyptus* poles during the period from 2022 to 2026.

These records were used to examine transportation patterns and assess changes in the movement of *Eucalyptus* poles over time.

To estimate the annual supply of small-diameter *Eucalyptus globulus* poles, the official annual vehicle records were combined with field-based information on the average carrying capacity of transport vehicles. Based on field observations and discussions with transport operators, each vehicle was estimated to carry approximately 300 small-diameter *Eucalyptus* poles (equivalent to about 12 m^3) per trip. This approach enabled the researcher to estimate the annual volume of *Eucalyptus* poles supplied to the market and to analyze long-term supply trends across the study areas.



Figure 3.5: Collection of Secondary Data from Forestry and Natural Resources Offices of Sodo and Ezha Woredas.

3.5. Data Analysis Methods

We employed a technique that examines both numerical data and text to evaluate the information gathered for the research. In this manner, we would be able to comprehend both the data and the qualitative information. The research employed a mixed-methods data analysis strategy to examine both categories of data. The use of multiple sources of information and different methods of analysis enabled triangulation and enhanced the reliability and validity of the study findings.

Quantitative Data Analysis

We got information from questionnaires. We put it into the computer and looked at it using the Statistical Package for the Social Sciences, which is also known as SPSS, version 26.

Descriptive Statistics:

We used tools like counting how many people said something and what percentage that is and we also looked at the average and how spread out the answers were. We did this to understand the people who answered the questions and some important things about the supply chain. These things included how stuff people made how much they sold it for, how much it cost to move it around how much they spent on marketing and what kinds of *Eucalyptus* products the construction people used.

Inferential Statistics:

We used math to see if some things were related to each other and if there were any differences. For example we used something called square tests to see if there was a connection between what kind of person someone was and what problems they had with the supply chain. We also used something called one-way ANOVA to compare groups of people and places like to see if the price that farmers got for their stuff was different, in areas.

We received data from surveys. We entered it into the computer and examined it with the Statistical Package for the Social Sciences, referred to as SPSS, version 26.

Descriptive Statics:

We employed methods such as tallying the number of people who responded and calculating the corresponding percentage, as well as examining the average and the distribution of the responses. We conducted this to comprehend the respondents and several key aspects of the supply chain. These aspects involved the prices for items created by individuals, the costs for transportation,

the marketing expenses, and the types of *Eucalyptus* products utilized by the construction workers.

Inferential Statistics:

We employed mathematics to determine if certain elements were connected and whether there were any distinctions. We utilized a method known as square tests to determine if there was a relationship between an individual's characteristics and the issues they experienced with the supply chain. We additionally employed a method known as one-way ANOVA to compare groups of individuals and locations to determine if the prices farmers received for their goods varied across different regions.

3.6. Ethical Considerations

Ethical considerations were taken into account throughout the research process to ensure the credibility and integrity of the study. Before commencing data collection, permission was obtained from the relevant authorities in the selected study areas.

Participants were informed about the purpose of the study and their voluntary involvement. Verbal consent was obtained from each respondent prior to the interview, and participants were free to decline or withdraw from the study at any stage without any obligation.

To protect respondents' privacy, personal identifiers were not recorded, and the information collected was used solely for academic purposes. The findings are presented in a manner that does not reveal the identity of individual participants. Furthermore, due consideration was given to local customs and cultural values during fieldwork. In general, the study was conducted in accordance with the ethical principles and research guidelines of the academic institution.

CHAPTER-4: RESULTS AND DISCUSSION

4.1. Socio-Economic Characteristics of Respondents

The socio-economic characteristics of respondents provide important information for understanding the *Eucalyptus globulus* pole supply chain. Variables such as gender, age, and educational level influence production decisions, market participation, and the adoption of improved practices.

Table 4.1: Socio-Demographic Characteristics of the Respondents (N = 121)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	116	95.9
	Female	5	4.1
	Total	121	100.0
Age Category (Years)	18–30	20	16.5
	31–45	51	42.1
	Above 45	50	41.3
	Total	121	100.0
Educational Level	Cannot read and write	2	1.7
	Primary	53	43.8
	Secondary	41	33.9
	Diploma	7	5.8
	Degree	18	14.9
	Total	121	100.0

Table 4.1 presents the socio-demographic characteristics of the 121 respondents who participated in this study, including their gender, age category, and educational level.

The results show that the respondents were predominantly male. Out of the total sample, 116 respondents (95.9%) were male, while only 5 respondents (4.1%) were female. This indicates that the production, marketing, and transportation of small-diameter *Eucalyptus globulus* poles in the study area are largely carried out by men. The low participation of women may be associated with the physically demanding nature of harvesting, loading, transporting, and marketing poles, as well as prevailing socio-cultural roles in rural communities.

Regarding age distribution, the majority of respondents were economically active adults. Respondents aged 31–45 years constituted the largest group, accounting for 51 individuals (42.1%), followed closely by those above 45 years, who represented 50 respondents (41.3%). Only 20 respondents (16.5%) were between 18 and 30 years of age. This indicates that the *Eucalyptus globulus* pole supply chain is largely managed by mature individuals who are likely to possess practical production experience, established market networks, and greater financial capacity to invest in plantation management and marketing activities. The relatively low participation of younger respondents may reflect challenges such as limited access to land, capital, and long-term investment opportunities required for tree-based enterprises. Similar findings were reported by (Mulugeta et al., 2023) in a study of smallholder commercial forestry in Ethiopia, where approximately 68% of tree growers were between 31 and 50 years of age, indicating that forestry-related enterprises are predominantly managed by economically active adults with accumulated production experience. Likewise, (Nyamweya et al., 2022) found that more than 70% of smallholder tree producers in Kenya were over 35 years of age, suggesting that mature household heads are more actively engaged in commercial tree production because they have greater access to productive resources, established market relationships, and the capacity to make long-term investments. The consistency between the present study and these findings suggests that participation in the *Eucalyptus globulus* pole supply chain is strongly influenced by the experience, resource availability, and long-term management decisions typically associated with middle-aged producers.

The educational profile of the respondents indicates that most had received formal education. More than two-fifths of the respondents (43.8%**)** had completed primary education, while 33.9% had attained secondary education. In addition, 14.9% held a university degree, and 5.8% had completed diploma-level education. Only 1.7% reported that they could not read or write. These findings suggest that the majority of actors involved in the *Eucalyptus globulus* pole supply chain possess basic literacy and educational backgrounds that can facilitate the adoption of improved production practices, market information, and extension recommendations. However, the relatively small proportion of respondents with post-secondary education indicates that additional technical and business capacity-building interventions could further improve the efficiency and competitiveness of the supply chain. A similar pattern was reported by (Duguma et al., 2022), who found that basic formal education enhanced farmers' ability to adopt improved forestry management practices, utilize extension services, and participate more effectively in commercial tree markets.

Overall, the socio-demographic characteristics indicate that the *Eucalyptus globulus* pole supply chain in Ezha and Sodo woredas is dominated by middle-aged and older male participants with primary or secondary education. These characteristics provide important context for understanding respondents' production decisions, marketing practices, and adoption of improved technologies discussed in the subsequent sections of this study.

4.1.1. Landholding Size Allocated for *Eucalyptus* Plantation

Table 4.2: Landholding Size Allocated for *Eucalyptus* Plantation

Land Size Allocated for *Eucalyptus* Plantation (ha)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.50	8	6.6	13.3	13.3
	1.00	26	21.5	43.3	56.7
	1.25	2	1.7	3.3	60.0
	1.50	10	8.3	16.7	76.7
	2.00	13	10.7	21.7	98.3
	3.00	1	.8	1.7	100.0
	Total	60	49.6	100.0	
Missing	-5.00	61	50.4		
Total		121	100.0		

Table 4.2 presents the size of land allocated to *Eucalyptus globulus* plantations by the respondents. Of the 121 respondents, 60 (49.6%) provided information on the area allocated to *Eucalyptus globulus*, while 61 respondents (50.4%) did not provide this information. Among those who responded, the largest proportion (26 respondents; 43.3%) allocated 1 ha of land to *Eucalyptus globulus* production. This was followed by 13 respondents (21.7%) who allocated 2 ha, 10 respondents (16.7%) with 1.5 ha, and 8 respondents (13.3%) with 0.5 ha. Only three respondents (5.0%) allocated more than 2 ha to *Eucalyptus globulus* plantations.

The findings indicate that *Eucalyptus globulus* production in the study area is predominantly undertaken by smallholder farmers operating on relatively small landholdings. Specifically, 56.7% of the respondents allocated 1 ha or less, while 76.7% allocated 1.5 ha or less to *Eucalyptus globulus* plantations. This suggests that tree planting is integrated into small-scale farming systems

rather than being managed as a large-scale commercial enterprise. Limited land availability may also influence production capacity, harvesting schedules, and the volume of poles supplied to the market.

These findings are consistent with those of (Kassa et al., 2023), who reported that the majority of smallholder tree growers in Ethiopia cultivated less than 2 ha of plantation forests, reflecting the dominance of small-scale commercial forestry in rural areas. Similarly, (Place et al., 2021) found that most smallholder tree farmers in eastern Africa managed plantations on less than 2 ha, demonstrating that commercial tree production is commonly integrated with mixed farming systems rather than undertaken on large estates.

The predominance of small landholdings observed in this study implies that improving productivity may depend less on expanding plantation area and more on enhancing plantation management, access to improved planting materials, extension services, and market linkages. Strengthening these areas would enable smallholder producers to increase production and improve their participation in the *Eucalyptus globulus* pole supply chain.

4.1.2. Main Occupation of Respondents

The main occupations of respondents are summarized in Table 4.3.

Table 4.3: Main Occupation of Respondents

Main Occupation					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Farmer	60	49.6	49.6	49.6
	Trader	28	23.1	23.1	72.7
	Government Employee	4	3.3	3.3	76.0
	Private Employee	12	9.9	9.9	86.0
	Other	17	14.0	14.0	100.0
	Total	121	100.0	100.0	

Table 4.3 shows that farming was the principal occupation of the respondents. Of the 121 respondents, 60 (49.6%) identified farming as their primary occupation, followed by traders with 28 respondents (23.1%). Respondents engaged in other occupations accounted for 17 (14.0%), while

private employees represented 12 (9.9%). Government employees constituted the smallest group, with only 4 respondents (3.3%).

The predominance of farmers indicates that the production and marketing of *Eucalyptus globulus* poles remain strongly embedded within the smallholder farming system of the study area. For many households, *Eucalyptus* production complements crop and livestock farming by providing an additional and relatively reliable source of cash income. The considerable proportion of traders also demonstrates that commercialization plays an important role in linking producers with urban markets and facilitating the movement of poles along the supply chain.

These findings are consistent with those of (Tadesse et al., 2023), who reported that 52.8% of participants in an Ethiopian smallholder tree production study were primarily farmers, while 24.5% were traders involved in wood marketing, indicating that farming remains the dominant livelihood supporting commercial tree production. Similarly, (Mwangi et al., 2022) found that approximately 57% of smallholder tree growers in Kenya identified farming as their principal occupation, whereas about 22% participated in trading and other off-farm businesses to diversify household income. These similarities suggest that commercial tree production in East Africa continues to be driven mainly by farming households, with traders playing a complementary role in improving market access.

Overall, the occupational structure observed in the present study demonstrates that the *Eucalyptus globulus* pole supply chain depends largely on smallholder farmers, while traders and other market actors contribute to the commercialization and distribution of products throughout the value chain.

4.1.3. Years of Experience in *Eucalyptus* Business

Table 4.4 presents the respondents' years of experience in the *Eucalyptus globulus* business.

Table 4.4: Years of Experience in *Eucalyptus* Business

Years of Experience in *Eucalyptus* Business					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1-5 years	20	16.5	16.5	16.5
	6–10 years	46	38.0	38.0	54.5
	11–15 years	21	17.4	17.4	71.9
	Above 15 years	34	28.1	28.1	100.0
	Total	121	100.0	100.0	

The *Eucalyptus globulus* business includes individuals with varying levels of experience. Among the 121 respondents, 46 (38.0%) had 6–10 years of experience, representing the largest group. This was followed by 34 respondents (28.1%) with more than 15 years of experience, indicating that a considerable proportion of respondents had extensive experience in the business. In addition, 21 respondents (17.4%) had 11–15 years of experience, while 20 respondents (16.5%) had 1–5 years of experience.

Overall, 54.5% of the respondents had 10 years or less of experience, whereas 45.5% had more than 10 years of experience. This indicates that the *Eucalyptus globulus* business consists of both relatively new entrants and experienced participants.

The findings suggest that many respondents have accumulated practical experience in production, harvesting, and marketing, which is likely to enhance production efficiency, improve marketing decisions, and strengthen business performance within the *Eucalyptus globulus* pole supply chain. Producers with longer experience are generally better positioned to adopt improved management practices, establish stable market relationships, and respond effectively to changing market conditions. Similar observations were reported by (Gebru et al., 2021)**,** who found that experienced smallholder *Eucalyptus* producers in northern Ethiopia were more actively involved in commercial production and market participation. Likewise, (Dessie et al., 2019) reported that practical experience plays an important role in improving plantation management, harvesting decisions, and household income from farm forestry in Ethiopia.

4.1.4. Production and Marketing Characteristics of Respondents

Table 4.5 presents the production and marketing characteristics of respondents involved in the *Eucalyptus globulus* pole supply chain. The descriptive statistics summarize respondents' age category, plantation size, annual production volume, years of experience in the business, and distance to market. These variables provide important information about production capacity and marketing conditions among sampled producers.

Table 4.5: Descriptive Statistics of Production and Marketing Characteristics of Respondents

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Age category Respondent	121	1	3	2.25	.722
Land Size Allocated for *Eucalyptus* Plantation (ha)	60	1	3	1.28	.538
Annual Production Volume of *Eucalyptus* Poles (m^3)	60	24	300	91.47	69.589
Years of Experience in *Eucalyptus* Business	121	1	4	2.57	1.071
Distance to Market (km)	121	1	205	43.04	57.885
Valid N (listwise)	60				

The results presented in Table 4.5 indicate that respondents were mainly within economically productive age groups, with a mean age category score of 2.25. Among the 60 producers who provided production information, the average land allocated to *Eucalyptus globulus* plantations was 1.28 ha, ranging from 0.50 to 3.00 ha. The average annual production volume was 91.47 m^3, with considerable variation among producers (24–300 m^3). Respondents also had practical experience in *Eucalyptus globulus* production and marketing, with a mean experience score of 2.57. The average distance from production areas to markets was 43.04 km, ranging from 1 to 205 km, indicating differences in market accessibility.

The average plantation size of 1.28 ha shown in Table 4.5 indicates that *Eucalyptus globulus* production in the study area is mainly based on smallholder farming systems. This finding is consistent with (Mulugeta et al., 2023)**,** who reported that smallholder *Eucalyptus* growers in North Shewa managed plantations averaging 1.1–1.4 ha. Similarly, (Ayele & Tadesse, 2022) found that most *Eucalyptus* producers in central Ethiopia cultivated less than 1.5 ha, confirming the dominance of small-scale plantation management.

The annual production volume reported in Table 4.5**,** with an average of 91.47 m^3 per producer, demonstrates the commercial importance of *Eucalyptus globulus* as a source of household income. Similar results were reported by (Deressa et al., 2023) who recorded an average annual production

of about 95 m³ per producer in Oromia. (Kassa et al., 2022) also observed wide production variations among Ethiopian smallholder plantations depending on plantation size, stand age, and management practices, which agrees with the variation observed in this study.

The experience level presented in Table 4.5 shows that respondents had considerable involvement in *Eucalyptus globulus* production and marketing, with a mean experience score of 2.57. This accumulated experience supports better plantation management, harvesting decisions, and market participation. (Gebru et al., 2021) reported a similar trend, showing that experienced *Eucalyptus* producers in northern Ethiopia developed better knowledge of production and marketing practices. Likewise, (CIFOR-ICRAF, 2023) emphasized that long-term involvement in smallholder tree production improves technical capacity and participation in forest-product markets.

According to Table 4.5**,** market accessibility varied considerably among producers, with an average market distance of 43.04 km. Producers located farther from markets face higher transportation costs and reduced market opportunities. Similar findings were reported by (Negash et al., 2023)**,** who indicated that smallholder forest producers in Ethiopia often travel considerable distances to access timber markets. In addition, World Agroforestry (ICRAF), 2022) noted that long transportation distances increase transaction costs and reduce the competitiveness of smallholder tree producers in Sub-Saharan Africa.

Overall, Table 4.5 demonstrates that the *Eucalyptus globulus* pole supply chain in the study area is dominated by experienced smallholder producers operating relatively small plantations. Differences in landholding size, production capacity, and market accessibility influence production performance and marketing outcomes among producers.

4.2. Supply Chain Actors and Their Functions

The study identified six major actors involved in the supply chain of small-diameter *Eucalyptus globulus* poles: producers, brokers, transporters, wholesalers, retailers, and end users (Table 4.6). Each actor performs a specific function that facilitates the movement of products, market information, and financial transactions from the production areas to the final consumers. Together, these actors form an interconnected supply chain in which the performance of one actor influences the efficiency of the entire marketing system.

This finding is consistent with the empirical study of (Lemenih & Kassa, 2014), which reported that the *Eucalyptus* marketing system in central Ethiopia involves several market participants who perform complementary functions but operate with limited coordination. Similarly,(Mena-Reyes

et al., 2025) found that effective coordination among producers, traders, transporters, and distributors is essential for improving the efficiency and competitiveness of industrial *Eucalyptus* supply chains. These similarities indicate that, despite differences in production scale, efficient coordination among supply chain actors remains fundamental to successful forest product marketing.

