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Perception of Local Community on Socioeconomic Benefits and Hydrological Impact of Eucalyptus Tree in Amuru District, Oromia, Ethiopia

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Abstract

The study, conducted in Amuru District, Horo Guduru Wollega Zone, Oromia, Ethiopia, assessed the local community's perceptions of the socioeconomic benefits and hydrological impacts of eucalyptus trees. In this study a cross-sectional survey design was used as research design, which combined quantitative and qualitative methods. Primary data were collected using semi-structured questionnaires, key informant interviews, and focus group discussions, with four kebeles purposively selected based on their potential for eucalyptus cultivation. A total of 140 eucalyptus growers were chosen through simple random sampling and proportional allocation, and the data were analyzed using SPSS Version 26.The findings revealed that farmers prefer growing eucalyptus over native species to cover expenses such as government taxes, school fees, construction needs, and community contributions. “Eucalyptus plantations in the district have increased by 96% over the past decade, expanding from 28.375 hectares in 2014 to 745.654 hectares in 2023. Nearly 99.3% of respondents reported cultivating eucalyptus for its socioeconomic benefits, while only 0.7% did so for soil and water conservation. Specifically, 58.6% use eucalyptus for home construction, 87.14% sell eucalyptus wood for products, and 71.4% primarily use it for fuel. Eucalyptus trees are highly valued, with 59.8% of respondents having production experience and 87.2% viewing them as a remedy for ailments, a symbol of modern savings, and a divine gift, serving as a source of livelihood and financial security. However, 40.2% of growers reported negative effects, such as drying of nearby water sources, when eucalyptus is planted near water bodies, swamps, and wetlands. The study concludes that eucalyptus significantly improves livelihoods and remains a valuable resource, but improper management, rather than the tree’s biological characteristics, is the primary cause of adverse effects. To maximize socioeconomic benefits and minimize environmental impacts, land users and growers should focus on planting eucalyptus in appropriate locations, such as degraded lands, steep slopes, and roadsides, while ensuring proper management practices.

Keywords*:* Amuru district; Ecological Value, environmental effects, Eucalyptus Tree, Socioeconomic benefits

1. Introduction

. Planting trees can address community needs while also preserving the environment (Fleischman *et al*., 2020). *Eucalyptus* trees, in particular, have become widely planted and dispersed globally (Diman, 2021). Eucalyptus is regarded as a significant resource for alleviating poverty and fostering rural development and appreciated by farmers for its high survival rate and constant demand, which contribute to its perception as a secure investment (Belay *et al.,* 2025; Alemayehu &Melka, 2022).

In the latter half of the 19th century, Australia introduced *eucalyptus* to African countries, notably Ethiopia, to fulfill the increasing demand for forest products for construction and fuel (Jaleta *et al*., 2016). Since 1894, various *eucalyptus* species have been introduced in Ethiopia to satisfy the country's growing need for construction and fuel wood, as well as to alleviate pressure on its remaining natural vegetation (Jenbere *et al.,* 2012).According to Zerga *et al.*, (2021), almost all communities and professionals agree that no alternative tree species has been found to replace *eucalyptus*, particularly for firewood purposes.

In South American countries, the *eucalyptus* tree is sometimes referred to as a "politicized" tree due to the challenges associated with controlling its spread (Jeffrey, 2007). However, small-scale farmers view *eucalyptus* as a boon, considering it a valuable asset and a form of retirement investment (Lemenih, 2010). In Ethiopia, small-scale farmers often describe *eucalyptus* as a “lifesaver” and a reliable “safety net,” frequently comparing it to money stored in a bank that can be “withdrawn” in times of financial need and consider it a reliable resource, akin to withdrawing money from a bank when needed((Belay *et al.,* 2025; Zerga *et al.,* 2021).*Eucalyptus* fast growth, high survival rate under diverse conditions, and stable market demand make *eucalyptus* a secure livelihood strategy, enabling households to cope with income fluctuations and unexpected expenses. Beyond serving as an emergency reserve, *eucalyptus* contributes significantly to poverty alleviation and rural development by providing timber, fuelwood, and construction materials while also generating cash income (Alemayehu &Melka, 2022; Edesa, 2021). These socio-economic benefits explain why many farmers perceive *eucalyptus* cultivation as a dependable investment, though its rapid expansion has also raised ecological concerns regarding soil fertility, water availability, and biodiversity, underscoring the need for balanced management approaches that sustain both livelihoods and ecosystem services. (Zerga *et al.,* 2021)

For instance, those who cultivate *eucalyptus* as a woodlot have greater confidence in their ability to mitigate financial risk during times of crop failure. In the face of climate change, crop diseases, or periods of violence, *eucalyptus* is perceived as a security measure and a form of "green bank account" (Gil *et al.,* 2010; Munuyee*et al.,* 2018). Consequently, *eucalyptus* is becoming a vital asset for smallholder farmers to enhance food security, boost farm incomes, and reduce poverty in various regions of the country. Additionally, *eucalyptus* holds cultural significance. For example, in the southern Ethiopian village of *Gurage*, owning a *eucalyptus* woodlot confers substantial social status and respect, with the prestige increasing as the size of the woodlot grows (Lemenih, 2014). Due to its adaptability, rapid growth, and suitability for cattle feed, *eucalyptus* trees are commonly cultivated in Ethiopian households. They generate substantial income through the sale of *eucalyptus* wood products (Molla*et al.,* 2023).

Recent studies indicate that eucalyptus is extensively planted across Ethiopia, particularly on large tracts of land previously used for agriculture (Liang *et al*., 2016).According to Zerga and Berta (2016),. Ethiopian farmers favor eucalyptus over native trees to cover expenses such as government *taxes,* school *fees*, and contributions to social organizations like *Mahibers, Zikirs, and Iddirs*. *Eucalyptus* wood is also used for construction at various stages: 3 to 4 years for small poles, 5 to 6 years for medium poles, 7 to 8 years for large poles, and more than 9 years for logs. Moreover, *eucalyptus* woodlots help save women and children time and energy spent on collecting fuel wood, thereby allowing them to focus more on education (Zerga& Berta, 2016). Urban forests and short-rotation trees contribute ecologically by reducing greenhouse gas emissions, improving soil and groundwater quality, enhancing certain wildlife habitats, and revitalizing rural economies (Kong *et al.,* 2021 & Allen *et al.*, 2013).