Table 4.6: Major Actors in the *Eucalyptus* Pole Supply Chain and Their Functions

Actor	Major Functions
Producers	Establish *Eucalyptus* plantations, manage stands, harvest poles, and supply products to the market
Brokers	Facilitate transactions between sellers and buyers and provide market information
Transporters	Transport *Eucalyptus* poles from production areas to local and urban markets
Wholesalers	Purchase poles in bulk and distribute them to retailers and large consumers
Retailers	Purchase poles from wholesalers or traders and sell them to final consumers in smaller quantities
End Users	Purchase *Eucalyptus* poles for construction, scaffolding, housing, fencing, and other purposes

Table 4.6 shows that producers are the starting point of the supply chain, while end users represent the final destination of the product. Brokers, transporters, wholesalers, and retailers act as intermediaries that facilitate product movement, market information exchange, and distribution. The findings indicate that the supply chain depends on the coordinated participation of all actors, and weaknesses at any stage can reduce overall supply chain efficiency.

Producers

The findings revealed that producers are the primary actors in the *Eucalyptus globulus* pole supply chain. They establish plantations, manage tree stands, harvest mature poles, and undertake preliminary post-harvest activities such as sorting, grading, and loading before marketing the products. In addition to production costs, producers bear most of the production and marketing risks, including fluctuations in market prices and transportation expenses. Consequently, they serve as the foundation of the entire supply chain.

These findings agree with (Alemayehu & Melka, 2022b), who reported that *Eucalyptus* plantations have become an important source of household income for rural farmers in Ethiopia. Likewise, (Bekele et al., 2021) demonstrated that smallholder producers play a central role in maintaining a reliable supply of *Eucalyptus* raw materials when supported by effective market linkages and production systems.

Brokers

The study found that brokers serve as intermediaries between producers and buyers by facilitating market transactions, identifying potential customers, negotiating prices, and sharing market information. Respondents indicated that brokers reduce the time and transaction costs associated with marketing; however, their greater access to market information often places producers in a weaker bargaining position during price negotiations. Similar observations were reported by(Development, 2024), who found that intermediaries frequently capture a larger share of marketing benefits because of their stronger market connections and information advantages.

Transporters

Transporters play a vital role by moving harvested *Eucalyptus globulus* poles from production areas to local and urban markets, particularly Addis Ababa. Since the poles are bulky and difficult to handle manually, transportation is essential for ensuring timely market delivery. However, respondents reported that poor rural roads and increasing transportation costs reduce marketing efficiency. These findings are consistent with(Mena-Reyes et al., 2025), who identified transportation efficiency and logistics management as critical factors influencing the competitiveness of *Eucalyptus* supply chains.

Wholesalers

The findings indicate that wholesalers purchase *Eucalyptus* poles in bulk from producers, brokers, or traders and distribute them to retailers and large consumers. Besides bulk purchasing, wholesalers temporarily store products and maintain a continuous supply to urban markets, thereby helping stabilize product availability throughout the marketing chain.

Retailers

Retailers purchase *Eucalyptus* poles from wholesalers or traders and sell them in smaller quantities to individual households, contractors, and construction firms. The study found that retailers improve product accessibility by supplying poles in different sizes and quantities that meet the diverse needs of consumers.

End Users

End users constitute the final stage of the supply chain. The findings revealed that *Eucalyptus globulus* poles are mainly purchased for house construction, scaffolding, roofing, fencing, and other structural applications. Increasing demand from the construction sector continues to stimulate production and marketing activities throughout the supply chain. This observation supports the findings of(Zips & Zips-Mairitsch, 2019), who emphasized that market demand and product quality strongly influence the performance and sustainability of *Eucalyptus* production systems.



Figure 4.1: Harvested Small-Diameter *Eucalyptus globulus* Poles Source: Field Observation (2026).

Photo 4.1 Illustrates harvested small-diameter *Eucalyptus globulus* poles assembled before transportation to local and urban markets. The large quantity of harvested poles observed during fieldwork reflects the strong and increasing demand for *Eucalyptus* products, particularly from the construction sector. This observation is consistent with the study findings, which indicate that expanding urban development and increasing demand for wood products continue to encourage farmers to invest in *Eucalyptus globulus* production as an important source of household income.

4.3. Distribution of Supply Chain Actors



Figure 4.2: Distribution of Supply Chain Actors in the *Eucalyptus* Pole Supply Chain

Figure 4.7 presents the distribution of respondents across the major actors involved in the small-diameter *Eucalyptus globulus* pole supply chain. The results indicate that producers constituted the largest group, accounting for 60 respondents (49.6%) of the total sample. This reflects the production-oriented nature of the study area, where *Eucalyptus globulus* cultivation has become an important livelihood activity for many rural households. As the primary suppliers of poles, producers are responsible for plantation establishment, stand management, harvesting, and the initial preparation of products for marketing.

The dominance of producers in the sample is consistent with the objectives of the study, which focused on understanding the supply chain from the point of production to final consumption. Similar findings were reported by (Alemayehu & Melka, 2022b), who observed that smallholder farmers are the principal actors in Ethiopia's *Eucalyptus* production system because they provide the raw materials that sustain the entire marketing chain. Likewise,(Pallant, 2020a) emphasized that producers remain the backbone of commercial *Eucalyptus* supply chains, as their production decisions directly influence product availability, market stability, and downstream business activities.

The second-largest group comprised end users, with 15 respondents (12.4%). These respondents mainly purchased *Eucalyptus globulus* poles for house construction, scaffolding, roofing, fencing, and other structural applications. Their participation demonstrates the strong market demand for

Eucalyptus poles, particularly within the rapidly expanding construction sector. The continued demand from end users provides a stable market that encourages producers to expand plantation development and maintain regular harvesting cycles.

Brokers and traders represented 13 respondents (10.7%) of the sample. Their primary role is to connect producers with buyers, facilitate price negotiations, and coordinate market transactions. Although brokers contribute to improving market access, field evidence indicated that their greater access to market information often places producers at a disadvantage during price negotiations. This observation is consistent with (Development, 2024), who reported that information asymmetry frequently strengthens the bargaining position of intermediaries while reducing producers' share of marketing benefits.

Transporters, wholesalers, and retailers each accounted for 11 respondents (9.1%). Despite their relatively smaller representation, these actors perform essential marketing functions by transporting, storing, distributing, and retailing *Eucalyptus* poles to final consumers. Their activities ensure that products move efficiently from rural production areas to urban markets such as Addis Ababa and nearby towns. Similar observations were reported by (Mena-Reyes et al., 2025), who highlighted that efficient coordination among logistics providers, wholesalers, and retailers is fundamental to improving the performance and competitiveness of forest product supply chains.

4.4. Supply Chain Mapping and Marketing Channels

This section describes the movement of small-diameter *Eucalyptus globulus* poles from producers to final consumers and illustrates the relationships among the various actors participating in the supply chain. The analysis considers the flow of products, market information, and financial transactions, thereby providing a comprehensive understanding of how *Eucalyptus* poles are marketed within the study area. Information used in this analysis was obtained from producers, brokers, transporters, wholesalers, retailers, end users, field observations, and key informant interviews.

Understanding the structure of marketing channels is important because it helps identify how products move through the supply chain, where value is added, and how different actors influence marketing efficiency. Similar approaches have been recommended by (Kaplinsky & Morris, 2001), who noted that supply chain mapping provides a useful framework for examining relationships among actors, identifying constraints, and improving market performance. Likewise, (Palander et al., 2026) emphasized that supply chain mapping enhances transparency and supports

decision-making by identifying critical points where coordination and value creation can be improved.

4.4.1. Map of the Supply Chain

The supply chain map illustrates the connections among all individuals involved in transporting *Eucalyptus* poles from their production sites to their usage locations. The primary individuals we identified as involved include the pole manufacturers, the brokers, the transporters, the wholesalers, the retailers, and the end users who utilize the poles.

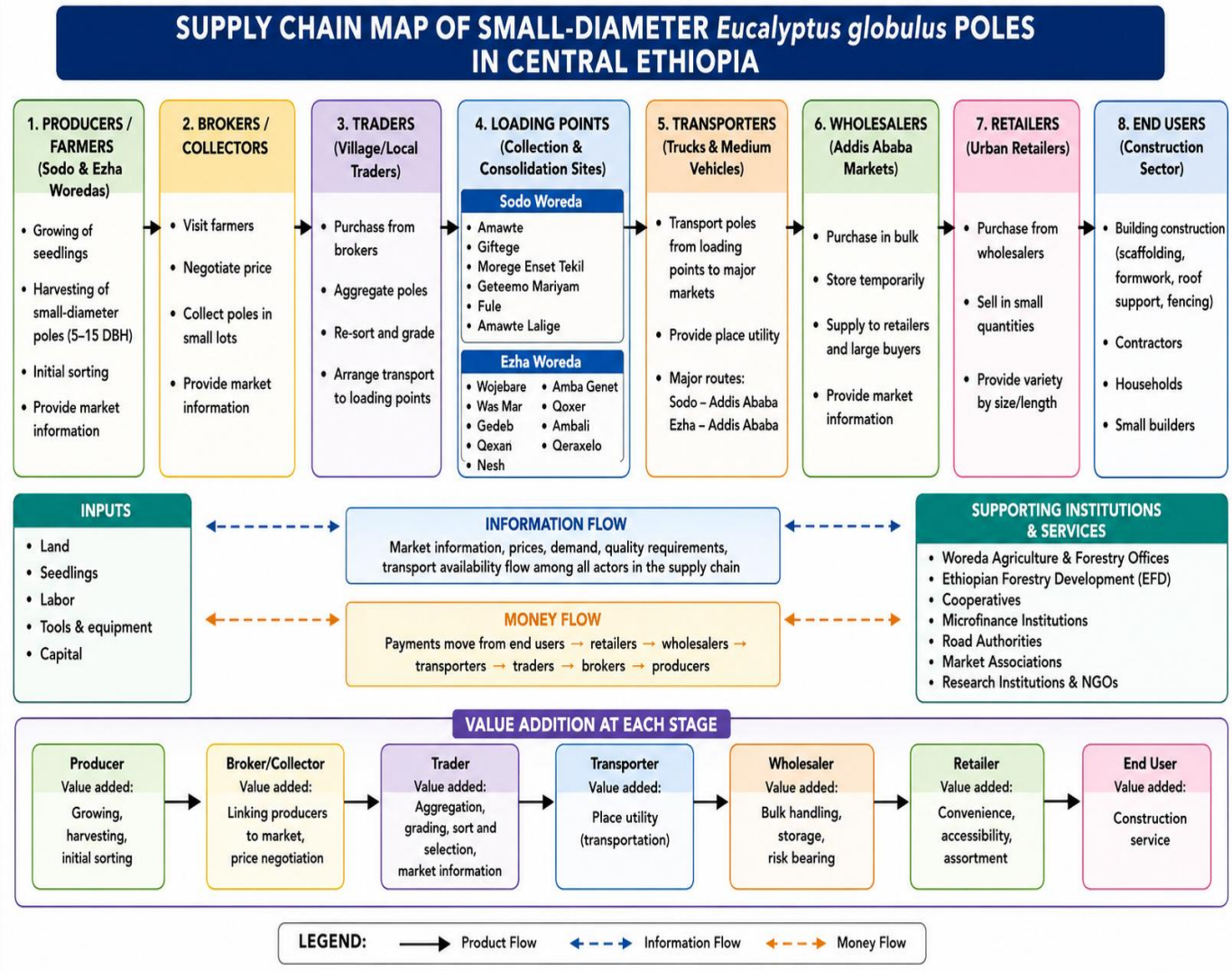


Figure 4.3: Supply Chain Map of Small-Diameter *Eucalyptus globulus* Poles

Figure 4.3 illustrates the supply chain of small-diameter *Eucalyptus globulus* poles identified during the study. The findings show that the supply chain begins with producers, who establish plantations, manage tree stands, harvest mature poles, and prepare them for marketing. After harvesting, the poles are assembled at collection points, where they are sold either directly to buyers or through intermediaries, depending on market conditions and access to buyers.

The study found that brokers frequently facilitate transactions between producers and traders, particularly for farmers who have limited access to urban markets. Transporters then move the harvested poles from production areas to major consumption centers, including Addis Ababa and surrounding towns. Once delivered to urban markets, wholesalers purchase poles in bulk and distribute them to retailers, who subsequently sell them in smaller quantities to contractors, households, and other end users.

The findings indicate that the marketing of *Eucalyptus globulus* poles involves several interconnected actors before products reach final consumers. While this multi-stage marketing system improves product availability across different markets, it may also increase transaction costs and widen price differences between producers and consumers because each intermediary performs a specific marketing function and incurs additional operating costs. Similar observations were reported by (Lemenih & Kassa, 2014), who found that forest product supply chains in Ethiopia commonly involve multiple intermediaries that facilitate product movement but also influence price formation and benefit distribution. Likewise, (Mena-Reyes et al., 2025) concluded that effective coordination among supply chain actors is essential for reducing transaction costs, improving logistics efficiency, and enhancing market competitiveness.

4.4.2. Product Flow Analysis

Product flow analysis describes the movement of small-diameter *Eucalyptus globulus* poles from production sites to final consumers through the different stages of the supply chain. Understanding product movement helps identify the major marketing routes, the functions performed by each supply chain actor, and the points where value is added or costs are incurred. Figure 4.4 illustrates the product flow identified during the study.



Figure 4.4: Product Flow of Small-Diameter *Eucalyptus globulus* Poles

Figure 4.4 shows that the movement of *Eucalyptus globulus* poles begins at production sites, where farmers harvest mature poles from their plantations. Following harvesting, producers sort and grade the poles according to size and quality before transporting them to nearby loading points. From these collection sites, the poles are loaded onto trucks and other transport vehicles for delivery to urban markets.

The findings indicate that Addis Ababa serves as the principal destination for small-diameter *Eucalyptus globulus* poles because of the high demand generated by the construction sector. Field observations further revealed that, in addition to Addis Ababa, poles are also supplied to nearby towns, including Butajira, Wolkite, Hossana, Worabe, Qoshe, Batu, Enseno, Agena, Bui and Meqi, where expanding construction activities have created additional market opportunities. However, the volume supplied to these secondary markets is considerably lower than that transported to Addis Ababa.

Throughout the marketing process, several post-harvest activities including sorting, loading, transportation, unloading, and temporary storage are carried out before the poles reach wholesalers, retailers, and final consumers. Although these activities facilitate product movement and improve market accessibility, they also increase handling costs and may affect product quality if not properly managed.

These findings are consistent with (Lemenih & Kassa, 2014), who reported that forest products in Ethiopia commonly pass through several marketing stages before reaching consumers, with each stage contributing to both value creation and additional marketing costs. Similarly, (Palander et al., 2026) emphasized that efficient product flow and logistics management are essential for reducing transaction costs, maintaining product quality, and improving the overall competitiveness of forest product supply chains. The similarity between these studies and the present findings suggests that improving transportation efficiency, handling practices, and market coordination would enhance the performance of the *Eucalyptus globulus* pole supply chain.

4.4.3. Harvesting Practices / Production and Harvesting Period

Field observations and interviews with producers revealed that harvesting of small-diameter *Eucalyptus globulus* poles is predominantly undertaken between October and May, which corresponds to the dry season in the study area. Producers explained that this period provides favorable weather conditions for harvesting and transportation while also improving the quality of harvested poles.

Respondents reported that dry-season harvesting allows vehicles to access plantation areas more easily because rural roads remain passable and soil conditions are relatively firm. During this period, harvested poles are often transported across adjacent farmland or temporarily stacked on nearby land before being loaded onto vehicles. Producers explained that landowners generally permit this temporary access because harvesting takes place after agricultural fields have been cleared. However, when vehicles pass through privately owned farmland, landowners may request compensation for soil disturbance caused by vehicle movement rather than for crop damage, since crops are usually absent during the harvesting season. This practice was consistently observed during field visits.

The study further found that harvesting during the dry season reduces soil compaction, facilitates loading and transportation, and enables harvested poles to dry more rapidly, thereby improving their strength and durability. Producers also indicated that harvesting before the onset of the main rainy season promotes successful coppice regeneration by encouraging the emergence of healthy new shoots. In addition, market demand for *Eucalyptus* poles is generally higher during this period because construction activities increase under favorable weather conditions.

These findings are consistent with (Pohjonen & Pukkala, 1990), who reported that dry-season harvesting improves operational efficiency and enhances the quality of *Eucalyptus* products under

Ethiopian conditions. Likewise, the(Nakai, 2018) noted that appropriate harvesting schedules and favorable weather conditions contribute to better product quality, reduced post-harvest losses, and improved marketing efficiency in commercial plantation forestry. The findings therefore demonstrate that harvesting time is influenced not only by biological considerations but also by transportation conditions and market demand.

4.4.4. Information Flow

Efficient information flow is an essential component of supply chain performance because it enables market participants to make informed production and marketing decisions. The study examined the major sources from which respondents obtained price information for *Eucalyptus globulus* poles. The results are presented in Table 4.8.

Table 4.7: Sources of Price Information

Source of Price Information					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Market	43	35.5	35.5	35.5
	Neighbor	11	9.1	9.1	44.6
	Phone	18	14.9	14.9	59.5
	Broker	49	40.5	40.5	100.0
	Total	121	100.0	100.0	

Table 4.7 shows that brokers were the primary source of price information, accounting for 40.5% of respondents. This indicates that brokers play a dominant role in disseminating market information and influencing price negotiations within the supply chain. The second most important source was direct observation of market prices **(**35.5%**),** followed by mobile phone communication (14.9%)**.** Only 9.1% of respondents reported obtaining price information from neighbors.

The heavy reliance on brokers suggests that market information is not equally accessible to all supply chain participants. During interviews, several producers explained that they depend on brokers because they have limited opportunities to visit urban markets where prices are determined. This imbalance in access to information weakens producers' bargaining power and increases their dependence on intermediaries when negotiating prices.

Similar findings were reported by (Caplow et al., 2011), who found that limited access to reliable market information reduces the negotiating capacity of smallholder producers and increases their dependence on intermediaries. Likewise, the (Bank, 2021) emphasized that improving market information systems enhances market transparency, strengthens producers' bargaining power, and contributes to more efficient agricultural and forest product supply chains. These findings suggest that expanding access to timely market information through digital communication, extension services, and producer organizations would improve marketing efficiency and promote fairer price determination within the *Eucalyptus globulus* pole supply chain.

4.4.5. Financial Flow

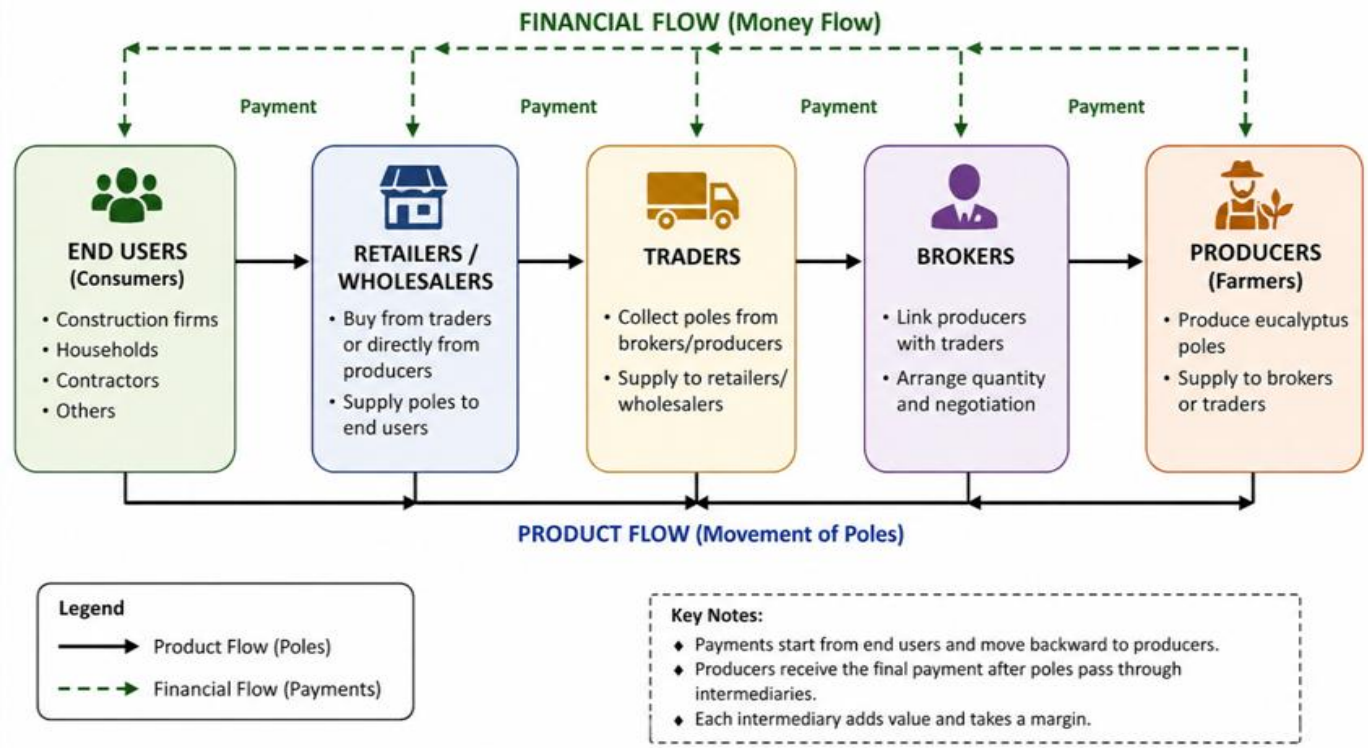


Figure 4.5: Financial Flow in the *Eucalyptus* Pole Supply Chain

Figure 4.5 illustrates the movement of financial resources among actors participating in the *Eucalyptus globulus* pole supply chain. Unlike product flow, which moves from producers to consumers, financial flow follows the opposite direction, beginning with end users and moving back through retailers, wholesalers, traders or brokers, before finally reaching producers.

The findings indicate that end users, including households, contractors, and construction companies, provide the initial financial resources by purchasing *Eucalyptus* poles. Payments are subsequently transferred through retailers, wholesalers, and brokers before producers receive their share

of the revenue. This demonstrates that producers, despite initiating the supply chain through production and harvesting, receive payment only after the product has passed through several marketing stages.

Field interviews further revealed that cash transactions are the most common payment method, particularly for direct sales between producers and buyers. However, transactions based on mutual trust and long-term business relationships were also observed, especially among traders and wholesalers. In some cases, delayed payments occurred because financial transactions passed through several intermediaries before reaching producers. Such delays reduce producers' cash flow and may limit their ability to finance future production activities.

These findings agree with (Kaplinsky & Morris, 2001), who explained that financial flows in value chains often move in the opposite direction to product flows and are influenced by market relationships, bargaining power, and contractual arrangements among supply chain actors. Similarly, the(Canton, 2021) reported that delayed payments and limited financial services reduce the capacity of smallholder producers to invest in production and improve supply chain performance.

Overall, the findings demonstrate that efficient financial flow is essential for maintaining the continuity of the *Eucalyptus globulus* pole supply chain. Strengthening transparent payment systems, improving access to financial services, and promoting fair contractual arrangements among market participants would improve producers' liquidity, reduce financial risks, and enhance the overall efficiency of the supply chain.

4.5. Marketing Channels and Market Destination

4.5.1. Marketing Channels

The study identified five major marketing channels through which small-diameter *Eucalyptus globulus* poles move from producers to final consumers (Table 4.8). These channels reflect the different marketing arrangements used by supply chain actors to transfer products from rural production areas to urban construction markets.

Table 4.8: Marketing Channels of *Eucalyptus* Poles:

Channel	Marketing Route
Channel I	Producer → End User
Channel II	Producer → Trader → End User
Channel III	Producer → Trader → Retailer → End User

Channel IV	Producer → Broker → Trader → Retailer → End User
Channel V	Producer → Broker → Trader → Wholesaler → Retailer → End User

The results presented in Table 4.8 show that Channel IV (Producer → Broker → Trader → Retailer → End User) and Channel V (Producer → Broker → Trader → Wholesaler → Retailer → End User) are the dominant marketing routes in the study area. Respondents explained that these channels are widely used because brokers and traders facilitate market access for producers who have limited information, transportation facilities, and direct links with urban buyers. Consequently, intermediaries play a central role in connecting rural production areas with major consumption markets.

Although longer marketing channels improve product distribution and market accessibility, they also involve a greater number of intermediaries, which increases marketing costs and reduces the proportion of the final selling price received by producers. In contrast, Channel I, where producers sell directly to end users, involves fewer intermediaries and enables producers to retain a larger share of the product value. However, direct marketing occurs less frequently because producers often lack reliable market information, transportation, and direct contact with consumers.

These findings are consistent with (Kaplinsky & Morris, 2001), who explained that value chains with multiple intermediaries generally improve market connectivity but often reduce the share of value captured by primary producers. Similarly, (Christopher, 2016) emphasized that efficient supply chain performance depends on minimizing unnecessary intermediaries while improving coordination and information sharing among market participants. The findings therefore suggest that strengthening producer organizations and improving direct market linkages could enhance producers' bargaining power and increase marketing efficiency.

4.5.2. Transportation and Product Movement

Transportation plays a critical role in linking *Eucalyptus* production areas with local and urban markets. Field observations and interviews revealed that harvested poles are transported from collection points in the study area to major consumption centers using trucks with an average carrying capacity of approximately 12 m^3 (about 300 poles) per trip. The transportation system supports the continuous movement of products throughout the supply chain and enables producers to reach both nearby towns and larger urban markets.

The findings further indicate that Addis Ababa remains the principal destination because of its high demand for construction materials. However, increasing quantities of *Eucalyptus globulus*

poles are also transported to Butajira, Wolkite, Hossana, Worabe, Qoshe, Batu, Enseno, Bui and Meqi, where rapid urban expansion and growing construction activities have created additional market opportunities. This expanding market network demonstrates the increasing commercial importance of *Eucalyptus* production in the study area.

4.5.3. Loading Points

The study identified several major loading points where harvested *Eucalyptus globulus* poles are assembled before being transported to urban markets. These collection centers serve as important logistical hubs that facilitate product aggregation and reduce transportation costs.

Table 4.9: Major Loading Points and Transportation Characteristics of Small-Diameter *Eucalyptus globulus* Poles

No	Variable	Sodo Woreda	Ezha Woreda
1	Respondent Type	Key Informant (Trans-porter/Trader)	Key Informant (Transporter/Trader)
2	Vehicles per Day	14	18
3	Vehicles per Week	98	126
4	Vehicles per Month	392	540
5	Vehicles per Year	5,110	6,570
6	Average Load per Vehicle (m^3)	About 12	About 12
7	Estimated Annual Volume (m^3/year)	61,320	78,840
8	Loading Points	Amawte, Gfitge, Morege Enset Tekil, Genete Mariyam, Fule, Amawte Lalige	Wojebare, Amba Genet, Was Mar, Qoxer, Gedeb, Ambali, Qexani, Qeraxelo, Nesh
9	Official Records Available	No	No
10	Transport Trend	Increasing	Increasing
11	Main Theme	*Eucalyptus* pole transportation and market movement	*Eucalyptus* pole transportation and market movement
12	Major Issue/Theme	Growing transport activity driven by increasing market demand	Growing transport activity and inflow from neighboring areas
13	Key Finding	Increasing movement of *Eucalyptus* poles from production areas to mar-kets	Increasing movement of *Eucalyptus* poles, including supply from other woredas and regions

Table 4.9 indicates that both Sodo and Ezha woredas have established loading points that function as collection centers for *Eucalyptus* poles produced in surrounding kebeles. In Sodo Woreda**,** the

major loading points include Amawte, Gfitge, Morege, Enset Tekil, Genete Mariyam, Fule, and Amawte Lalige**,** while Wojebare, Amba Genet, Was Mar, Qoxer, Gedeb, Ambali, Qexani, Qerax-elo, and Nesh were identified as the principal loading points in Ezha Woreda. Key informants reported that these locations improve transportation efficiency by allowing products from different producers to be assembled before loading onto trucks destined for urban markets. The findings also revealed an increasing trend in vehicle movement, reflecting growing market demand for *Eucalyptus* poles and the expansion of supply to Addis Ababa and surrounding towns.

These findings agree with (I. T. T. Organization, 2022), who emphasized that strategically located collection centers reduce transportation costs, improve logistics efficiency, and strengthen agricultural and forest product supply chains. Likewise,(Lambert & Cooper, 2000) noted that efficient coordination of logistics activities is essential for maintaining a continuous flow of products from production areas to consumers. The results therefore indicate that loading points play a significant role in improving product aggregation, reducing transaction costs, and facilitating market access.

4.5.4. Transportation System and Volume

Secondary data obtained from the Forestry and Natural Resources Offices of Ezha and Sodo woredas were used to examine trends in vehicle movement transporting small-diameter *Eucalyptus globulus* poles between 2022 and 2026. These administrative records provide evidence of changes in transportation activity and market supply over time.

Table 4.10: Estimated Number of Vehicles Transporting Small-Diameter *Eucalyptus globulus* Poles in Ezha and Sodo Woredas (2022–2026)

Time Limit	Area	Year	Per Day	Per Week	Per Month	Per Year
Estimated number of vehicles	Ezha Woreda	2022	14	98	420	5,110
	Ezha Woreda	2023	15	105	450	5,475
	Ezha Woreda	2024	16	112	480	5,840
	Ezha Woreda	2025	17	119	510	6,205
	Ezha Woreda	2026	18	126	540	6,570
Estimated number of vehicles	Sodo Woreda	2022	11	77	330	4,015
	Sodo Woreda	2023	12	84	360	4,380
	Sodo Woreda	2024	12	84	360	4,380
	Sodo Woreda	2025	13	91	390	4,745
	Sodo Woreda	2026	14	98	420	5,110

Table 4.10 shows a steady increase in vehicle movement in both study woredas during the five-year period. In Ezha Woreda, annual vehicle movement increased from 5,110 vehicles in 2022 to 6,570 in 2026, while Sodo Woreda increased from 4,015 to 5,110 vehicles**.** Throughout the study period, Ezha consistently recorded higher transportation volumes, indicating relatively greater production and market participation.

The increasing transportation trend reflects the expanding commercial importance of *Eucalyptus globulus* production and growing demand from the construction sector. Information obtained from woreda officials and key informants indicated that expanding urban construction, increasing private investment in *Eucalyptus* plantations, and improved market opportunities in Addis Ababa and nearby towns have contributed to this growth. Similar findings were reported by (Tesfaw et al., 2021) who observed that increasing market demand stimulated greater movement of *Eucalyptus* products in Ethiopia. Likewise, (FAO & UNECE, 2024) noted that increasing transportation volumes are an important indicator of expanding forest-product markets and stronger market integration.

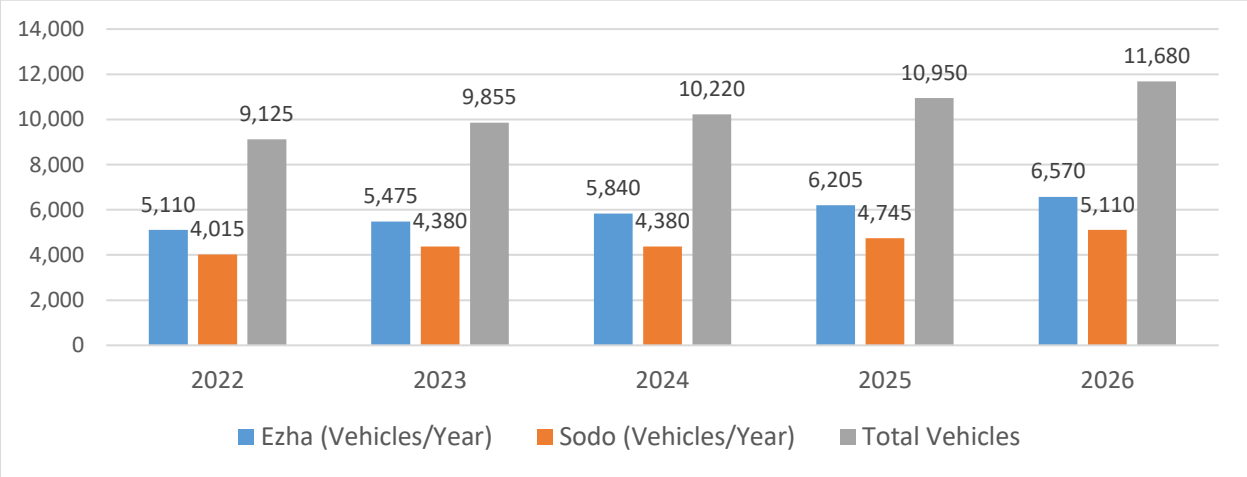


Figure 4.6: Trend of Annual Vehicle Movement Transporting Small-Diameter *Eucalyptus globulus* Poles in Ezha and Sodo Woredas (2022–2026)

Figure 4.6 clearly illustrates a positive upward trend in vehicle movement for both Ezha and Sodo woredas over the five-year period. Although both areas experienced continuous growth, the rate of increase was consistently higher in Ezha Woreda, reflecting its comparatively larger production base and stronger market participation. The parallel upward movement of the two trend lines indicates that the expansion of *Eucalyptus* transportation is occurring across the study area rather than being confined to a single woreda. Overall, the figure provides additional evidence that the supply

of small-diameter *Eucalyptus globulus* poles to major markets has increased steadily between 2022 and 2026, corresponding with rising market demand and expanding construction activities.

Table 4.11: Estimated Annual Supply of Small-Diameter *Eucalyptus globulus* Poles Based on Vehicle Movement (2022–2026)

Year	Ezha (Vehicles/Year)	Sodo (Vehicles/Year)	Total Vehicles	Estimated Pole Supply (Pieces/Year)
2022	5,110	4,015	9,125	2,737,500
2023	5,475	4,380	9,855	2,956,500
2024	5,840	4,380	10,220	3,066,000
2025	6,205	4,745	10,950	3,285,000
2026	6,570	5,110	11,680	3,504,000

Note: Estimated pole supply was calculated using official annual vehicle movement records obtained from the Forestry and Natural Resources Offices of Ezha and Sodo woredas. The calculation assumes an average carrying capacity of approximately 300 small-diameter *Eucalyptus globulus* poles (about 12 m^3) per vehicle, based on field observations and interviews with transport operators.

Table 4.11 presents the estimated annual supply of small-diameter *Eucalyptus globulus* poles derived from annual vehicle movement records. The results indicate that the estimated supply increased steadily from 2,737,500 poles in 2022 to 3,504,000 poles in 2026, representing an overall increase of approximately 28% during the five-year period.

The increasing supply reflects the growing importance of *Eucalyptus* production in meeting the rising demand for construction materials. The expansion of transportation activities observed during the study also indicates improved market connectivity between production areas and major consumption centers. According to key informants, the increase in annual supply has been driven by expanding urban development, increasing private investment in *Eucalyptus* plantations, and greater demand from construction contractors and wood-processing enterprises.

These findings are comparable with those reported by the (Canton, 2021), which noted that expanding forest product supply is closely associated with increasing urbanization and infrastructure

development in many developing countries. Likewise, (Hetemäki & Hurmekoski, 2020) emphasized that commercial plantation forestry has become an increasingly important source of industrial wood supply because of rising demand from the construction and manufacturing sectors. The findings therefore demonstrate that *Eucalyptus globulus* production has become an increasingly significant economic activity contributing to both rural livelihoods and urban construction markets.