Small-scale farmers use *eucalyptus* for firewood, fencing, and construction, and they also generate income by selling eucalyptus products such as *cefeka, mager, weraj*, and *quwami*. For daily living activities, *Eucalyptus* trees' stems, bark, branches, leaves, and roots are gathered in the majority of Ethiopia (Mokonen, 2016). But also raise important hydrological concerns that complicate the agriculture–environment tradeoff. Recent empirical research from the Ethiopian Highlands indicates that the expansion of *eucalyptus* plantations imposes measurable hydrological costs in the Amen watershed, with actual evapotranspiration in the dry monsoon phase leading to lower water storage, delayed onset of runoff, and reduced base flow (Fenta *et al.,* 2025). Moreover, in Ethiopia’s Koga watershed, soils near *eucalyptus* borders dry down faster after rains, and local reports associate *eucalyptus* with spring flow diminution (Chanie *et al.,* 2013). The study made

in South Africa by Kaptein *et al.,* (2024), is also reported that the fast-growing *Eucalyptus* grandis and *Eucalyptus*. Urophylla increase seasonal transpiration rates that can significantly draw on soil moisture. A comparison between the highland and midland areas of the study is particularly relevant because adoption patterns vary across agro-ecological zones, influencing both environmental and livelihood outcomes. In the highlands, *eucalyptus* is often planted on steep and degraded land, where water scarcity is already a pressing concern, increasing the risk of hydrological stress. In the midlands, however, plantations are typically established on more fertile soils with better water availability, where environmental pressures are less severe and income opportunities are greater. This contrast demonstrates how the same species can produce different ecological and economic impacts depending on the local context, underscoring the importance of considering agro-ecological conditions when evaluating the role of *eucalyptus*

This study identifies a research gap in understanding how local communities perceive eucalyptus trees, particularly regarding their socioeconomic benefits and hydrological impacts. Existing research often emphasizes the environmental effects of *eucalyptus* cultivation but lacks comprehensive insights into how these trees influence community livelihoods and water resources from the perspective of those directly affected. The researcher aimed to address this gap by exploring community perceptions and experiences with *eucalyptus* trees. This approach provides clarity on how *eucalyptus* cultivation impacts local economic conditions and water availability, facilitating informed decisions that balance economic benefits with environmental sustainability, ultimately promoting community well-being while mitigating hydrological impacts. Hence, The study was conducted with the following specific objectives

- ✓ To assess the socioeconomic benefits that households gain from eucalyptus plantations.
- ✓ To examine the hydrological and environmental impacts of eucalyptus as perceived by the local community.
- ✓ To analyze how community perceptions influence household decisions regarding the planting and management of eucalyptus.

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted in *Amuru* district, Horo Guduru Wellega Zone, Oromia, Western Ethiopia (Fig figure 1). *Amuru* District was selected for this study based on survey data, which showed that *eucalyptus* plantations have grown rapidly, increasing by 96% over the past ten years from 28.38 hectares in 2014 to 745.65 hectares in 2023.

The district is geographically located between 9° 59' 22.99" to 9° 59' 23 N and 37° 01' 44.00" E to37° 18' 44.99" E. The district is the remotest in the zone, which borders *Jarte Jardaga* district of H/G/Wellega Zone in the west, Amhara Regional State in the north, and *Kiremu* district in the east and south. *Obora* is the capital town of Amuru district, which is located 392km and 68km away to the west of Addis Ababa and from zone town, respectively. According to *Amuru* district socioeconomic data, the district has a land cover of approximately 129,452.0535 hectares (ha), and 21 peasant associations (unpublished data of 2022–23).

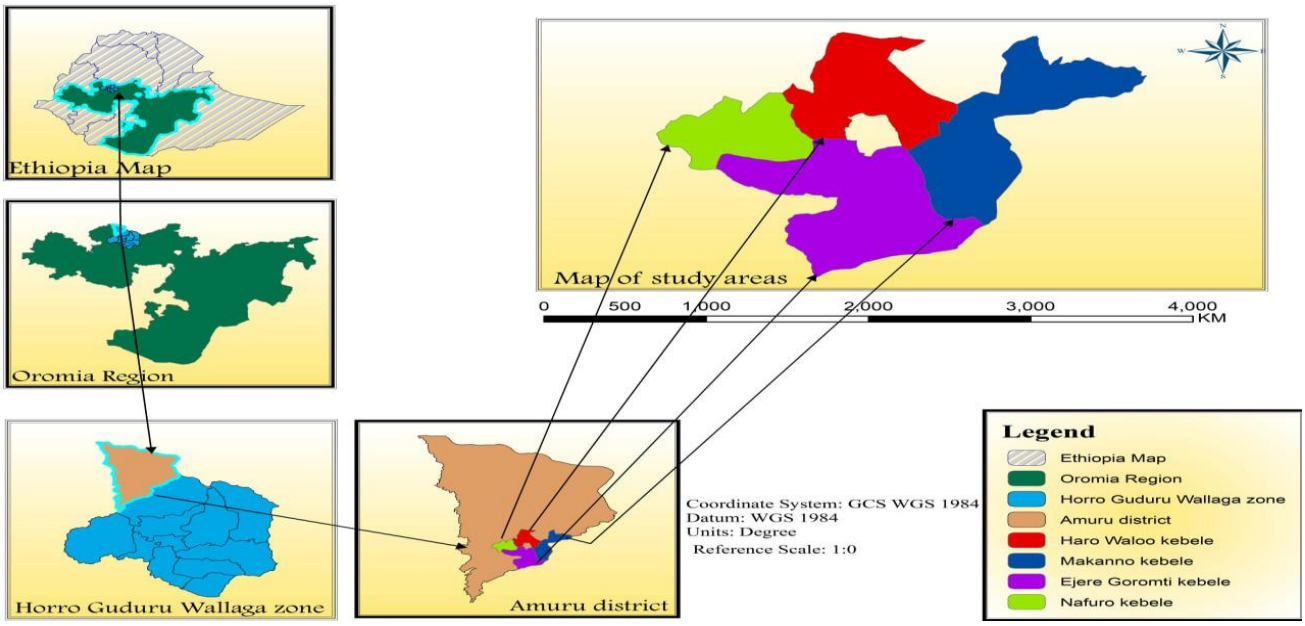


Figure 1.Map of the study area.