4.5.5. Marketing Channels and Market Destination

The study examined the principal destinations for small-diameter *Eucalyptus globulus* poles marketed from the study area. The findings indicate that products are supplied to Addis Ababa, nearby towns, and local markets, although the volume distributed to each destination varies according to market demand and accessibility.

Table 4.12: Destination of *Eucalyptus* Poles

	Frequency	Percent	Valid Percent
Addis Ababa	66	54.5	54.5
Local Market	24	19.8	19.8
Other Towns	31	25.6	25.6
Total	121	100.0	100.0

Table 4.12 shows that Addis Ababa is the dominant market destination, accounting for 54.5% of all responses. This finding indicates that the capital city remains the principal market because of its continuous demand for construction materials, scaffolding poles, roofing materials, and other wood products. Approximately 25.6% of respondents supplied their products to other towns, while 19.8% marketed their products within local markets.

The findings suggest that the majority of producers target urban markets where demand and prices are relatively higher than in local markets. Interviews with producers revealed that Addis Ababa offers greater marketing opportunities because of rapid urbanization, continuous infrastructure development, and the presence of numerous construction projects. Meanwhile, nearby towns such as Butajira, Wolkite, Hosanna, Worabe, Batu, Meqi, Enseno , Bui and Qoshe are emerging as important secondary markets due to increasing residential and commercial development.

These findings are consistent with (Caplow et al., 2011), who reported that urbanization significantly increases demand for forest products by expanding construction activities and commercial

development. Similarly, the (I. T. T. Organization, 2022) noted that rapid urban growth in developing countries has substantially increased the demand for affordable construction materials, including plantation-grown timber products. The findings therefore indicate that urban expansion continues to be the primary driver of market demand for small-diameter *Eucalyptus globulus* poles.

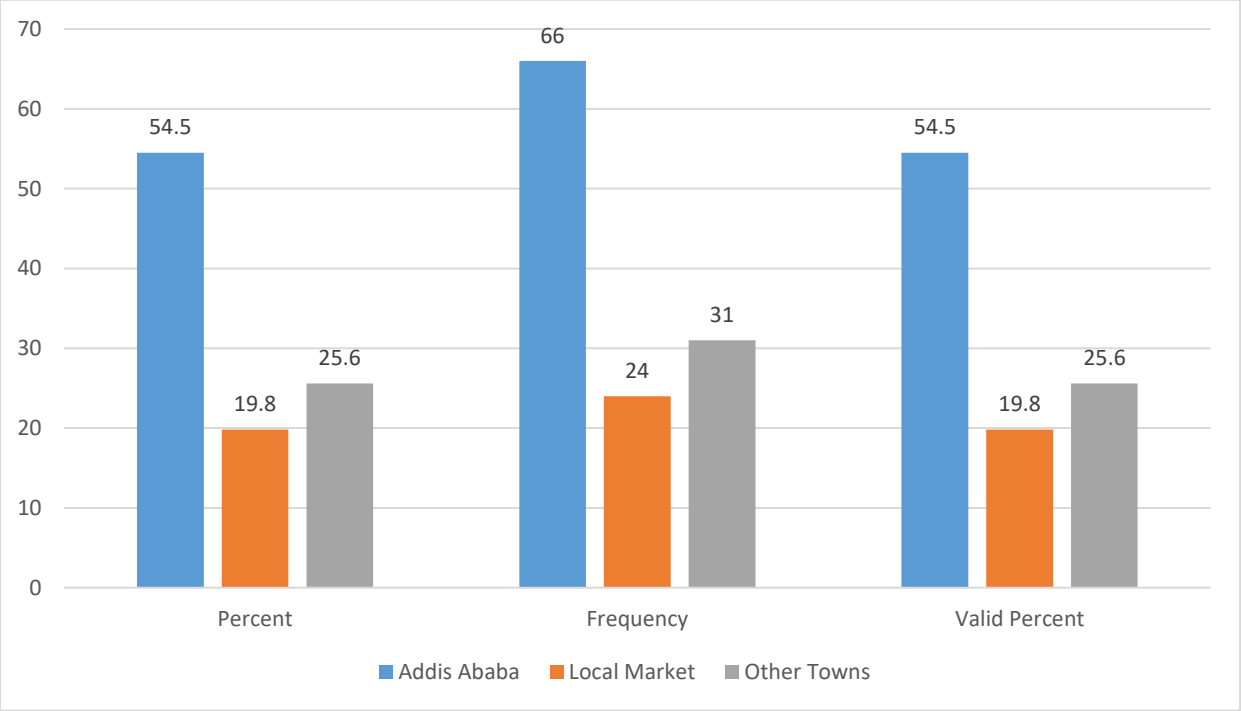


Figure 4.7: Key Market Destinations for ***Eucalyptus*** **Poles**

Figure 4.7 shows that Addis Ababa is the principal market destination for small-diameter *Eucalyptus globulus* poles produced in the study area, accounting for 54.5% of total market destinations. This reflects the city's high demand for construction materials, driven by rapid urban expansion and continuous residential and commercial development. In addition, the presence of wood-processing industries and large construction projects has further strengthened the demand for *Eucalyptus globulus* poles.

The second largest market destination comprised other nearby towns, which accounted for 25.6% of sales. These findings indicate that the market for *Eucalyptus globulus* poles extends beyond the study area and Addis Ababa, reflecting increasing demand from emerging urban centers. Similar findings were reported by (Mekuria et al., 2023), who found that Addis Ababa remains the dominant market for plantation wood products supplied by smallholder producers in central Ethiopia because of its expanding construction sector and well-developed marketing networks. Likewise, (Omondi et al., 2022) reported that major cities in Kenya attracted more than half of smallholder

tree products owing to rapid urbanization, increasing construction activities, and stronger market infrastructure. These similarities suggest that urban growth continues to be a major driver of demand for plantation forest products across East Africa.

Only approximately 19.8% of those surveyed indicated that they sell their *Eucalyptus globulus* poles in the local market. This is the endpoint for *Eucalyptus globulus* timber. It appears that those who cultivate and market *Eucalyptus globulus* poles choose to sell them in urban areas for higher prices.

In general, Figure 4.7 indicates that the trade of *Eucalyptus globulus* poles primarily concentrates in urban areas. Addis Ababa utilizes *Eucalyptus globulus* poles. It is evident that the majority of *Eucalyptus globulus* poles are sold in urban areas. This indicates that possessing roadways and market links is crucial for the *Eucalyptus globulus* supply chain. It indicates that with the expansion of cities and the growth of industries, the need for *Eucalyptus globulus* poles in Central Ethiopia will rise.

4.6. Marketing Margin Analysis

Marketing margin analysis was conducted to examine how the final selling price of small-diameter *Eucalyptus globulus* poles is distributed among the different actors in the supply chain. The analysis considered four major products traded in the study area: scaffolding poles (*Quami*), rafters (*weraji*), truss members (yeqorqoro *Mager*), and bracing/tie members (*Chefeqa*). The results reveal the share of income received by each supply chain actor and illustrate how value is added as products move from producers to final consumers.

Similar approaches have been widely applied in forest product value-chain studies to evaluate equity in benefit sharing and identify actors who capture the largest proportion of market value. For example, (Kaplinsky & Morris, 2001)noted that value chain analysis provides a practical framework for understanding how value is created and distributed among market participants, while (Nations, 2022) emphasized that transparent marketing systems are essential for improving producers' returns and enhancing supply chain efficiency.

4.6.1. Marketing Margin Analysis of Scaffolding Poles (Quami)

Scaffolding poles (locally known as *Quami*) are the most widely traded *Eucalyptus globulus* product in the study area because of their extensive use in building construction and scaffolding. The high demand for this product makes it an important source of income for supply chain actors. Table

4.13 presents the distribution of marketing margins among the major participants involved in the marketing of scaffolding poles.

Table 4.13: Marketing Margin Distribution for Scaffolding Poles (Fonte /Quami)

Actor	Buy Price (ETB)	Sell Price (ETB)	Cost (ETB)	Net Margin (ETB)	Share (%)
Producer	-	100	80	20	6.90
Broker	100	180	20	60	20.69
Transporter	180	260	25	55	18.97
Wholesaler	260	360	25	75	25.86
Retailer	360	460	20	80	27.59
Total		460	170	290	100.00

The results presented in Table 4.13 show that the total net marketing margin for a scaffolding pole was 290 ETB. Retailers received the largest share of the total margin **(**80 ETB; 27.59%**),** followed by wholesalers **(**75 ETB; 25.86%**).** Brokers and transporters earned 60 ETB (20.69%) and 55 ETB (18.97%)**,** respectively. In contrast, producers received only 20 ETB**,** representing 6.90% of the total net marketing margin.

These findings indicate that most of the value generated along the supply chain is captured after the product leaves the farm. Although producers undertake plantation establishment, management, harvesting, and initial post-harvest handling, they receive the smallest share of the final market value. This imbalance suggests that producers have relatively weak bargaining power and limited participation in value-adding and marketing activities.

The findings are consistent with (Kaplinsky & Morris, 2001), who argued that value chain benefits are often concentrated among downstream market actors that control distribution and market access. Similarly, (Feller et al., 2006) emphasized that value is frequently added through marketing, logistics, and distribution activities, allowing intermediaries to capture a larger proportion of the final selling price. The results therefore highlight the importance of strengthening producer organizations and improving direct market access to increase producers' share of marketing benefits.

4.6.2. Marketing Margin Analysis of Rafters (weraji)

Rafters (weraji) are another important product obtained from small-diameter *Eucalyptus globulus* poles and are widely used in roof construction and residential buildings. Table 4.14 presents the

distribution of marketing margins among the different actors participating in the marketing of rafters.

Table 4.14: Distribution of Marketing Margins for Rafters (weraji)

Actor	Buy Price (ETB)	Sell Price (ETB)	Cost (ETB)	Net Margin (ETB)	Share (%)
Producer	-	100	70	30	10.71
Broker	100	180	25	55	19.64
Transporter	180	270	35	55	19.64
Wholesaler	270	370	30	70	25.00
Retailer	370	460	20	70	25.00
Total		460	180	280	100.00

The results indicate that the total net marketing margin for rafters was 280 ETB per pole. Wholesalers and retailers each received 70 ETB**,** accounting for 25.00% of the total margin. Brokers and transporters each earned 55 ETB (19.64%)**,** whereas producers obtained 30 ETB**,** representing 10.71% of the overall marketing margin.

Compared with scaffolding poles, producers obtained a slightly larger proportion of the total margin for rafters. Nevertheless, the majority of the economic benefits continued to accrue to wholesalers and retailers, who perform marketing and distribution functions closer to the final consumers.

These findings agree with (Hellin & Meijer, 2006), who reported that agricultural and forest product producers often receive relatively small shares of the final market value because they have limited bargaining power and restricted access to profitable markets. Likewise, (Worku, 2020) noted that strengthening producer participation in value addition and marketing can improve income distribution and increase the competitiveness of forest product supply chains.

4.6.3. Marketing Margin Analysis of Truss Members (Yeqorqoro Mager)

Truss members (yeqorqoro *Mager*) are commonly used for roof framing and structural support in residential construction. Table 4.15 summarizes the distribution of marketing margins among the major supply chain actors.

Table 4.15: Marketing Margin Distribution for Truss Members (Yeqorqoro Mager)

Actor	Buy Price (ETB)	Sell Price (ETB)	Cost (ETB)	Net Margin (ETB)	Share (%)
Producer	-	80	55	25	9.09
Broker	80	150	15	55	20.00
Transporter	150	230	20	60	21.82
Wholesaler	230	320	20	70	25.45
Retailer	320	400	15	65	23.64
Total		400	125	275	100.00

Table 4.15 shows that the total net marketing margin for truss members (Yeqorqoro *Mager*) was 275 ETB per pole. Wholesalers received the largest share of the margin (70 ETB; 25.45%), followed by retailers (65 ETB; 23.64%)**.** Transporters and brokers earned 60 ETB (21.82%) and 55 ETB (20.00%), respectively, whereas producers obtained only 25 ETB, representing 9.09% of the total net marketing margin.

The findings indicate that a greater share of value is captured by downstream actors involved in aggregation, transportation, and marketing than by producers, who bear most of the production costs and risks. Similar results were reported by (Asfaw et al., 2023) who found that traders and wholesalers captured a larger proportion of marketing margins than producers in Ethiopian agricultural value chains because they perform marketing, storage, and distribution functions. Likewise, (Kaplinsky & Morris, 2001) explained that value chain actors engaged in processing, coordination, and market access often receive higher returns than primary producers due to the value they add beyond production. These findings suggest that improving producers' bargaining power, strengthening collective marketing, and enhancing direct market access could increase producers' share of the final market value.

These findings are supported by (Christopher, 2016), who explained that downstream supply chain actors frequently capture higher returns because they control logistics, customer relationships, and product distribution. Similarly, (Gereffi et al., 2016) noted that upgrading producer participation in value chains is essential for achieving a more equitable distribution of economic benefits among supply chain participants.

4.6.4. Marketing Margin Analysis of Bracing/Tie Members (Chefeqa)

Bracing or tie members (*Chefeqa*) are smaller structural components produced from *Eucalyptus globulus* poles and are commonly used to reinforce roof structures and temporary construction frameworks. Table 4.16 presents the distribution of marketing margins among supply chain actors.

Table 4.16: Marketing Margin Distribution for Bracing/Tie Members (Chefeqa)

Actor	Buy Price (ETB)	Sell Price (ETB)	Cost (ETB)	Net Margin (ETB)	Share (%)
Producer	-	25	13	12	9.45
Broker	25	65	10	30	23.62
Transporter	65	105	10	30	23.62
Wholesaler	105	145	10	30	23.62
Retailer	145	180	10	25	19.69
Total		180	53	127	100.00

Table 4.16 shows that the total net marketing margin for *Chefeqa* was 127 ETB per pole. Brokers, transporters, and wholesalers each earned 30 ETB, accounting for 23.62% of the total net marketing margin, while retailers received 25 ETB (19.69%). Producers obtained only 12 ETB, representing 9.45% of the total marketing margin.

Although the marketing margin for *Chefeqa* was distributed more evenly among intermediaries than for the other pole products, producers still received the smallest share of the final market value. This suggests that producers have limited bargaining power and remain highly dependent on intermediaries for market access and price negotiation. Comparable findings were reported by (Getahun et al., 2022) who found that smallholder producers in Ethiopia received a relatively small share of the final market value because traders and other intermediaries performed aggregation, transportation, and marketing functions. Similarly, (Donovan et al., 2021) observed that weak producer bargaining power and limited direct access to markets often result in an unequal distribution of benefits along agricultural and forest-product value chains. These findings highlight the importance of strengthening producer organizations, improving market linkages, and expanding direct marketing opportunities to enhance producers' returns.

Similar findings were reported by (Belay Zerga et al., 2021), which noted that producers of primary commodities often capture only a limited share of value because downstream actors perform mar-

keting, aggregation, and distribution activities. Likewise, (Canton, 2021) emphasized that improving producer organizations and strengthening market linkages can increase producers' participation in value creation and improve income distribution throughout agricultural and forest product value chains.

4.6.5. Comparative Marketing Margin Analysis

Table 4.17: Comparative Marketing Margin Distribution among *Eucalyptus* Pole Products

Product Type	Producer Share (%)	Highest Margin Actor	Highest Margin Share (%)	Total Net Margin (ETB)
Scaffolding Poles (Qami)	6.90	Retailer	27.59	290
Rafters (Fonte)	10.71	Wholesaler/Retailer	25.00	280
Truss Members (Mager)	9.09	Wholesaler	25.45	275
Bracing/Tie Members (Chefeqa)	9.45	Broker/Transporter/Wholesaler	23.62	127

Table 4.17 compares the marketing margins of the four major *Eucalyptus globulus* pole products traded in the study area. Among the products, scaffolding poles (*Qami*) generated the highest total net marketing margin (290 ETB per pole**),** followed by rafters (*Fonte*) (280 ETB**),** truss members (*Mager*) (275 ETB**),** and bracing/tie members (*Chefeqa*) (127 ETB**).**

The variation in marketing margins reflects differences in product demand, end use, handling requirements, and transportation costs. Products such as scaffolding poles and rafters, which are widely used in building construction, generated higher returns because of their greater market demand and wider commercial utilization. Similar findings were reported by (Berhanu et al., 2023) who found that construction-grade plantation wood products in Ethiopia generated higher marketing margins than lower-value products due to stronger demand and greater commercial importance. Likewise, (Ingram et al., 2022) reported that value-added forest products used in the construction sector generally command higher market prices because of their broader applications and consistent demand.

The comparison further shows that producers consistently received the smallest share of the final selling price across all product categories, whereas wholesalers and retailers captured the largest proportions of the marketing margin. This indicates that downstream actors add considerable value through aggregation, transportation, market coordination, and distribution. Comparable findings were reported by (Minten et al., 2021)**,** who observed that intermediaries often receive a larger share of marketing margins because they perform essential marketing functions and bear marketing-related costs and risks. These findings suggest that strengthening producer cooperatives, improving access to market information, and promoting direct market linkages could enhance producers' bargaining power and increase their share of the final market value.

Similar recommendations have been made by (U. N. I. D. Organization, 2019), which emphasized that strengthening producer organizations and improving market access are essential for achieving more equitable value distribution in agricultural and forest product supply chains.

4.7. Value Addition Practices by Supply Chain Actors

Value addition is an important component of forest product marketing because it improves product quality, enhances marketability, and increases economic returns for supply chain actors. In the present study, respondents were asked to identify the value addition activities they commonly perform before marketing small-diameter *Eucalyptus globulus* poles. The major practices investigated included sorting, grading, bundling, debarking, trimming, and size selection.

Studies on forest product marketing have shown that even simple post-harvest practices can improve product quality and increase market competitiveness. (Porter, 1985) emphasized that value is created through activities that improve product quality and satisfy customer requirements, while (I. T. T. Organization, 2023b) reported that grading and product standardization are essential practices for improving the competitiveness of timber and other forest products in domestic and international markets.

Table 4.18: Value Addition Practices Performed by Supply Chain Actors

Value Addition Practice	Yes	No
Sorting	89 (73.6%)	32 (26.4%)
Grading	100 (82.6%)	21 (17.4%)
Bundling	0 (0.0%)	121 (100.0%)
Debarking	60 (49.6%)	61 (50.4%)
Trimming	41 (33.9%)	80 (66.1%)
Size selection	91 (75.2%)	30 (24.8%)

The findings presented in Table 4.18 show that grading was the most widely practiced value addition activity, performed by 82.6% of respondents. This was followed by size selection (75.2%) and sorting (73.6%)**.** These activities enable producers and traders to classify poles according to length, diameter, and quality, making products more attractive to buyers and facilitating price differentiation.

Approximately half of the respondents **(**49.6%**)** reported practicing debarking, whereas 33.9% carried out trimming before marketing. In contrast, none of the respondents practiced bundling, indicating that poles are generally transported and sold individually rather than as standardized bundles.

The predominance of grading, sorting, and size selection suggests that value addition within the study area remains relatively simple and is mainly intended to improve product presentation rather than undertake substantial processing. Similar findings were reported by (I. T. T. Organization, 2023b), which observed that many developing-country forest product markets rely primarily on basic post-harvest handling practices because of limited processing technologies and inadequate investment.

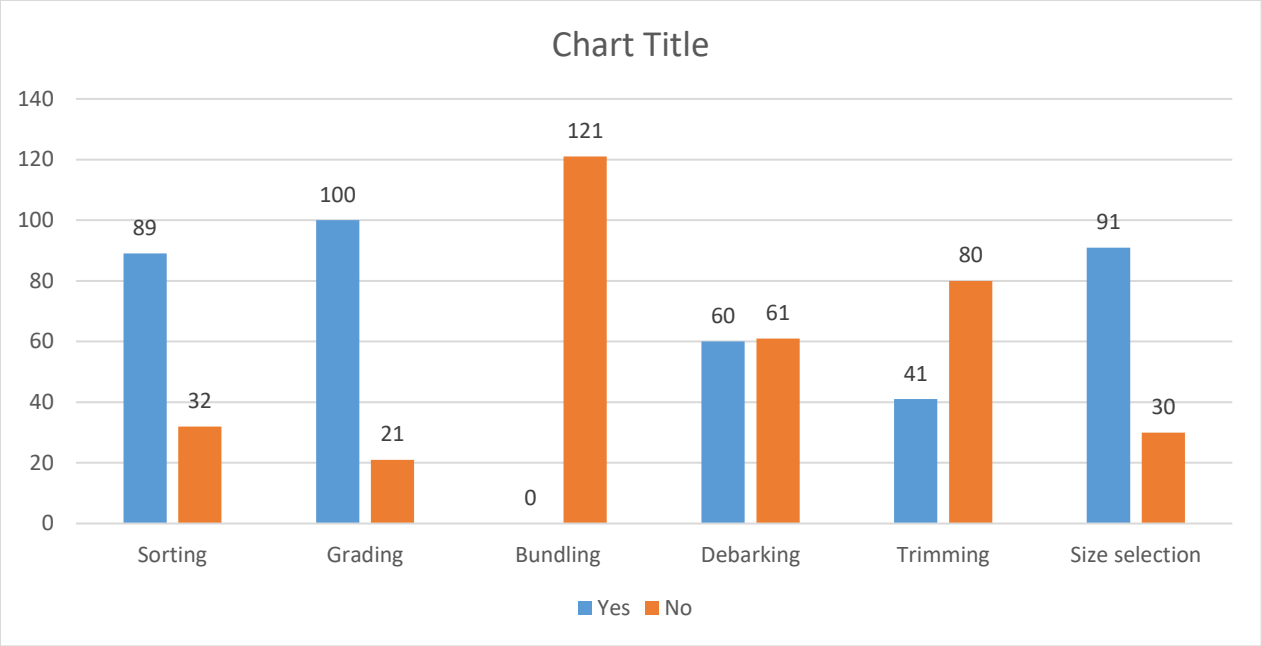


Figure 4.8: Value Addition Practices Performed by Supply Chain Actors

Figure 4.8 further illustrates that grading, size selection, and sorting are the dominant value addition practices performed by supply chain actors. These activities were considerably more common than debarking and trimming, while bundling was not practiced by any respondent. The figure indicates that most actors focus on improving product classification and quality rather than processing products into higher-value forms.

The limited adoption of advanced value addition practices suggests opportunities for improving producer income through training, improved processing technologies, and stronger market incentives. According to (Bank, 2021), increasing value addition within forest product supply chains can substantially improve rural employment, market competitiveness, and household income by enabling producers to supply higher-quality products that meet evolving market requirements.



Figure 4.9: Roadside *Eucalyptus* pole storing and selling at (a) Sodo wored , (b) Ezha woreda (c) and Addis Ababa .

The arrangement of *Eucalyptus* poles along the roadside indicates that the *Eucalyptus* pole industry is highly commercial. It demonstrates the significance of having roads that link the rural areas where the poles are made to major cities like Addis Ababa where consumers wish to purchase them. In urban markets, numerous poles are visible, indicating that residents are seeking *Eucalyptus* products due to the expansion of the city, construction activities, and an increase in wood factories. In figure 4.9 *Eucalyptus* poles are being relocated and sold, reinforcing our findings that there is substantial demand in the supply chain, and individuals are enhancing the value of the poles. They depend on basic methods for storing and selling them by the roadside.

4.8. Statistical Analysis

To further examine the relationships among variables affecting the small-diameter *Eucalyptus globulus* pole supply chain, inferential statistical analyses were performed using SPSS version 27. Before conducting the analyses, the assumptions required for each statistical test were assessed. Pearson's correlation analysis was applied to determine the relationships between continuous variables, while Chi-square tests and cross-tabulation were used to examine associations between categorical variables. One-way Analysis of Variance (ANOVA) was employed to compare mean values among respondent groups. Statistical significance was evaluated at the 5% probability level ($p < 0.05$).

4.8.1. Correlation Analysis

Pearson correlation analysis was used to examine the relationships between selected continuous variables related to the *Eucalyptus globulus* pole supply chain. Prior to analysis, the assumptions of Pearson correlation were considered. The variables included in the analysis were measured on continuous scales, observations were independent, and the relationships were assumed to be linear. Statistical significance was evaluated at the 5% probability level.

Relationship between Years of Experience and Annual Production Volume

Table 4.19: Presents the correlation between years of experience in the *Eucalyptus* business and annual production volume of *Eucalyptus* poles.

Correlations			
		Years of Experience in *Eucalyptus* Business	Annual Production Volume of *Eucalyptus* Poles (m^3)
Years of Experience in *Eucalyptus* Business	Pearson Correlation	1	.139
	Sig. (2-tailed)		.290
	N	121	60
Annual Production Volume of *Eucalyptus* Poles (m^3)	Pearson Correlation	.139	1
	Sig. (2-tailed)	.290	
	N	60	60

Table 4.19 shows a weak positive correlation between years of experience in the *Eucalyptus* business and annual production volume ($r = 0.139$). This indicates that production tended to increase slightly as producers gained more experience. However, the relationship was not statistically significant **(**$p = 0.290$**),** suggesting that the observed association was too weak to conclude that experience alone influences annual production.

The findings imply that experience, although important for improving technical knowledge and management skills, is not sufficient by itself to increase production. In the study area, annual production appears to depend more on access to productive resources such as plantation land, financial capital, market opportunities, and other production inputs than on the number of years producers have been engaged in *Eucalyptus* production. Consequently, experienced producers may not necessarily achieve higher production if they face constraints related to land availability or limited investment capacity.

A similar observation was reported by (Nations, 2022), which noted that improvements in forest production are often constrained by limited access to productive resources and market opportuni-

ties rather than by producers' experience alone. Likewise, (Scherr et al., 2004) reported that smallholder forest production depends more on access to land, capital, and institutional support than on farming experience, particularly in developing countries.

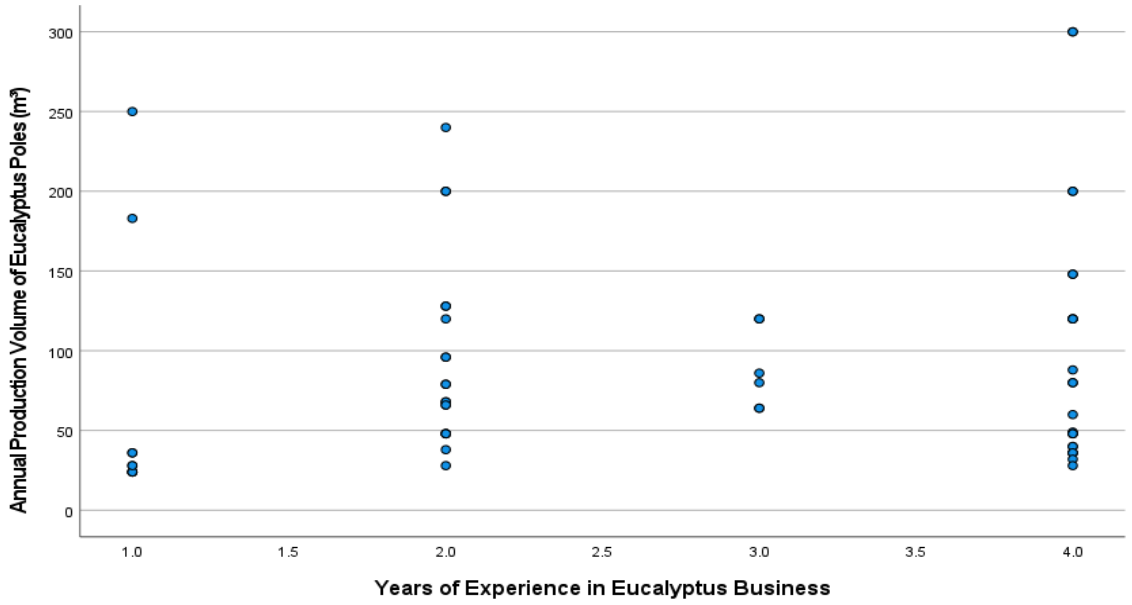


Figure 4.10: Scatter Plot Showing the Relationship between Years of Experience in the *Eucalyptus* Business and Annual Production Volume of *Eucalyptus* Poles

The scatter plot showed a weak positive relationship between years of experience in the *Eucalyptus* business and annual production volume of *Eucalyptus* poles. The Pearson correlation coefficient ($r = 0.139$) indicates that production volume tends to increase slightly with increasing years of experience. However, the relationship was not statistically significant ($p = 0.290 > 0.05$). Therefore, years of experience had no significant association with annual production volume among the sampled producers.

Relationship between Land Size and Annual Production Volume (Insert Scatter Plot here.)

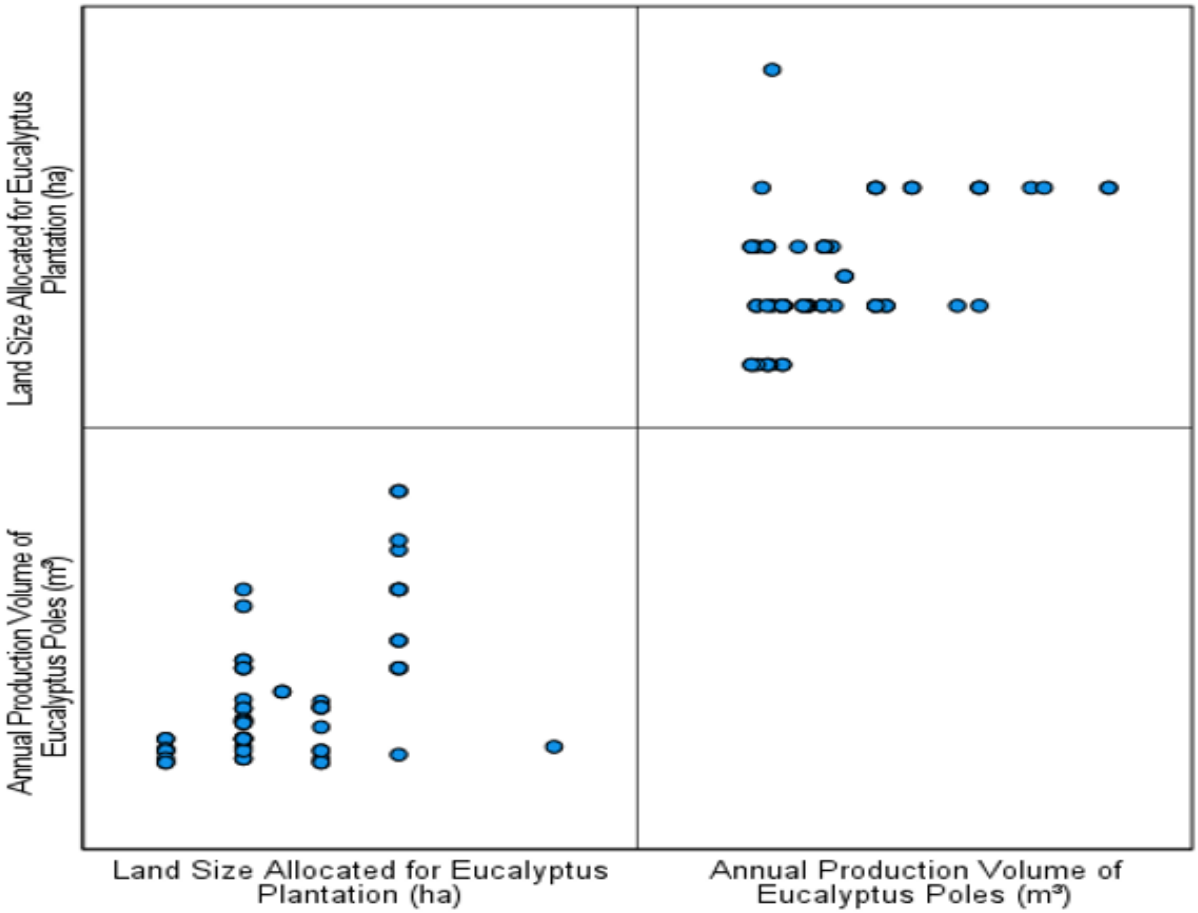


Figure 4.11: Scatter Plot Showing the Relationship between Land Size Allocated to *Eucalyptus globulus* Plantation and Annual Production Volume

Figure 4.11 illustrates the relationship between the area allocated to *Eucalyptus globulus* plantations and annual production volume. The scatter plot shows a clear upward trend, indicating that producers with larger plantation areas generally achieved higher production volumes.

Pearson's correlation analysis confirmed a moderate positive and statistically significant relationship between land size and annual production volume ($r = 0.508$, $p < 0.01$). This result indicates that increasing the area devoted to *Eucalyptus* cultivation is associated with a corresponding increase in annual pole production.

The finding demonstrates that land availability is one of the most important factors determining production capacity in the study area. Producers with larger plantation areas have greater opportunities to increase output and supply larger quantities of *Eucalyptus* poles to the market.

This finding is consistent with (Siry et al., 2005), who reported that plantation size is a major determinant of wood production because larger forest holdings generally generate greater production volumes and improve economies of scale. Similarly, (Cubbage et al., 2010) found that commercial tree plantation productivity is strongly associated with the area under cultivation and efficient resource allocation.

4.8.2. Chi-Square Test and Crosstab Analysis

Chi-square tests were conducted to examine the relationships between selected categorical variables associated with the small-diameter *Eucalyptus globulus* pole supply chain. Before performing the analysis, the assumptions of the Chi-square test were verified. All variables included in the analysis were categorical, observations were independent, and the expected frequencies met the minimum requirements for applying the test. Cross-tabulation was used to summarize the distribution of respondents across categories and to facilitate interpretation of the relationships. Statistical significance was assessed at the 5% level ($p < 0.05$).

4.8.2.1. Association between Education Level and Credit Access

Table 4.20:a. Cross-tabulation of Education Level and Credit Access

Education Level	No, n (%)	Yes, n (%)	Total
Cannot read and write	2 (100.0)	0 (0.0)	2
Primary	48 (90.6)	5 (9.4)	53
Secondary	37 (90.2)	4 (9.8)	41
Diploma	4 (57.1)	3 (42.9)	7
Degree	13 (72.2)	5 (27.8)	18
Total	**104 (86.0)**	**17 (14.0)**	**121**

Table 4.20a presents the relationship between respondents' educational level and access to credit services within the *Eucalyptus globulus* pole supply chain. The cross-tabulation results show that access to formal credit was generally low across all educational categories. Among respondents with primary education, 90.6% reported that they did not have access to credit services, while only 9.4% had access. A similar pattern was observed among respondents with secondary education, where 90.2% lacked access to credit. In comparison, respondents with diploma and degree qualifications had relatively better access to credit facilities than those with lower educational attainment.

Table 4.21. Chi-square Test Results for the Association between Education Level and Credit Access

Statistic	Value
Pearson Chi-square (χ^2)	9.508
Degrees of freedom (df)	4
p-value	0.050
Valid cases (N)	121

Note: Forty percent (40%) of the expected cell frequencies were less than five; therefore, the results should be interpreted with caution.