The district mainly experiences sub-tropical (W/Dega) and temperate (Dega) types of climatic conditions. The altitude ranges from 860m to 2657m above sea level. The district has a humid and hot climate, with average annual temperatures ranging from 9.0 degrees Celsius to 24.60 degrees Celsius (figure 2). The study area receive high rainfall during summer that starts in June and ends in September and short rain season is in, spring, which encompass March, April,

and May. The average monthly rainfall of the current study area is ranged between 1167mm to 1781.7mm.

Yearly Average Rainfall, Minimum and Maximum Temperatures of the Study Area (1993–2022)

The data from 1993 to 2022 for *Amuru* District shows fluctuations in rainfall, minimum and maximum temperatures (Figure 2). Average annual rainfall varied, with the lowest recorded at 70.9 mm in 2013 and the highest at 148.5 mm in 1994, indicating some years of drought and others of higher-than-average rainfall. Average temperatures remained relatively stable over the years, with the minimum average temperature ranging from 7.6°C to 10.4°C, and maximum average temperatures generally fluctuating between 22.5°C and 24.6°C. The overall average temperature saw a slight increase over the years, generally ranging from 14.6°C in 1993 to 16.8°C in 2022. This suggests a gradual warming trend alongside variable rainfall patterns, which could influence agricultural activities, including the growth of eucalyptus plantations.

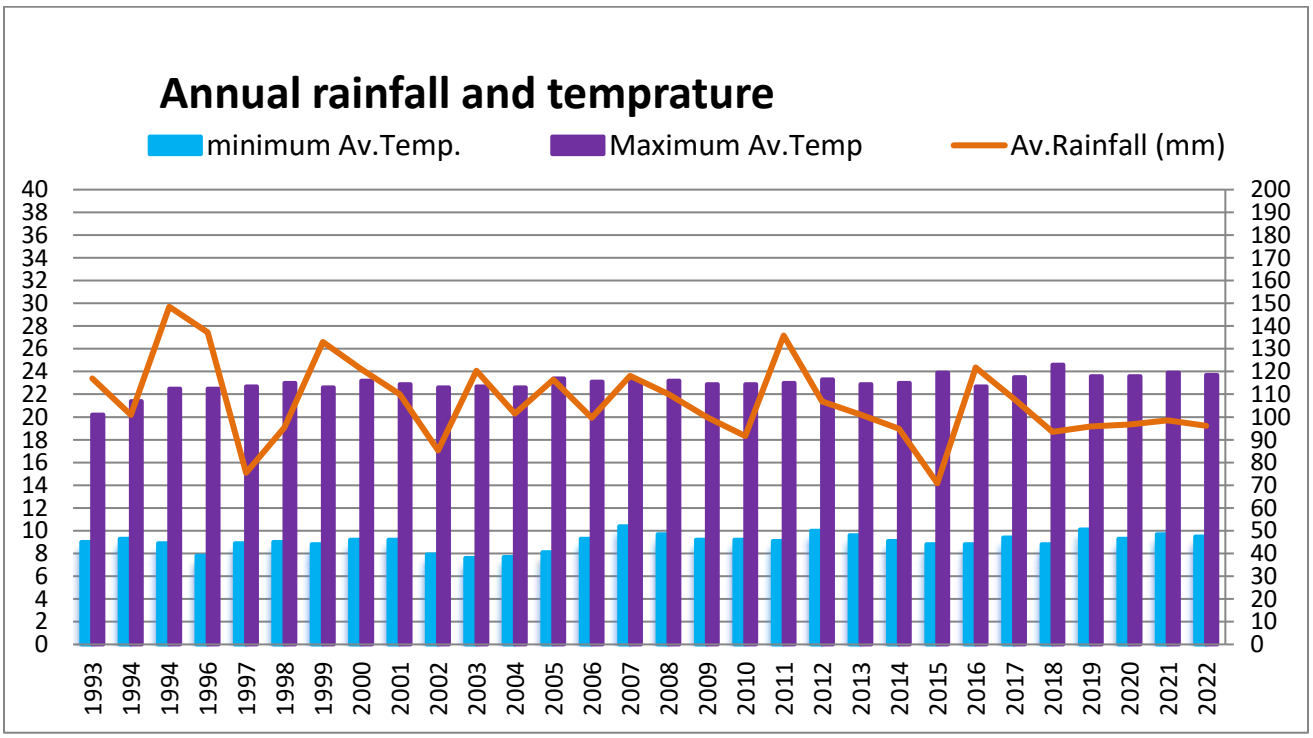


Figure 3.YearlyAverage Rainfall and temperature of the study area (Field Survey 2023/24)

In the district, 4,817.96 hectares are covered with forest vegetation. The area hosts a diverse range of plant species, including both broad-leaved and evergreen varieties. Notable tree species include *Pouteria adolfi-friederici (Kerero /Keretaa), Mimusopskummel (Ishe / Ishetta), Millettia ferruginea (Birbira),Teclea nobilis (Haddessa / Haddessaa),Podocarpus falcatus (Zigba/ Birbirsa), Celtis africana (Medehanit / Mehandis)*

Croton macrostachyus (Bisana), Dracena steudneri(Shibra /Woba), Allophylus abyssinicus (Embuacho /Embwaacho),Albizia gummifera (Sassa),Prunus africana (Tikur Inchet /Miessa),Polyscias fulva (Serdo/Serdoo),Cordia africana (Wanza /Waddeessa), Warburgia ugandensis (Ishe/ Muujja),Diospyros abyssinica (Kita /Hiddiisaa), Macranga capensis (Mushir/ Muushira), Nuxia congesta (Muka Abbaatii /Qaqama), Ekbergia capensis (Weira /Weyra), Ficus spp. (Baqa/ Odaa), Syzygium guineense subsp. Afromontanum (Dokma / Baddeessaa), Olea capensis subsp. Macrocarpa (Ejersa), Pittosporum viridiflorum (Tedecha /Teedichaa), Albizia schimperiana (Mokmoko / Mukmukoo),Acacia spp. (Girar / Laaftoo), Celtis africana (Medehanit /Mehandis), Eucalyptus globulus (BahirZaf / Bargamo /Nech Bahir Zaf),Eucalyptus camaldulensis(Key Bahir Zaf /Bargamoo Diimaa).