The Pearson Chi-square test yielded a χ^2 value of 9.508 with 4 degrees of freedom and a p-value of 0.050, indicating a statistically significant association between educational level and access to credit at the 5% significance level. This finding suggests that respondents with higher educational attainment are more likely to access formal financial services because they are better able to understand loan procedures, satisfy institutional requirements, and use available financial information effectively. Similar evidence was reported by (Gelata & Han, 2024)**,** who found that access to credit and farmers' capacity to utilize financial services are strongly associated with improved adoption of agricultural technologies and greater participation in contract farming among smallholders in Ethiopia. Similar findings were reported by (Borena, 2021)**,** who found that farmers' educational level significantly increased the likelihood of accessing formal agricultural credit in Ethiopia.

These findings are consistent with those reported by (K. G. Gebremedhin & Negash, 2023) who found that education enhances the ability of smallholder tree growers in Ethiopia to access financial services and participate more effectively in commercial forestry activities. Similarly, the(I. F. for A. Development, 2021)**,** emphasized that improved educational attainment strengthens financial literacy, increases access to rural credit, and encourages greater investment in agricultural and forestry value chains.

Although the association was statistically significant, the results should be interpreted with caution because 40% of the cells had expected frequencies below five, indicating a slight violation of one of the assumptions of the Chi-square test. Nevertheless, the findings underscore the importance of expanding financial inclusion and improving access to credit, particularly for producers with lower

educational attainment, to support investment in plantation management, value addition, and overall supply chain development.

4.8.3. Association between Supply Chain Actor Type and Market Information

Table 4.22: Chi-Square Test of Association between Supply Chain Actor Type and Market Information.

Supply Chain Actor	Low, n (%)	Medium, n (%)	High, n (%)	Total
Producers	14 (23.3)	34 (56.7)	12 (20.0)	60
Traders/Brokers	8 (61.5)	5 (38.5)	0 (0.0)	13
Transporters	8 (72.7)	3 (27.3)	0 (0.0)	11
Wholesalers	8 (72.7)	3 (27.3)	0 (0.0)	11
Retailers	11 (100.0)	0 (0.0)	0 (0.0)	11
End Users	9 (60.0)	6 (40.0)	0 (0.0)	15
Total	**58 (47.9)**	**51 (42.1)**	**12 (9.9)**	**121**

Table 4.23: Chi-square Test Results for the Association between Supply Chain Actor Type and Market Information

Statistic	Value
Pearson Chi-square (χ^2)	38.625
Degrees of freedom (df)	10
p-value	<0.001
Valid cases (N)	121

Note: Forty-four point four percent (44.4%) of the cells had expected frequencies below five; therefore, the results should be interpreted with caution.

Table 4.23 and Table 4.24 show the relationship between supply chain actor type and market information access. More than half of the producers (56.7%) reported having a medium level of market information, while only 20.0% had a high level. In contrast, traders, brokers, transporters, wholesalers, retailers, and end users mainly reported low or medium levels of market information, and none reported a high level.

These findings indicate that access to reliable market information remains limited across the supply chain, reducing actors' bargaining power and their ability to make informed marketing decisions. Similar findings were reported by (Tadesse et al., 2023)**,**who found that about 58% of smallholder forest producers in Ethiopia had only moderate access to market information. Likewise, (Mwangi et al., 2022) reported that nearly 65% of smallholder tree producers in Kenya relied on informal market information, limiting their market participation and negotiating power. Overall, improving market information systems and extension services would strengthen market efficiency and enhance the performance of the *Eucalyptus globulus* pole supply chain.

The Chi-square analysis produced a Pearson Chi-square (χ^2) value of 38.625 with 10 degrees of freedom and a p-value of less than 0.001**,** indicating a statistically significant association between supply chain actor type and access to market information. This finding suggests that market information is unevenly distributed among participants in the supply chain. Such disparities may influence bargaining power, pricing decisions, and access to profitable market opportunities.

These findings are consistent with those reported by (Lemenih & Kassa, 2014), who found that unequal access to market information is one of the major constraints affecting forest product marketing in Ethiopia, limiting producers' ability to negotiate favorable prices. Similarly, (Kaplinsky & Morris, 2001), explained that effective information sharing among supply chain participants enhances coordination, reduces transaction costs, and promotes a more equitable distribution of benefits within value chains.

The observed variation in market information access highlights the need to strengthen market information systems, improve communication among supply chain actors, and expand extension services that provide timely and reliable market intelligence. Such interventions would improve market transparency, strengthen producers' bargaining capacity, and contribute to a more efficient and competitive *Eucalyptus globulus* pole supply chain.

Although the association was statistically significant, the findings should be interpreted with caution because 44.4% of the cells had expected frequencies below five**,** indicating a slight violation of one of the assumptions of the Chi-square test. Nevertheless, the strength of the statistical association suggests that meaningful differences in market information exist among the different supply chain actors.

4.8.4. Analysis of Variance (ANOVA)

Analysis of Variance (ANOVA) was employed to determine whether statistically significant differences existed among respondent groups regarding selected variables related to the *Eucalyptus globulus* pole supply chain. Prior to conducting the analysis, the assumptions of ANOVA were evaluated. These included the independence of observations, normality of the dependent variable within each group, and homogeneity of variances. Homogeneity of variance was assessed using Levene's test, while statistical significance was evaluated at the 5% probability level ($p < 0.05$).

4.8.4.1. Education Level and Land Size Allocated for *Eucalyptus* Plantation

The one-way ANOVA was conducted to examine whether the average land allocated for *Eucalyptus globulus* plantations differed across respondents with different educational backgrounds. The descriptive statistics showed only slight variation in the average plantation size among the education categories. Producers with primary education had the largest average plantation size (1.31 ha), followed by respondents with secondary education and degree qualifications (1.25 ha each), while respondents who could not read and write had the smallest average plantation size (1.00 ha).

Before interpreting the ANOVA results, Levene's test was performed to assess the assumption of equal variances. The test was statistically significant (Levene Statistic = 5.605, $p = 0.002$), indicating that the assumption of homogeneity of variances was not fully satisfied. Consequently, the ANOVA findings should be interpreted with some caution.

Despite these differences in average landholding, the ANOVA results revealed no statistically significant difference in land allocated to *Eucalyptus* plantations among the different educational groups **(**$F(3,56) = 0.220$, $p = 0.882$**).** This finding indicates that educational attainment did not significantly influence the amount of land devoted to *Eucalyptus globulus* production in the study area. Similar findings were reported by (H. Kassa et al., 2022)**,** who found that farm size allocated to tree planting was influenced more by land availability and household resources than by farmers' educational status. Likewise, (Place et al., 2021)**,** observed that land allocation decisions for perennial tree crops are primarily determined by land ownership and household assets rather than formal education.

The result suggests that land ownership and plantation size are influenced more by household resource availability, local land tenure arrangements, and inherited landholding patterns than by formal education. In rural Ethiopia, access to agricultural land is often determined by family ownership and local administrative arrangements rather than educational status.

This finding is consistent with (Lemenih & Kassa, 2014), who reported that the expansion of *Eucalyptus* plantations in Ethiopia is primarily influenced by land availability and household livelihood strategies rather than educational attainment. Similarly, the (Bank, 2021) noted that access to productive assets such as land remains one of the principal determinants of rural agricultural investment in developing countries, whereas education alone does not necessarily increase farm size.

4.8.4.2. Market Information and Annual Production Volume of *Eucalyptus* Poles

Table 4.24: ANOVA Results for Annual Production Volume by Market Information Level

Source of Variation	Sum of Squares	df	Mean Square	F-value	p-value
Between Groups	10,785.073	2	5,392.537	1.118	0.334
Within Groups	274,933.860	57	4,823.401	—	—
Total	285,718.933	59	—	—	—

Table 4.24 presents the results of the one-way ANOVA conducted to determine whether annual production volume differed according to producers' level of market information. The descriptive statistics indicated that producers with high market information recorded the highest average annual production volume (109.67 m^3), followed by those with low market information (104.07 m^3), whereas respondents with medium market information reported the lowest average production (79.85 m^3).

Levene's test showed that the assumption of homogeneity of variances was satisfied (Levene Statistic = 1.578, $p = 0.215$), indicating that the variability among the groups was sufficiently similar to permit the application of ANOVA.

The ANOVA results, however, demonstrated that the observed differences in mean annual production volume were not statistically significant **(**$F(2,57) = 1.118$, $p = 0.334$**).** Furthermore, Tukey's HSD multiple comparison test revealed no statistically significant differences between any pair of market information groups, while the homogeneous subsets analysis placed all groups within the same subset. These findings indicate that the variations in production volume among respondents with different levels of market information were too small to represent meaningful statistical differences.

The results imply that although producers with better market information tended to report slightly higher production volumes, market information alone was insufficient to increase production significantly. Other production factors, including land availability, financial capacity, plantation management, and access to production inputs, are likely to exert a greater influence on production performance.

A comparable finding was reported by (Fekadu et al., 2024**),** who indicated that although improved market linkages and information access support better marketing decisions, the development of the *Eucalyptus* pole value chain in Ethiopia is largely influenced by production capacity, availability of resources, and actors' investment capacity. Similarly, (B. Gebremedhin & Negash, 2023) emphasized that market information alone cannot enhance production unless producers have adequate access to productive resources, technical support, and institutional services.

Multiple linear regression analysis was performed to examine the combined effects of age category, years of experience in *Eucalyptus* production, extension service access, market information, distance to market, and land allocated for *Eucalyptus globulus* plantations on annual production volume. Credit access was excluded from the regression model because SPSS identified it as a constant variable and it did not exhibit sufficient variation for inclusion in the analysis.

Model Fitness

The regression model produced a multiple correlation coefficient of $R = 0.551$, indicating a moderate relationship between the explanatory variables and annual production volume. The coefficient of determination ($R^2 = 0.303$**)** shows that approximately 30.3% of the variation in annual production volume was explained by the variables included in the model. After adjusting for the number of predictors, the adjusted R^2 decreased to 0.224, indicating that approximately 22.4% of the variation in production volume was explained after accounting for model complexity.

The overall regression model was statistically significant ($F(6,53) = 3.846$, $p = 0.003$**),** demonstrating that the explanatory variables jointly contributed to explaining variations in annual production volume.

Effects of Individual Variables

Among the explanatory variables, only land size allocated for *Eucalyptus globulus* plantation had a statistically significant effect on annual production volume. The coefficient for land size was positive and significant ($B = 60.243$, $\beta = 0.466$, $p < 0.001$), indicating that an increase of one

hectare in land allocated to *Eucalyptus* plantation increased annual production volume by approximately 60.24 m^3, holding other factors constant.

Age category had a negative coefficient (B = –20.219) and was marginally significant at the 10% level (p = 0.089), suggesting that older age categories tended to produce lower volumes, although the effect was not statistically significant at the conventional 5% level.

Years of experience in the *Eucalyptus* business (B = 5.974, p = 0.473), extension service access (B = 12.285, p = 0.672), market information (B = 6.654, p = 0.589), and distance to market (B = –0.416, p = 0.728) did not have statistically significant effects on annual production volume.

Multicollinearity Diagnosis

The collinearity diagnostics confirmed that multicollinearity was not a concern in the regression model. Tolerance values ranged from 0.689 to 0.982**,** while Variance Inflation Factor (VIF) values ranged from 1.018 to 1.451**,** well below the commonly accepted threshold of 10. These statistics indicate that the explanatory variables were sufficiently independent and that the estimated regression coefficients were reliable.

Regression Equation

The estimated regression model is expressed as:

Annual Production Volume=17.824−20.219(Age)+5.974(Experience)+12.285(Extension Service)+6.654(Market Information)−0.416(Distance to Market)+60.243(Land Size)\text{Annual Production Volume} = 17.824 -20.219(\text{Age}) +5.974(\text{Experience}) +12.285(\text{Extension Service}) +6.654(\text{Market Information}) -0.416(\text{Distance to Market}) +60.243(\text{Land Size})Annual Production Volume=17.824−20.219(Age)+5.974(Experience)+12.285(Extension Service)+6.654(Market Information)−0.416(Distance to Market)+60.243(Land Size)

This equation indicates that, among all explanatory variables included in the model, land size allocated to *Eucalyptus* plantation had the greatest positive contribution to annual production volume, while the effects of the remaining variables were comparatively small and statistically insignificant.

Table 4.25: Multiple Linear Regression Results for Annual Production Volume of *Eucalyptus* Poles

Variable	B	Beta	t-value	p-value	VIF
Constant	17.824	—	0.357	0.722	—
Age category	-20.219	-0.223	-1.734	0.089	1.262
Years of experience	5.974	0.100	0.723	0.473	1.451
Extension service	12.285	0.049	0.425	0.672	1.018
Market information	6.654	0.063	0.544	0.589	1.033
Distance to market	-0.416	-0.043	-0.350	0.728	1.129
Land size allocated for *Eucalyptus* plantation	60.243	0.466	3.717	0.000	1.195

Dependent Variable: Annual Production Volume of *Eucalyptus* Poles (m^3).

The regression analysis showed that land size allocated for *Eucalyptus globulus* plantation was the only variable that significantly influenced annual production volume ($B = 60.243$, $\beta = 0.466$, $p < 0.001$). The positive coefficient indicates that producers with larger plantation areas achieved higher production volumes, confirming that land availability is a critical determinant of production capacity. This finding is consistent with (Kerbo et al., 2024)**,**who reported that land allocation for *Eucalyptus* cultivation among smallholder farmers in the Gurage Zone is influenced by household resources and production conditions. Similarly, (Dessie et al., 2019) found that production and commercial values of *Eucalyptus* woodlots in Ethiopia are strongly associated with farm-level resource availability and management practices. International studies also indicate that access to land and productive resources is a major factor affecting the expansion and productivity of smallholder tree-based production systems.

The result agrees with (Gebremedhin & Negash, 2023) who reported that the productivity of smallholder *Eucalyptus* plantations in Ethiopia depends primarily on access to land and productive resources rather than farmers' socioeconomic characteristics. Similarly, (Cubbage et al., 2010) found that plantation size is one of the strongest predictors of wood production because larger plantation areas enable producers to achieve higher levels of output and greater production efficiency.

4.9. Constraints Affecting the *Eucalyptus* Pole Supply Chain

The survey identified several constraints affecting the efficiency of the small-diameter *Eucalyptus globulus* pole supply chain (Table 4.25). Respondents reported that price fluctuation, poor road infrastructure, broker dominance, transport costs, limited market information, inadequate extension services, and limited access to credit continue to affect production and marketing activities. These constraints reduce marketing efficiency, increase transaction costs, and limit the benefits obtained by producers.

Similar findings were reported by (Kebede, 2022)**,** who identified unstable prices, poor transportation infrastructure, and weak institutional support as major constraints affecting *Eucalyptus* marketing in Ethiopia. Similar findings have been reported in Ethiopia by (Alemayehu et al., 2024b)**,**who found that unstable market prices, weak infrastructure, and limited institutional support are among the major challenges affecting the *Eucalyptus* value chain. Likewise, (Nations, 2022) reported that inadequate rural infrastructure and imperfect market systems remain major barriers to efficient forest product marketing in many developing countries. These similarities suggest that improving market institutions and rural infrastructure is essential for strengthening forest product supply chains.

Table 4.26: Major Constraints Affecting the *Eucalyptus* Pole Supply Chain (n = 121)

Constraints					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Price fluctuation	43	35.5	35.5	35.5
	Transport cost	12	9.9	9.9	45.5
	Road access	27	22.3	22.3	67.8
	Market info	12	9.9	9.9	77.7
	Credit	2	1.7	1.7	79.3
	Broker dominance	19	15.7	15.7	95.0
	Extension support	6	5.0	5.0	100.0
	Total	121	100.0	100.0	

Table 4.26 shows that price fluctuation was identified as the most important constraint, accounting for 35.5% of the responses. This was followed by poor road access **(**22.3%**)** and broker dominance **(**15.7%**).** Transport costs and limited market information each accounted for 9.9%**,** whereas inadequate extension services **(**5.0%**)** and limited access to credit **(**1.7%**)** were reported less frequently. The findings indicate that market-related and infrastructural challenges have a greater influence on the *Eucalyptus* pole supply chain than production-related constraints. Frequent price changes reduce producers' ability to plan production and marketing activities, while poor transportation infrastructure increases marketing costs and delays product delivery.

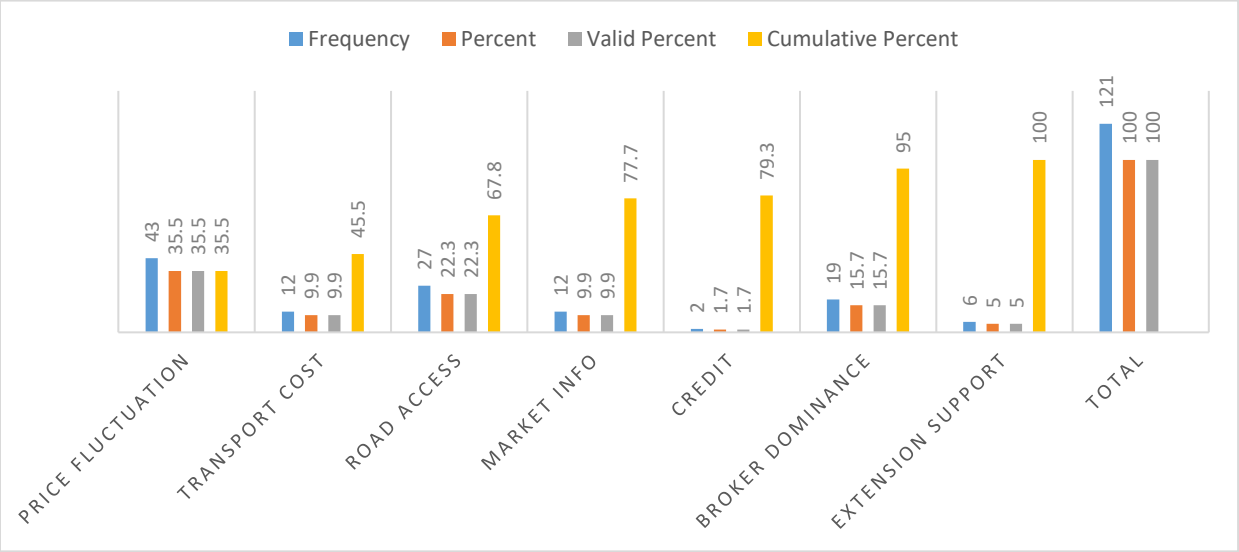


Figure 4.12: Major Constraints Affecting the *Eucalyptus* Pole Supply Chain

Figure 4.12 visually confirms that price fluctuation, poor road infrastructure, and broker dominance were the most frequently reported constraints. These challenges reduce marketing efficiency by increasing transaction costs, limiting market access, and weakening producers' bargaining power. The findings highlight the importance of improving rural infrastructure, strengthening market information systems, and promoting fair market competition to enhance supply chain performance.

4.9.1. Severity of Supply Chain Constraints

In addition to identifying the major constraints, respondents were asked to assess the severity of each problem. Their responses were categorized as low, medium, or high severity (Table 4.27).

Table 4.27: Severity Levels of Major Supply Chain Constraints (n = 121)

Constraint	Low (%)	Medium (%)	High (%)
Road access	33.1	44.6	22.3
Extension support	10.7	36.4	52.9
Market information	47.9	42.1	9.9
Credit access	4.1	31.4	64.5
Transport cost	27.5	52.5	20.0
Price fluctuation	43.0	30.6	26.4
Broker dominance	28.1	42.1	29.8

The results indicate that limited access to credit (64.5%) and inadequate extension support (52.9%) were perceived as the most severe constraints. Respondents also rated broker dominance, transport costs, and poor road access as important challenges affecting supply chain performance. Although price fluctuation was the most frequently reported constraint in Table 4.28, respondents expressed varying perceptions regarding its severity, suggesting that its impact differs across supply chain actors depending on their market position.

These findings are consistent with (Alemayehu et al., 2024b) who reported that limited financial services and weak extension systems reduce the productivity and marketing performance of small-holder tree growers in Ethiopia. Similarly, (Bank, 2024b) emphasized that improving rural finance, extension services, and transport infrastructure is fundamental for increasing the competitiveness of agricultural and forest product value chains in developing countries.

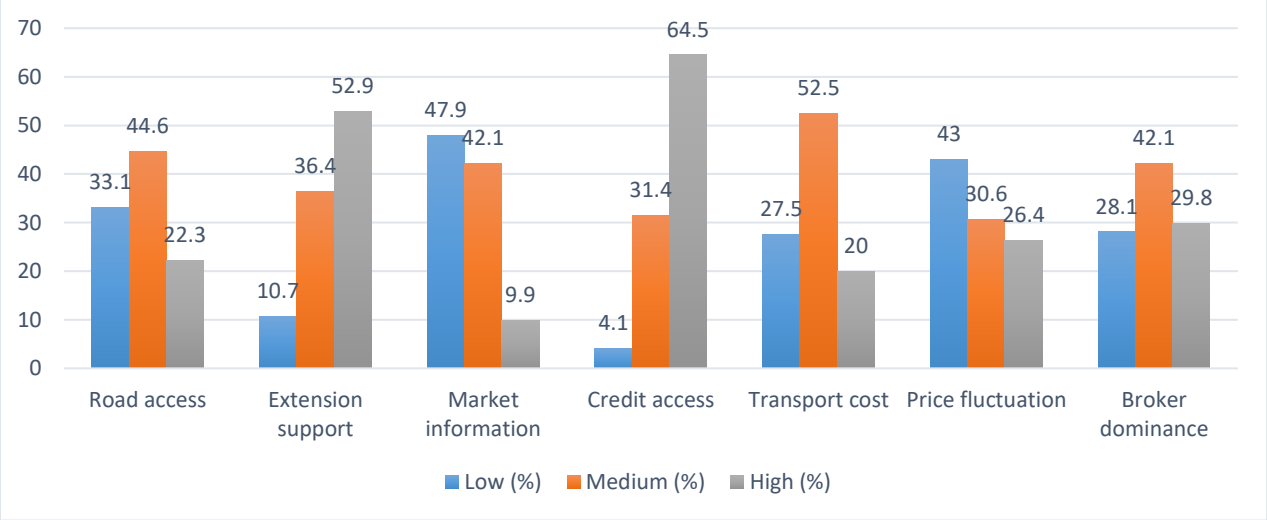


Figure 4.13: Severity of Supply Chain Constraints

Figure 4.13 illustrates the distribution of respondents according to the perceived severity of each constraint. Credit access and extension services were more frequently rated as highly severe, while market information was generally perceived as a less severe constraint. The figure complements the survey findings by demonstrating that not all frequently reported constraints are necessarily considered equally severe by supply chain participants.

4.9.2. Opportunities

Despite the identified challenges, respondents and key informants identified several opportunities for improving the efficiency of the *Eucalyptus globulus* pole supply chain. The establishment of producer cooperatives and marketing associations was frequently recommended as an effective strategy for strengthening farmers' bargaining power, improving collective marketing, and facilitating direct access to large urban markets.

Respondents further indicated that stronger producer organizations could reduce dependence on intermediaries and improve value addition through collective grading, sorting, and marketing. Improved market linkages with major construction companies and wood-processing industries in Addis Ababa were also considered important opportunities for increasing producers' incomes.

These findings are supported by (Bongwa, 2019)**,** who reported that collective action and producer organizations improve market participation and strengthen bargaining power among smallholder forest producers. Likewise, (O. for E. C. and Development, 2023) emphasized that producer organizations enhance value chain efficiency by improving market coordination, reducing transaction costs, and facilitating access to financial and technical services.

4.10. Field Observations

Field observations provided additional evidence supporting the survey and interview findings regarding the operation of the small-diameter *Eucalyptus globulus* pole supply chain.

One of the most important observations was the poor condition of rural road infrastructure, particularly in Wojebar Kebele of Ezha Woreda. Limited road access forced producers to transport harvested poles across neighboring farmland before reaching collection points. This practice often resulted in conflicts with landowners because transportation activities damaged cultivated land and caused soil compaction. Consequently, producers incurred additional transportation costs, labor requirements, and marketing delays.

Another important observation was the limited level of collective organization among producers. Although *Eucalyptus* production has expanded considerably, most producers continue to market

their products individually. Key informants indicated that stronger producer cooperatives could improve bargaining power, facilitate collective marketing, and establish direct business relationships with major construction companies in Addis Ababa.

During data collection, some respondents were initially reluctant to disclose information regarding land ownership and production volumes because they feared that the information might be used for taxation or administrative purposes. However, after the objectives of the study were clearly explained and confidentiality was assured, respondents participated openly and provided reliable information.

Field observations also revealed that market demand for *Eucalyptus globulus* poles has expanded beyond Addis Ababa. Increasing construction activities in towns such as Butajira, Wolkite, Bui, Enseno,Agena , Batu, Qoshe, and Meqi have created additional marketing opportunities for producers and traders. The expansion of these urban markets has diversified market destinations and reduced dependence on a single metropolitan market.

These observations agree with (A. Tesfaw et al., 2021b), who reported that improving physical infrastructure and strengthening producer-market linkages are essential for enhancing the efficiency of smallholder forest product supply chains. Similarly, (Ickowitz et al., 2022) found that expanding urban construction markets are creating new commercial opportunities for smallholder tree growers across many developing countries, thereby increasing the contribution of farm forestry to rural livelihoods.

Key informant interviews were conducted with experts from the Forestry and Natural Resources Offices, agricultural development offices, environmental protection offices, and experienced stakeholders involved in the *Eucalyptus globulus* supply chain. The interviews provided valuable qualitative evidence that complemented the household survey and field observations.

The informants consistently reported that the cultivation of *Eucalyptus globulus* has expanded rapidly across the Gurage Zone and surrounding areas of Central Ethiopia. According to the respondents, favorable agroecological conditions, relatively fast tree growth, and increasing market demand have encouraged many farmers to establish *Eucalyptus* plantations. They further explained that the expansion of residential housing, commercial buildings, and wood-processing industries, including medium-density fiberboard (MDF) and plywood manufacturing, has substantially increased the demand for small-diameter *Eucalyptus* poles. Similar trends have been reported by

(Lemenih & Kassa, 2014)who observed that the rapid expansion of *Eucalyptus* plantations in Ethiopia has been driven primarily by growing urban demand for construction materials and wood-based industries. Similarly, the rising demand for wood products worldwide, together with the need to ensure a sustainable supply of timber, has increased interest in plantation forestry and fast-growing tree species as reliable sources of industrial raw materials (Nations, 2024).

Despite the expanding market, most key informants emphasized that producers receive only a limited share of the final market value. They explained that intermediaries, including brokers, traders, wholesalers, and retailers, generally obtain higher returns because they control product aggregation, transportation, and market access. Producers, however, bear most of the production risks while receiving comparatively lower financial benefits. This finding supports the quantitative marketing margin analysis presented earlier in this chapter, where producers obtained the smallest proportion of the total marketing margin. Similar observations were reported by (Alemayehu et al., 2023), who found that unequal bargaining power and limited market access reduce producers' income within Ethiopian forest product value chains. At the international level, (Kaplinsky & Morris, 2001) also argued that unequal distribution of value among supply chain participants is a common characteristic of agricultural and forest product value chains where producers have weak negotiating power.

The informants also explained that government support for *Eucalyptus* production has declined in recent years because of environmental concerns associated with extensive plantation expansion. According to the experts, policymakers increasingly encourage farmers to establish *Eucalyptus* plantations on degraded land, hillsides, and marginal areas rather than on highly productive agricultural land. The interviewees noted that concerns regarding water consumption, competition with food crops, and potential impacts on soil resources have influenced current extension recommendations. These views are consistent with the findings of (Zerga et al., 2021c), who reported that although *Eucalyptus* provides important economic benefits, its expansion requires careful land-use planning to minimize environmental impacts. Similarly, (Nations, 2025) recommends balancing plantation forestry with sustainable land management practices to ensure long-term environmental sustainability.

Several key informants from Ezha Woreda reported that increasing taxation on *Eucalyptus* products has raised marketing costs and reduced producers' net returns. In Sodo Woreda, experts indicated that some farmers increasingly prefer annual cash crops because they generate faster income,

whereas *Eucalyptus* plantations generally require four to five years before harvesting. Although *Eucalyptus* remains profitable over the long term, delayed financial returns influence farmers' land-use decisions where alternative income opportunities are available.

Nevertheless, nearly all interview participants agreed that *Eucalyptus globulus* continues to play an important role in supporting rural livelihoods. They emphasized that the species grows rapidly, requires relatively low management costs after establishment, and provides a dependable source of household income, particularly during periods when annual crop production is uncertain. These observations agree with (Kebede, 2022), who reported that *Eucalyptus* plantations significantly contribute to household income diversification and livelihood resilience among smallholder farmers in Ethiopia. Likewise, (Nair et al., 2021) noted that fast-growing tree plantations provide important economic security for rural households by generating stable income and reducing livelihood risks.

Finally, the key informants recommended several measures to improve the efficiency and sustainability of the *Eucalyptus globulus* pole supply chain. These include strengthening research-based extension services, improving rural road infrastructure, promoting producer cooperatives, enhancing market information systems, encouraging sustainable land-use planning, and supporting environmentally responsible plantation management practices. According to the interviewees, implementing these interventions would improve producers' bargaining power, increase marketing efficiency, promote equitable benefit sharing, and enhance the long-term sustainability of the *Eucalyptus* sector in Central Ethiopia. These recommendations complement the quantitative findings presented throughout this chapter and provide practical directions for strengthening the supply chain.

CHAPTER-5: CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

This study assessed the supply chain of small-diameter *Eucalyptus globulus* poles in Ezha and Sodo woredas of Central Ethiopia by examining production and supply trends, supply chain structure, value addition practices, and the major constraints affecting its performance. The findings demonstrate that *Eucalyptus globulus* has become an increasingly important source of livelihood and construction material due to its rapid growth, high market demand, and favorable growing conditions. The supply chain involves several interconnected actors, including producers, brokers, transporters, wholesalers, retailers, and end users; however, producers receive a relatively small share of the final market value despite bearing most of the production costs and risks. The study further revealed that land allocated to *Eucalyptus* plantations is the principal factor influencing annual production, while experience, market information, extension services, and distance to market showed no significant effect on production volume. Although basic value addition activities such as grading, sorting, and size selection are commonly practiced, more advanced practices remain limited, reducing opportunities to increase product value and producer income. In addition, the supply chain continues to face important challenges, including unstable prices, inadequate road infrastructure, limited access to credit and market information, weak extension support, and the dominant role of intermediaries, all of which reduce marketing efficiency and weaken producers' bargaining power. Overall, the study concludes that the small-diameter *Eucalyptus globulus* pole supply chain has considerable potential to contribute to rural livelihoods and the growing construction sector in Central Ethiopia, but realizing this potential requires stronger institutional support, improved infrastructure, better market coordination, expanded value addition, and policies that promote both economic efficiency and sustainable plantation management.

5.2. Recommendations

Based on the findings of this study, the following recommendations are proposed to improve the efficiency and sustainability of the small-diameter *Eucalyptus globulus* pole supply chain in Central Ethiopia:

1. Government institutions, including the Ethiopian Forestry Development (EFD), Ministry of Agriculture, and woreda offices, should strengthen extension services through training on plantation management, sustainable harvesting, post-harvest handling, and value addition practices.
2. Improvement of rural road infrastructure is recommended to reduce transportation costs, minimize market delays, and enhance the movement of *Eucalyptus* poles from production areas to markets.
3. Financial institutions, cooperatives, and microfinance organizations should improve access to affordable credit to support plantation management, transportation, and value addition activities among supply chain actors.
4. Producers should be encouraged to establish cooperatives or associations to strengthen collective marketing, improve bargaining power, access market information, and reduce reliance on intermediaries.
5. Producers and traders should adopt improved value addition practices, including grading, sorting, debarking, trimming, and standardized sizing, to improve product quality and market competitiveness.
6. Stakeholders should develop reliable market information systems to provide updated information on prices, demand, and market opportunities for better decision-making.
7. Sustainable plantation management and appropriate land-use planning should be promoted to balance the economic benefits of *Eucalyptus globulus* production with environmental protection and food security.
8. Further research should focus on the environmental impacts of *Eucalyptus globulus* expansion, value chain upgrading opportunities, equitable benefit sharing among supply chain actors, and the long-term sustainability of Eucalyptus pole production under increasing market demand.

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APPENDICIES

Appendix I: Questioner

Institution: - Federal Technical and Vocational Education and Training Institute

- **Structured Questionnaire for Thesis Field Survey**
- ✓ **Thesis Title**: Supply Chain Analysis of Small-Diameter *Eucalyptus globulus* Poles in Central Ethiopia
- ✓ **Researcher**: Sisay Jemberu
- ✓ **Purpose**: This questionnaire is for academic purposes to analyze the supply chain of small-diameter *Eucalyptus globulus* poles. All responses will be kept confidential.

Instructions to Respondents:

Dear Participant,

Thank you for agreeing to participate in this research. This study is for academic purposes for a Master of Science Degree Wood Science Technology Management. Your insights are extremely valuable for understanding how the *Eucalyptus* supply chain works. All your answers will be kept confidential and anonymous. Participation is voluntary, and you can choose to skip any question or stop at any time.

This interview will take about 15-20 minutes.

Before You Begin – Please Read This Briefly

- This questionnaire has **58 questions**, including both **multiple choice** and **short answer** types.
- For checkboxes (□), just tick (✓) the answer(s) that fit you.
- For open questions, write clearly in the space provided.
- There are **no right or wrong answers** – we just want your honest opinion and experience.
- Your answers are **confidential** and will only be used for research.
- Participation is **voluntary**, and you can skip any question or stop at any time.

Thank you for your time and support!

SECTION A: SOCIO-DEMOGRAPHIC CHARACTERISTICS

1. Respondent ID
2. Gender □ Male □ Female
3. Age Category □ 18–30 year's □ 31–45 years' □ Above 45 years
4. Educational Status

□ cannot read and write □ Primary education □ Secondary education □ Diploma □ Degree and above

5. Main Occupation

□ Farmer □ Trader □ Transporter □ Wholesaler □ Retailer □ End User

6. Your role in the *Eucalyptus globulus* pole supply chain

□ Producer □ Trader/Broker □ Transporter □ Wholesaler □ Retailer □ Consumer

7. Are you a member of any cooperative or association? □ Yes □ No
8. Do you have access to market information? □ Yes □ No
9. How long have you been involved in this activity?