The district has an estimated population of 70,501, with 49% males and 51% females. Of this population, 9,738 are urban residents, while the remainders live in rural areas (Amuru District Administrative Office, 2017). Most inhabitants are farmers, with some engaged in commerce or government employment. The predominant economic activities are mixed agriculture, including crop and livestock production, with coffee and honey farming also occurring in forested areas. Traditional farming practices lead to the exploitation of forested areas for agricultural expansion and settlement.

According to data from AWAO, (2023), the district's land cover includes approximately 33,547 hectares of arable land, 30,434 hectares of pasture, 4,817.96 hectares of forest, and 60,653.0245 hectares of swampy land. Major crops include maize, groundnuts, Niger seed, lentils, beans, peas, and various vegetables (potatoes, onions, garlic), as well as fruits like mangoes, papayas, oranges, and bananas. Agriculture in the area primarily relies on rain-fed irrigation. The topography of the districts includes rugged, plain, mountainous and the remaining gorge/valley accounts 60,653.0245 ha. There are eight major soil groups were identified in the amuru district:*Chromic Luvisols,Eutric Cambisols, EutricLeptosols, EutricVertisols, HaplicAlisols, H aplic Arenosols,HaplicPhaeozems, Rhodic Nitisols* from which *Eutric Vertisols* is the most dominants (2123.5 km^2) and least dominant soil type is P*haeozem*s with an area of (2 km^2) (Kenea *et al*.,2021).

The natural forests of Amuru District host a diverse array of wildlife, including *Colobus monkeys, wild pigs, various bird species,* mammals, and reptiles. Notable wildlife species

include the *Anubis baboon, Ververt monkey, porcupine, common warthog, African civet cat, leopard, common bushbuck, and platypus*, highlighting the forest's rich fauna diversity. Eucalyptus plantations in the district have surged by 96% over the past decade, expanding from 28.375 hectares in 2014 to 745.6537 hectares in 2023, indicating that farmers' interest in eucalyptus cultivation remains strong.

2.2. Research Methods

2.2.1. Research Design

In the present study, a cross-sectional survey was used to explore how residents of the locality perceived the socioeconomic advantages and hydrological impacts of eucalyptus plantation. This design was considered appropriate because it facilitated the collection of data from many different respondents around one point in time to explore both economic contributions of eucalyptus to household livelihoods, but also views among community on its potential ecological and hydroloical implications. The approach also allowed for combining quantitative household surveys with qualitative instruments, such as focus group discussions and key informant interviews, ensuring a rich understanding of the intricate relationships between eucalyptus farming, local livelihoods and environmental sustainability.

Data were gathered through a structured questionnaire, key informant interviews, and focus group discussions. The questionnaire focused on both the socioeconomic benefits of *eucalyptus,* such as income, fuelwood, construction materials, and employment, and its hydrological impacts, including water shortages, soil fertility decline, and reduced crop yields. Interviews and discussions provided deeper insights into these issues. Data analysis relied only on descriptive statistics (mean, median, and standard deviation), since no hypothesis testing was conducted. The term formation system of the study area refers to the community's socioeconomic structure, land-use practices, and the role of *eucalyptus* within farming systems. Overall, the study aimed to understand community perceptions of *eucalyptus* by answering three questions: (1) what socioeconomic benefits do households gain from eucalyptus? (2) What hydrological and environmental impacts are perceived? (3) How do these perceptions influence household decisions to plant eucalyptus?

2.2.2. Sampling Technique and Sample Size determination

The study district, Amuru, was purposively selected because the rapid expansion of eucalyptus plantations has made it one of the major eucalyptus-growing areas in Oromia. Eucalyptus

provides substantial benefits to the local community, including income generation, fuelwood supply, and construction materials. However, it also raises critical concerns such as water scarcity, soil fertility decline, and potential impacts on agricultural productivity. Moreover, the absence of previous research on eucalyptus in Amuru underscores the importance of this study, as it not only addresses a local knowledge gap but also generates insights and lessons that can inform sustainable eucalyptus management strategies in other regions experiencing similar challenges.

From the study district four *kebeles/vilages* were purposively selected from the 21 *kebeles* in the district, representing about 19% of the total. The selection was based on two main reasons: (i) their suitability for *eucalyptus* cultivation, and (ii) the political situation during the study period, which restricted access to other kebeles. It should be noted that the mention of "displacement of residents" does not mean that people from other *kebeles* moved into these four kebeles; rather, it indicates that due to political issues, residents in some *kebeles* were displaced, limiting the researcher's opportunity to include those *kebeles* in the study. A total of 140 respondents were selected to represent the four *kebeles*. The households were chosen randomly, with the sample size from each kebele determined proportionally to the number of *eucalyptus* planters in that *kebele*.

The sample size, determined using Yamane's (1967) formula, provides a 95% confidence level with a 0.05 precision margin. According to the district administration records (government census data), these *kebeles* comprise a total of 1,353 households. From this population, households were randomly selected, with the number of respondents from each *kebele* determined proportionally to the number of *eucalyptus* planters. This ensured that the sample was representative of the *eucalyptus*-farming households in the study area. (Table 1). The sample size determination of house hold from each *kebele* was made based on proportionality which was based on the formula developed by Israel, (1992).

$$n = \frac{N}{1+N(e)}2 = \frac{1353}{1+1353(0.08)}2 = 140 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

Where; n = Sample size, N = Total eucalyptus cultivators in the sample *kebeles*,

e = level of precision considered.

The formula used to calculate the number of household head *in* i^{th} *selected kebeles is*:

$ni = \frac{Ni*n}{N}$……..... (2)

Where: ni = number of the household heads selected from the i[th] *kebele*

Ni= is the total number of eucalyptus cultivating household heads in i[th]*kebele*

n= is the number of sample size N = is the total number of eucalyptus cultivating household heads in the four selected kebeles

Table 1.Total *eucalyptus* cultivators' households and Sample size household heads from each kebele by proportionality

No.	*Kebeles*	Total *eucalyptus* cultivators households			Sample size household heads ni $= \frac{Ni*n}{N}$		
		Male	Female	Total	Male	Female	Total
1 .	Harowalo	317	28	345	$\frac{317*140}{1353}$=33	$\frac{28*140}{1353}$=3	36
2 .	Ejeregoromti	432	47	479	$\frac{432*140}{1353}$ =45	$\frac{47*140}{1353}$= 5	50
3 .	Nafuro	193	21	214	$\frac{193*140}{1353}$=20	$\frac{21*140}{1353}$= 2	22
4 .	Makanno	276	39	315	$\frac{276*140}{1353}$=29	$\frac{39*140}{1353}$=3	32
5 .	Total	1218	135	1353	127	13	140

Source: Field Survey (2023/24)

2.2.3. Data Collection methods

Survey questionnaires were administered to 140 households by the researcher with the support of trained enumerators who spoke the local language. In addition to the household survey, qualitative data were collected after the questionnaire survey through 20 key informant interviews (KIIs), which included four development agents (one per *kebele*), four *kebele* representatives, two model farmers, one experienced middleman, one officer from the district environment, forest, and climate change office, and eight knowledgeable tree growers. Two focus group discussions (FGDs) were also conducted, involving 10 tree growers (five per

kebele), representing men, women, and youth. These FGDs discussed *eucalyptus* production, its use for fuelwood, and its role in household livelihoods.

The questionnaire-based survey covered several sections, including household socioeconomic characteristics (demographics, assets, and income sources) and *eucalyptus* tree landholdings. To capture perceptions of socioeconomic benefits, households were asked questions related to income generated from *eucalyptus* (e.g., firewood, poles, and timber sales), contributions to education, healthcare, and food security, as well as the role of *eucalyptus* in asset building and improving livelihoods. To assess hydrological impacts, respondents were asked about their perceptions of changes in water availability, soil moisture, crop yields near *eucalyptus* plantations, and effects on communal water sources. The closed-ended questionnaires were initially designed in English and then translated into Afaan Oromo for respondent interviews. Secondary data were obtained from published and unpublished materials, including documents, records, and reports, to provide comprehensive information for the discussion.

This study was reviewed and approved by the Ambo University Institutional Research Ethical Committee.. All research methods were performed in accordance with the relevant ethical guidelines and regulations, specifically the Declaration of Helsinki (Ethical Principles for Medical Research Involving Human Subjects) and the National Research Ethics Review Guideline of Ethiopia

2.3. Method of Data Analysis

Both quantitative and qualitative data were collected and analyzed in this study. Quantitative data from household surveys on socioeconomic benefits (income, education, healthcare, food security, and household assets) and hydrological impacts (water availability, soil moisture, crop yields near *eucalyptus* plantations, and communal water sources) were analyzed using descriptive statistics, including mean, median, and standard deviation. Results were presented using tables, bar charts, histograms, and pie charts. Qualitative data from focus group discussions and key informant interviews were analyzed using thematic analysis to identify key patterns and insights regarding the social, economic, and environmental impacts of *eucalyptus* cultivation.

3. Results and Discussion

3.1. Demographic Characteristics of the Respondents

3.1.1. Age and sex of the respondent Farmers

Findings from focus group discussions (FGDs) and key informant interviews (KIIs) show noticeable differences in *eucalyptus* adoption across groups. Men are more involved in planting *eucalyptus* trees, while women mainly engage in horticultural activities. This difference is linked to cultural roles, access to resources, and livelihood preferences. Elderly farmers also prefer *eucalyptus* cultivation over crop production because it requires less labor and suits their physical capacity. With their long-term experience, they can compare past and present uses of *eucalyptus* and often rely on indigenous knowledge, such as using the tree for medicinal purposes like treating colds.

Elderly farmers are more likely to plant *eucalyptus* as they seek alternatives to physically demanding agricultural work, such as crop and vegetable harvesting. In contrast, younger farmers prioritize crop production, adopting new technologies for immediate returns rather than investing in long-term projects like *eucalyptus* planting. This trend reflects broader rural agricultural practices, where younger generations emphasize short-term productivity over long-term investments in trees. This observation aligns with studies by Gebreegziabher *et al.* (2010), which found that older farmers are more inclined to invest in *eucalyptus* woodlots as a stable source of income.

3.1.2. Educational Level of the Respondents

The study shows a clear trend, based on descriptive statistics from survey data, that farmers with higher education levels tend to be more aware of the potential negative effects of eucalyptus, such as soil degradation and water depletion. Among respondents, 35.7% attended adult education, 32.1% completed high school (grades 9–12), 23.6% attended elementary school (grades 1–8), 3.6% had a certificate or higher education, and 5.0% were illiterate. These findings were further supported by focus group discussions (FGDs) and interviews with key informants, where participants emphasized that more educated farmers are often better informed about environmental risks and adopt improved management practices. For example,

several farmers noted that they prefer planting *eucalyptus* on degraded or hilly lands rather than on cropland, as this reduces soil and water impacts.

One respondent in a key informant interview stated: "We plant *eucalyptus* on steep slopes because it does not compete with our food crops and helps restore degraded land."Overall, the results suggest that education plays an important role in shaping farmers' perceptions and management strategies, highlighting the need for awareness programs to complement *eucalyptus* cultivation practices in the district. Less educated farmers, including those with only elementary education, adult education, or no formal schooling, were less aware of these potential downsides. While indigenous knowledge supports traditional uses of *eucalyptus*, formal education provides essential technical knowledge, highlighting its role in shaping farmers' attitudes and promoting sustainable *eucalyptus* cultivation.