□ ≤5 year's □ 6–10 year's □ More than 15 years

SECTION B: EUCALYPTUS PRODUCTION AND HARVESTING *(For Producers Only)*

10Land allocated for *Eucalyptus globulus* plantation _____hectares

1. Average age at which trees are harvested: _____years
2. How do you harvest the trees? ☐ Manually ☐ Using machinery

11. During which season do you usually harvest *Eucalyptus globulus* poles?

□ Dry season □ Wet season □ both seasons □ Other _____

12. Do you undertake any processing after harvesting before selling the poles?

□ Yes □ No

13. Who is your main buyer?

□ Trader □ Wholesaler □ Consumer □ Other _____

14. What is your main source of price information?

□ Market actors □ Previous experience □ Market observation

15. Do you receive institutional support related to production or marketing?

□ Yes □ No

16. What is your average annual production of *Eucalyptus globulus* poles? _____ m³/year

17. What is the main source of the poles you sell?

□ Own plantation □ Purchased □ other _____

SECTION C: MARKETING AND MARKET ACCESS

18. How is the selling price determined?

□ Negotiation □ Fixed market price □ other _____

19. Average volume supplied/traded _____ m³

20. Do you grade poles before selling? □ Yes □ No

21. Have you experienced registration or legal problems while marketing poles?

□ Yes □ No

22. What type of transportation do you mainly use?

□ Donkey/horse cart □ Manual □ Truck □ Tractor □ other: _____

23. Average transportation cost _____ ETB

24. How would you rate road accessibility? □ Poor □ Moderate □ Good

25. Have you experienced transportation delays? □ Yes □ No

26. Do you store poles before selling? □ Yes □ No

27. Do you undertake value addition activities before selling? □ Yes □ No

28. What is the main utilization of the poles?

□ Construction □ Energy/Fuel □ Other _____

29. Have you experienced product quality problems? □ Yes □ No

30. Would customers be willing to pay more for high-quality poles? □ Yes □ No

31. Where do you mainly sell your poles?

□ Local market □ Regional market □ Addis Ababa market

32. Do customers generally prefer straight poles? □ Yes □ No

33. Do customers prefer specific pole diameter sizes? □ Yes □ No

34. What is the main reason for rejection of poles?

□ Poor quality □ Wrong size □ Defect □ Other _____

35. Overall, how satisfied are you with your market activities?

□ Low □ Medium □ High

36. Do you have access to credit services? □ Yes □ No

37. If yes, what is your main source of credit?

□ Bank □ Microfinance Institution □ Informal source

38. Distance from your business to the main market _____ km

39. How satisfied are you with the current selling price?

□ Dissatisfied □ Neutral □ Satisfied

SECTION D: PRODUCT CHARACTERISTICS AND INSTITUTIONAL SUPPORT

40. What is the main type of *Eucalyptus globulus* pole that you produce, trade, or use?

□ Scaffolding pole (Qami) □ Rafter (Fonte) □ Truss member (Mager) □ Bracing/Tie member (Chefeqa)

41. Do you practice product grading before selling? □ Yes □ No

42. What is the most common type of product loss or damage?

□ Physical damage □ Quality deterioration □ Quantity loss

43. Do you receive extension services related to *Eucalyptus globulus* production or marketing? □ Yes □ No

44. How often do you receive extension services?

□ Monthly □ Quarterly □ Occasionally

SECTION E: SUPPLY CHAIN CONSTRAINTS

45. What is the major constraint affecting your business?

□ Price fluctuation □ Poor road access □ High transportation cost □ Broker-related problems □ Lack of market information □ Limited extension services □ Limited access to credit

46. Is price fluctuation a major problem? □ Yes □ No

47. Is poor road access a major problem? □ Yes □ No

48. Is broker involvement a major problem? □ Yes □ No

49. Is lack of extension service a major problem? □ Yes □ No

50. Is lack of market information a major problem? □ Yes □ No

51. Is transportation a major problem? □ Yes □ No

52. Is limited access to credit a major problem? □ Yes □ No

SECTION F: VALUE ADDITION PRACTICES

53. Do you sort poles before selling? □ Yes □ No

54. Do you grade poles according to quality? □ Yes □ No

55. Do you bundle poles before transportation or sale? □ Yes □ No

56. Do you remove the bark (debarking) before selling? □ Yes □ No

57. Do you trim poles before selling? □ Yes □ No

58. Do you select poles according to size before selling? □ Yes □ No

Key Informant Interview (KII) Section for Woreda Officials

Target Respondents: Woreda-Level Forestry, Agriculture, and Natural Resource Experts

Position/Office: _____ **Woreda**: _____

🚚 **Transport Flow and Volume Questions**

1. Based on your records or observations, how many vehicles (cars/trucks) transport small-diameter *Eucalyptus globulus* poles from this woreda?

Time Frame	Per Day	Per Week	Per Month	Per Year	Total
Estimated No. of Vehicles					

2. What is the average load per vehicle?
   - Cubic meters (m^3): _____
   - Approximate number of poles per vehicle: _____
3. Are vehicle counts or transport data officially recorded in this woreda?

   ☐ Yes ☐ No

   If yes, where are they recorded? _____
4. Have you observed any recent trends in transport volume (e.g., increasing, decreasing)?

   ☐ Increasing ☐ Decreasing ☐ No change

   Please explain: _____
5. Which kebeles or sites in this woreda are the major loading points for *Eucalyptus* poles?
6. Respondent Signature: _____ (Date): _____

Thank you for your time and cooperation in supporting this important research!

📞 Researcher Contact Information

👤 **Name:** Sisay Jemberu

📱 **Phone:** +251-926915654

✉️ **Email:** sisayjemberu866@gmail.com

Appendix II: Key Informant Interview (KII) checklist
Institution: - Federal Technical and Vocational Education and Training Institute

Structured Questionnaire for Thesis Field Survey and Data Analysis

Key Informant Interview (KII) Questionnaire

For Government and Forestry Officials

Thesis Title: Supply Chain Analysis of Small-Diameter *Eucalyptus globulus* Poles in Central Ethiopia

Researcher: Sisay Jemberu Ayano

Purpose: The purpose of this interview is to gather information regarding eucalyptus pole production, marketing, transportation, institutional support, environmental impacts, and supply chain challenges.

Instructions to Respondents:
Dear Participant,
Thank you for agreeing to participate in this research. This study is for academic purposes for a Master of Science Degree Wood Science Technology. Your insights are extremely valuable for understanding how the eucalyptus supply chain works. All your answers will be kept confidential and anonymous. Participation is voluntary, and you can choose to skip any question or stop at any time.

This interview will take about **15** minutes.

Before You Begin – Please Read This Briefly

This questionnaire has 20 questions, including both multiple choice and short answer types.

For checkboxes (□), just tick (✓) the answer(s) that fit you.

For open questions, write clearly in the space provided.

There are no right or wrong answers – we just want your honest opinion and experience.

Your answers are confidential and will only be used for research.

Participation is voluntary, and you can skip any question or stop at any time.

Thank you for your valuable cooperation!.

Section A: General Information

No	Item	Response
1	Respondent ID	
2	Name of Institution	
3	Position/Responsibility	
4	Woreda	
5	Date of Interview	
6	Interviewer Name	

Section B: Production Status and Trends

1. What is the current status of *Eucalyptus globulus* pole production in the area?

☐ Increasing ☐ Stable ☐ Decreasing

2. Is eucalyptus plantation expanding or decreasing in recent years?

☐ Expanding ☐ Decreasing

3. What are the major eucalyptus-producing kebeles/woredas?

_____

_____

_____

_____

Section C: Supply Chain Actors and Marketing System

4. Who are the main actors in the eucalyptus pole supply chain?

☐ Producers ☐ Consumers

☐ Brokers ☐ Others _____

☐ Traders

5. What are the common marketing channels used?

☐ Producer → Consumer

☐ Producer → Broker → Consumer

☐ Producer → Trader → Consumer

☐ Producer → Broker → Trader → Consumer

6. How are eucalyptus pole prices determined?

☐ Demand and supply ☐ Broker influence

☐ Negotiation ☐ Other _____

7. Which actors benefit most in the supply chain?

☐ Producers ☐ Brokers ☐ Traders ☐ Consumers

8. What are the major marketing constraints?

☐ Transport problem ☐ Broker dominance

☐ Price fluctuation ☐ Poor road access

☐ Lack of market information

9. Are there illegal or informal market practices in the supply chain?

☐ Yes ☐ No If yes, explain:

_____

Section D: Transportation, Market Access, and Information

10. Are transportation services sufficient for pole marketing?

☐ Sufficient ☐ Not sufficient

11. What challenges affect market access for producers?

☐ Poor road access ☐ Long market distance

☐ High transportation cost ☐ Lack of buyers

12. Is market information easily available to farmers?

☐ Easily available ☐ Limited ☐ Not available

Section E: Institutional Support and Policy

13. What support services does the government provide to eucalyptus producers?

☐ Training ☐ Technical advice

☐ Extension support ☐ No support

14. Are extension services available and adequate for producers and traders?

☐ Adequate ☐ Inadequate

15. Are there policies regulating eucalyptus harvesting and trade?

☐ Yes ☐ No If yes, specify:

_____

_____

Section F: Environmental Impact and Sustainability

16. What environmental impacts are associated with eucalyptus plantation?

☐ Soil degradation ☐ Biodiversity reduction

☐ Water depletion ☐ No major impact

17. How does eucalyptus affect soil and water resources?

☐ Negative effect ☐ Positive effect ☐ No effect

18. What mitigation measures are recommended?

☐ Proper spacing ☐ Soil conservation

☐ Mixed plantation ☐ Water management

Section G: Recommendations and Future Improvement

19. What recommendations do you suggest for sustainable eucalyptus pole production and marketing?

☐ Improve roads ☐ Improve price system

☐ Improve market linkage ☐ Environmental protection

☐ Strengthen extension service

Additional comments:

_____

_____

_____

_____

Additional Questions for Ethiopian Forestry Development (EFD) Officials

Section E: Institutional Support and Policy

20. Does Ethiopian Forestry Development provide support for Eucalyptus globulus plantation establishment and management?

□ Yes □ No

If yes, specify the type of support:

□ Seedling supply □ Plantation management advice

□ Technical training □ Market linkage support

□ Extension services □ Other _____

21. Are there guidelines or standards used by Ethiopian Forestry Development for eucalyptus harvesting and pole marketing?

□ Yes □ No

If yes, specify:

22. How would you evaluate the current level of collaboration among Ethiopian Forestry Development, agricultural offices, traders, and producers?

□ Very good □ Poor

□ Good □ Very poor

□ Moderate

23. Does Ethiopian Forestry Development collect and maintain data on eucalyptus pole production and marketing in the area?

□ Yes □ No

If yes, what type of information is recorded?

24. What are the major challenges faced by Ethiopian Forestry Development in promoting sustainable *Eucalyptus Globulus* production?

□ Shortage of financial resources □ Environmental concerns

□ Limited manpower □ Lack of policy enforcement

□ Lack of awareness among producers □ Other _____

□ Weak market linkage

25. Are there reforestation or afforestation programs related to Eucalyptus globulus in the area?

□ Yes □ No

If yes, describe:

36. In your opinion, what actions should be prioritized to improve the sustainability and efficiency of the eucalyptus pole supply chain?

□ Strengthen extension services

□ Improve market information systems

□ Promote producer cooperatives

□ Improve road infrastructure

□ Strengthen policy implementation

□ Encourage sustainable forest management

□ Other _____

Respondent Signature _____ Date:- _____

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Thank you very much for your cooperation and valuable information.

Appendix III: Variable Coding and Measurement Description

No.	Variable Name	Description	Measurement/Coding	Variable Type / Scale
1	ID	Respondent identification number	1–121	Identifier
2	Gender	Sex of respondent	1 = Male, 2 = Female	Nominal
3	Age	Age category of respondent	1 = 18–30 years, 2 = 31–45 years, 3 = Above 45 years	Ordinal
4	Edu	Educational status	1 = Cannot read and write, 2 = Primary education, 3 = Secondary education, 4 = Diploma, 5 = Degree and above	Ordinal
5	MainOccu	Main occupation of respondent	1 = Farmer, 2 = Trader, 3 = Transporter, 4 = Wholesaler, 5 = Retailer, 6 = End user	Nominal
6	Role	Supply chain actor category	1 = Producer, 2 = Trader/Broker, 3 = Transporter, 4 = Wholesaler, 5 = Retailer, 6 = Consumer	Nominal
7	Coop	Membership in cooperative/association	0 = No, 1 = Yes	Nominal
8	Info	Access to market information	0 = No, 1 = Yes	Nominal
9	Land	Land allocated for *Eucalyptus globulus* plantation	Measured in hectares (ha)	Continuous
10	Harvest	Harvesting season	1 = Dry season, 2 = Wet season, 3 = Both seasons, 4 = Other	Nominal
11	Process	Processing activity after harvesting	0 = No, 1 = Yes	Nominal
12	Buyer	Main buyer of poles	1 = Trader, 2 = Wholesaler, 3 = Consumer, 4 = Other	Nominal
13	PriceInfo	Source of price information	1 = Market actors, 2 = Previous experience, 3 = Market observation	Nominal
14	Support	Institutional support received	0 = No, 1 = Yes	Nominal
15	ProdVol	Annual production volume	Measured in m^3/year	Continuous
16	Source	Source of poles	1 = Own plantation, 2 = Purchased, 3 = Other	Nominal
17	PriceMethod	Method of price determination	1 = Negotiation, 2 = Fixed market price, 3 = Other	Nominal
18	Volume_m^3	Volume supplied/traded	Measured in cubic meter (m^3)	Continuous

19	Grade	Product grading practice	0 = No, 1 = Yes	Nominal
20	RegProb	Registration/legal problem during marketing	0 = No, 1 = Yes	Nominal
21	TransType	Transportation method	1= Donkey/horse cart 2= Manual 3=Truck 4= Tractor 5= other	Nominal
22	CostTrans	Transportation cost	Measured in ETB	Continuous
23	Road	Road accessibility condition	1 = Poor, 2 = Moderate, 3 = Good	Ordinal
24	Delay	Transportation delay problem	0 = No, 1 = Yes	Nominal
25	Store	Storage practice	0 = No, 1 = Yes	Nominal
26	ValueAdd	Value addition activity	0 = No, 1 = Yes	Nominal
27	Use	Main utilization of poles	1 = Construction, 2 = Energy/fuel, 3 = Other	Nominal
28	QualityProb	Product quality problem	0 = No, 1 = Yes	Nominal
29	PayMore	Customer willingness to pay for quality poles	0 = No, 1 = Yes	Nominal
30	Experience	Years of experience in the activity	1 = ≤5 years, 2 = 6–10 years, 3 = >15years	Ordinal
31	SellDestination	Product selling destination	1 = Local market, 2 = Regional market, 3 = Addis Ababa market	Nominal
32	PrefferStraight	Preference for straight poles	0 = No, 1 = Yes	Nominal
33	PreferDiam	Preference for diameter size	0 = No, 1 = Yes	Nominal
34	RejectReason	Reason for pole rejection	1 = Poor quality, 2 = Wrong size, 3 = Defect, 4 = Other	Nominal
35	Satisfaction	Satisfaction with market activity	1 = Low, 2 = Medium, 3 = High	Ordinal
36	CredAcc	Access to credit service	0 = No, 1 = Yes	Nominal
37	CredSrc	Source of credit	1 = Bank, 2 = Microfinance, 3 = Informal source	Nominal
38	DistMkt	Distance to market	Measured in km	Continuous
39	SatPrice	Satisfaction with selling price	1 = Dissatisfied, 2 = Neutral, 3 = Satisfied	Ordinal
40	ProdType	Type of pole product	1 = Scaffolding pole, 2 = Rafter, 3 = Truss member, 4 = Bracing/tie member	Nominal
41	GradePra	Product grading practice	0 = No, 1 = Yes	Nominal
42	LossType	Type of product loss/damage	1 = Physical damage, 2 = Quality deterioration, 3 = Quantity loss	Nominal
43	ExtServ	Access to extension service	0 = No, 1 = Yes	Nominal

44	ExtFreq	Frequency of extension contact	1 = Monthly, 2 = Quarterly, 3 = Occasionally	Ordinal
45	Constraints	Main supply chain constraint	1 = Price fluctuation, 2 = Road problem, 3 = Transport cost, 4 = Broker problem, 5 = Market information problem, 6 = Extension problem, 7 = Credit problem	Nominal
46	ConPrice	Price fluctuation constraint	0 = No, 1 = Yes	Nominal
47	ConRoad	Road access constraint	0 = No, 1 = Yes	Nominal
48	ConBroker	Broker-related constraint	0 = No, 1 = Yes	Nominal
49	ConExt	Extension service constraint	0 = No, 1 = Yes	Nominal
50	ConInfo	Market information constraint	0 = No, 1 = Yes	Nominal
51	ConTrans	Transportation constraint	0 = No, 1 = Yes	Nominal
52	ConCredit	Credit access constraint	0 = No, 1 = Yes	Nominal
53	Sorting	Sorting practice	0 = No, 1 = Yes	Nominal
54	Grading	Grading practice	0 = No, 1 = Yes	Nominal
55	Bundling	Bundling practice	0 = No, 1 = Yes	Nominal
56	Debarking	Debarking practice	0 = No, 1 = Yes	Nominal
57	Trimming	Trimming practice	0 = No, 1 = Yes	Nominal
58	SizeSele	Size selection practice	0 = No, 1 = Yes	Nominal

Table. Market Margin Distribution of Eucalyptus Pole Products by Supply Chain Actors

Product Type	Actor	Buy Price (ETB)	Sell Price (ETB)	Cost (ETB)	Net Margin (ETB)	Share (%)
Scaffolding Poles (Qami)	Producer	-	100	80	20	6.90
	Broker	100	180	20	60	20.69
	Transporter	180	260	25	55	18.97
	Wholesaler	260	360	25	75	25.86
	Retailer	360	460	20	80	27.59
	Total		**460**	**170**	**290**	**100.00**
Rafters (Fonte)	Producer	-	100	70	30	10.71
	Broker	100	180	25	55	19.64
	Transporter	180	270	35	55	19.64
	Wholesaler	270	370	30	70	25.00
	Retailer	370	460	20	70	25.00
	Total		**460**	**180**	**280**	**100.00**
Truss Members (Mager)	Producer	-	80	55	25	9.09
	Broker	80	150	15	55	20.00
	Transporter	150	230	20	60	21.82
	Wholesaler	230	320	20	70	25.45
	Retailer	320	400	15	65	23.64
	Total		**400**	**125**	**275**	**100.00**
Bracing/Tie Members (Chefeqa)	Producer	-	25	13	12	9.45
	Broker	25	65	10	30	23.62
	Transporter	65	105	10	30	23.62
	Wholesaler	105	145	10	30	23.62
	Retailer	145	180	10	25	19.69
	Total		**180**	**53**	**127**	**100.00**

Appendix IV: Field photographs and observations



