As noted by Dessie *et al*., (2019b), without adequate education, farmers may continue to plant *eucalyptus* in unsuitable areas, exacerbating environmental challenges. Consequently, the low educational level in the study area hinders the sustainable management of *eucalyptus* woodlots.

Table 2.Respondents' Educational status

Variable	Description	agro ecology of the respond				Total percentages	
		high land		mid land			
		N	%	N	%	N	%
Educational status	illiterate	6	8.80	1	1.40	7	5.00
	adult education	23	33.80	27	37.50	50	35.70
	primary school	15	22.10	18	25.00	33	23.60
	high school	19	27.90	26	36.10	45	32.10
	Certificate &above	5	7.40	0	0.00	5	3.60

3.1.3. Community Perception on Family Size

The study's data, obtained from key informant interviews and focus group discussions, indicate a trend in community perceptions of family size and eucalyptus cultivation. Households with larger families were generally less involved in *eucalyptus* woodlot production, likely because they have sufficient labor for more labor-intensive crops that provide quicker returns. In

contrast, smaller families, with fewer laborers and resources for intensive crop production, were more likely to engage in *eucalyptus* planting, benefiting from its low-maintenance nature and long-term income potential. This trend is further supported by insights from KIIs and FGDs, which showed that older households, often with fewer working members, are more inclined toward *eucalyptus* cultivation. The data obtained from key informant interviews and focus group discussions indicate a trend that older households, often with fewer laborers, are more likely to engage in eucalyptus cultivation due to its lower workload compared to crop farming. While no statistical tests were conducted, this tendency aligns with previous studies Dessie *et al.,* (2019a), which suggest a positive relationship between household age and income from *eucalyptus*, indicating that older households may increasingly rely on *eucalyptus* as a stable source of income.

3.1.4. Residence of the respondent in the area

The history of settlement and the duration of farmers' presence in the area play a critical role in shaping their perceptions and decisions regarding *eucalyptus* cultivation. Farmers with extensive knowledge of the region's history, particularly those who have lived there longer, are more inclined to plant *eucalyptus*, recognizing its historical and economic importance. Their decisions are influenced by a mix of demographic, socioeconomic, and psychological factors, including age, education, family size, household income, land size, and productivity. Together, these factors determine their level of commitment to *eucalyptus* cultivation. As noted by Dessie *et al*., (2019b), farmers with a long-standing connection to the area are more likely to adopt sustainable agricultural practices and better understand how *eucalyptus* fits into the local ecosystem. This deep-rooted knowledge helps guide their decisions on where and how to plant *eucalyptus*, ensuring that it benefits both the environment and the economy.

3.2. Socioeconomic characteristic of the respondents

3.2.1. Trends of *eucalyptus* plantations at study area

The significant increase in *eucalyptus* plantations in *Amuru* District (Figure 4.), from 28.375 hectares in 2014 to 745.6537 hectares in 2023, reflects a 96% growth and suggests a clear shift in agricultural practices across both midland and highland areas of the district.

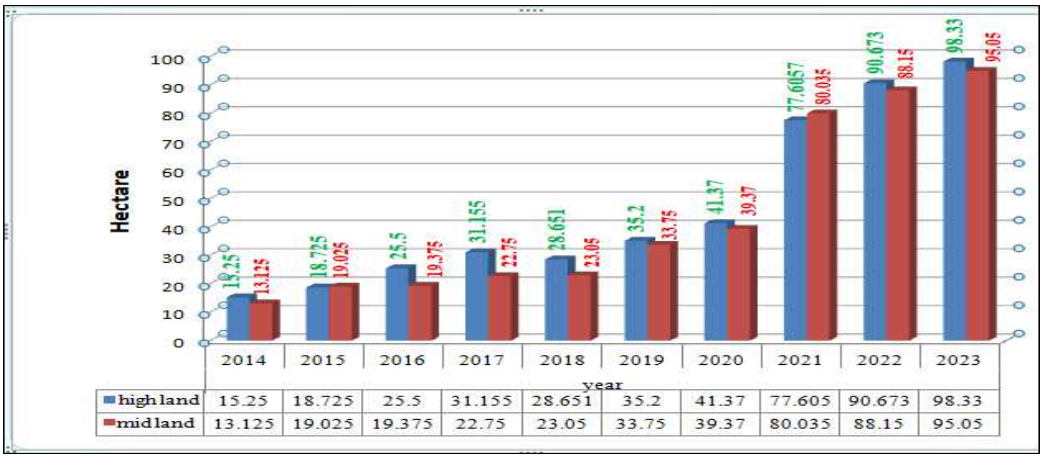


Figure 5. Trends of *eucalyptus* plantations at study area (Field Survey 2023/24)

The survey results indicate that the expansion of *eucalyptus* cultivation is primarily driven by the increasing demand for wood products, especially construction materials and fuel. Most respondents reported that this demand has strongly motivated farmers to adopt *eucalyptus* on a wider scale. In addition, the majority did not identify major environmental or economic challenges that could significantly hinder its growth. These findings are consistent with Tefera and Kassa (2017), who reported similar rapid growth of *eucalyptus* woodlots, identifying rising wood demand as the primary driver of expansion. In *Amuru* District, this demand remains central to the widespread adoption of *eucalyptus*, as farmers value its economic versatility. More broadly, the rapid spread of *eucalyptus* plantations mirrors a regional trend in which the species is increasingly perceived as a sustainable and profitable option, supported by both market demand and the economic benefits it provides.

The data presented in (Figure 4) are drawn from survey responses, supported by FGDs and key informant interviews. While minimum, maximum, and mean values were initially included to illustrate household-level variability, the range adds little analytical value because it can already be inferred from the minimum and maximum. Therefore, the mean is highlighted as the most representative figure, offering a clearer reflection of household adoption patterns. A comparison between highland and midland areas is especially relevant because adoption patterns vary across agro-ecological zones, shaping both environmental and livelihood outcomes. In the highlands, *eucalyptus* is often established on steep and degraded land, where water scarcity is already a pressing concern, amplifying the risk of hydrological stress. In the midlands, however, plantations are typically established on more fertile soils with better water availability, where environmental pressures are less severe and income opportunities are

stronger. This contrast demonstrates how the same species can generate different ecological and economic impacts depending on local context, underscoring the importance of considering agro-ecological conditions when evaluating the role of *eucalyptus*.

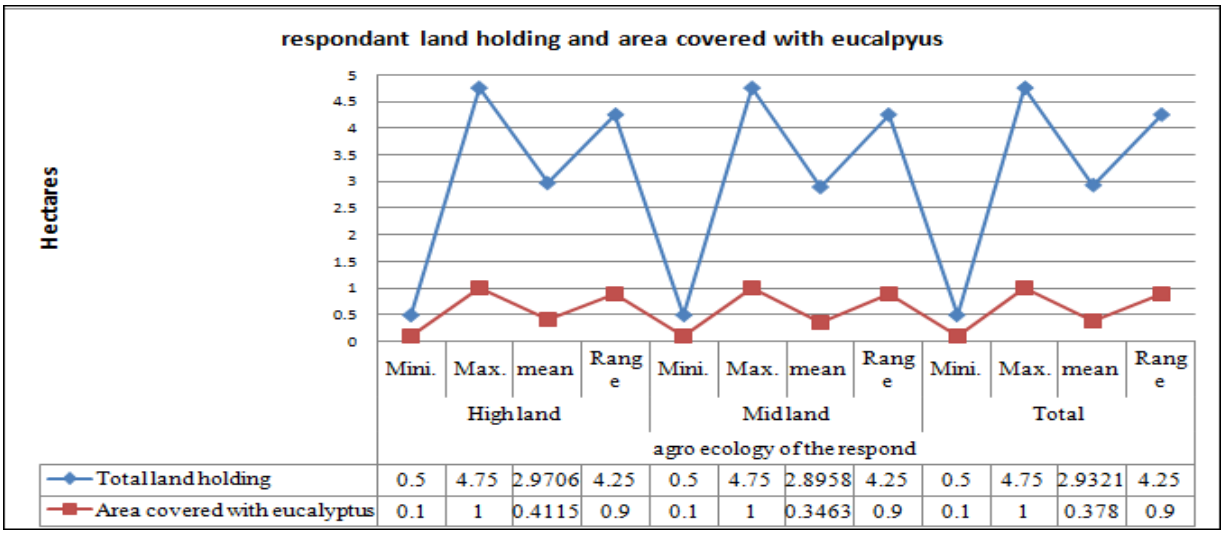


Figure 4.Trends of *eucalyptus* cultivation at *Amuru* districts (Field Survey 2023/24)

The survey results show that *eucalyptus* is increasingly regarded as a viable land-use option in both highland and midland areas. Respondents indicated that its cultivation is particularly common on hilly, steep, and degraded lands, where conventional crop production is less effective. This suggests that farmers are using eucalyptus as an alternative strategy to make productive use of marginal lands. This trend is consistent with the results of Worku *et al.* (2020), who emphasized the adaptability of eucalyptus to less fertile and water-scarce environments. Farmers reported that *eucalyptus* requires relatively low labor, time, and capital inputs**,** making it more practical than many conventional crops. Moreover, it produces valuable outputs such as fiber, saw timber, and chipboard, all of which are in high demand. The strong market value of these products has encouraged many households to shift land use from traditional crops to *eucalyptus* woodlots, thereby enhancing income and employment opportunities with minimal initial investment.

Evidence from FGDs, survey responses, and key informant interviews further supports this perspective. District specialists and extension staff, in line with Ayele and Mekonnen (2018), confirmed that *eucalyptus* is widely recognized as a suitable alternative for marginal lands. Farmers in *Kebeles* such as *Haro Walo, Ejere Goromti, Nafuro***,** and *Makano* have increasingly prioritized *eucalyptus*, highlighting its role as both an economically profitable and

environmentally adaptable land-use strategy. The increment of plantation shown in the figure refers to the expansion of land size (in hectares) allocated to *eucalyptus* over time**,** reflecting farmers' growing commitment to this plant.

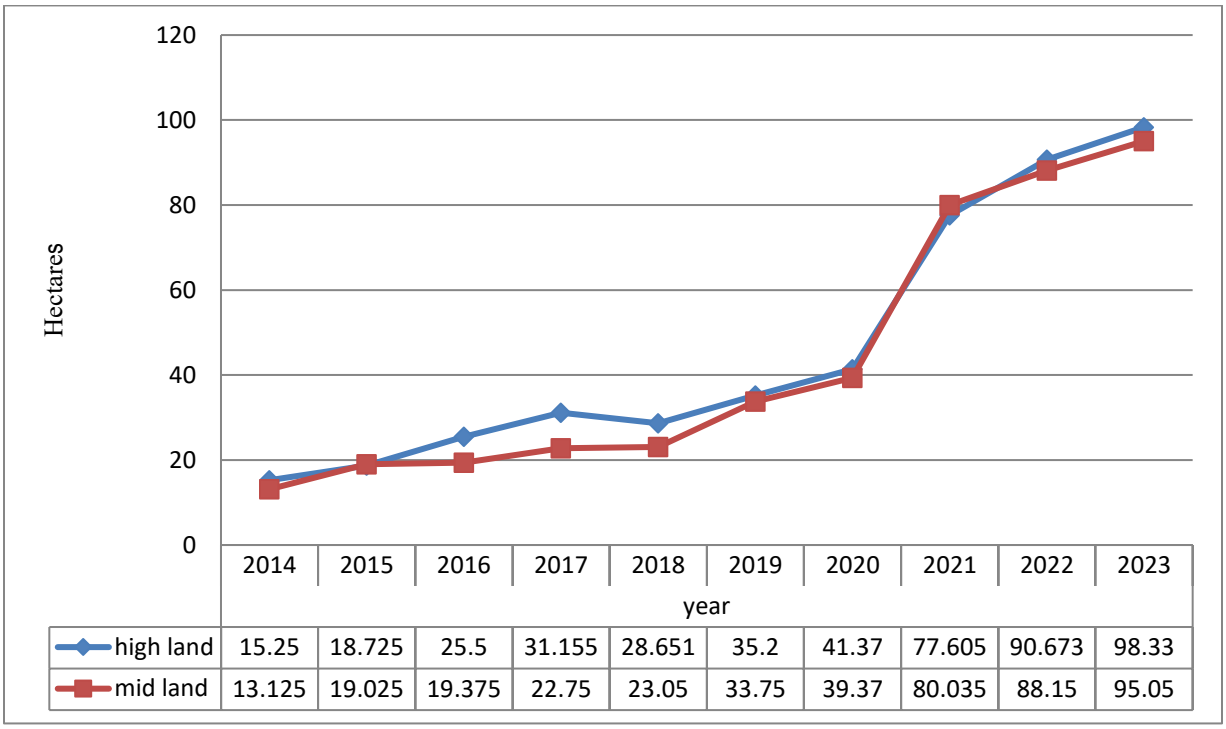


Figure 5. An increment of eucalyptus plantation (Amuru agriculture office 2023/24)

3.2.2. Size of land holding and area covered with *eucalyptus* tree in the study area

The study's empirical results highlight a clear relationship between landholding size, *eucalyptus* cultivation, and annual income. According to survey data ((Table3.), respondents have an average landholding of 2.93 hectares, of which 0.378 hectares is allocated to *eucalyptus*, contributing to an average annual income of 8,601.07. This indicates that land size plays a crucial role in the decision to plant *eucalyptus.* Larger landholdings provide farmers with the space and resources to allocate part of their land to *eucalyptus,* enabling them to optimize land use for both immediate and long-term benefits.

In contrast, smallholders often prioritize short-term crops to meet household food security and income needs, limiting their capacity to invest in tree planting. Insights from FGDs and key informant interviews confirm that *eucalyptus* requires land to be set aside for several years,

making it more feasible for farmers with ample land. Larger plots also allow for economies of scale, improving management efficiency and overall income, whereas smaller plots constrain tree planting options. Overall, these findings demonstrate that landholding size is a key factor in the adoption of *eucalyptus* and its economic returns, with larger landowners benefiting more from both the ecological and financial advantages of tree cultivation. These findings align with Ayele, (2009) research, which shows that farmers with larger landholdings can produce higher yields of *eucalyptus* compared to those with smaller plots. Farmers with limited land are less likely to invest in *eucalyptus*, opting instead for crops that yield quicker returns or require less space. Therefore, land size significantly influences the adoption of *eucalyptus* farming, with larger landowners more likely to engage in this practice. Moreover, the study suggests that *eucalyptus* cultivation can enhance farmers' income by diversifying their revenue streams. This could improve their financial stability, particularly in areas with sufficient land resources.

Promoting *eucalyptus* farming in such regions could serve as a sustainable strategy for increasing agricultural productivity and income in rural areas. Farmers who own sufficient land to produce enough food for their families are more likely to cultivate *eucalyptus* compared to those with small landholdings. Survey data, FGDs, and key informant interviews indicated that small-scale farmers tend to prioritize crops such as fruits and vegetables over tree planting, since their agricultural land is needed for immediate food production (Table 3). As one FGD participant explained, “I prefer planting vegetables and fruits because I need to feed my family; planting *eucalyptus* takes space I cannot afford to lose” (Table 3). The farmers who have small landholdings prefer to produce crops and another purpose, like growing fruits and vegetables, than tree growing, like a *eucalyptus* tree.

The family who has enough landholding, using their land for diversifying the source of income, like growing crops, fruit, tree planting, vegetables, and animal raising. Thus, the size of farmland owned by farmers appears to be an important agent that determines the farmer’s decision in the planting of the *eucalyptus* tree. The family with enough land uses it to diversify their sources of income by cultivating crops, fruit, vegetables, trees, and animals, as well as other crops and plants. As a result, it looks like a key factor influencing a farmer's decision to plant a eucalyptus tree is the size of their farmland. This is similar to other research' findings (Jenbere *et al*., 201).

475 **Table 3 .Total land holding, Area covered with *eucalyptus* and Income of the respondent**

476

Variables	agro ecology of the respond											
	High land				Mid land				Total			
	Mini	Max	mean ± SE	Range	Mini.	Max	mean ± SE	Range	Mini.	Max	mean ± SE	Range
Total land holding in (hek.)	0.5	4.75	2.9706 ±.11386	4.25	0.5	4.75	2.8958±	4.25	0.5	4.75	2.9321±.07885	4.25
Area covered with *eucalyptus* in (hek.)	0.1	1	.4115±.02614	0.9	0.1	1	.3463±.01979	0.9	0.1	1	.3780±.01645	0.9
Income of the respon dent in (ETB.Birr)	5000	25000	10867.92±930.641	20000	5080	25000	6859.86±279.482	19920	5000	25000	8601.07±468.127	20000

3.2.3. Ownership Land of the farmers

Land ownership is a key socioeconomic factor influencing agricultural decisions. In the study area, land can be owned, rented, leased, or managed through sharecropping. Typically, leased, rented, or sharecropped lands are used for crop production rather than tree planting. This finding is supported by survey data and key informant interviews, which indicated that landowners are more likely to plant *eucalyptus*, while leased, rented, or sharecropped lands are primarily used for annual crop production. Landowners often prefer not to allow *eucalyptus* planting on their rented or sharecropped lands, which limits the adoption of *eucalyptus* to lands owned outright or inherited. This finding is supported by a study in Burkina Faso, which showed that individuals with insecure land tenure are more inclined to plant fruit trees rather than wood-producing trees (Etongo *et al.,* 2015). Similarly, farmers with low-quality or non-agricultural land are more likely to plant eucalyptus compared to those with high-quality agricultural land.

The availability of non-agricultural land increases the likelihood of adopting *eucalyptus* cultivation, aligning with Nsiah, (2010), that non-agricultural land positively influences tree planting decisions. The extent of farmland also significantly impacts planting decisions. In the study area, *eucalyptus* trees are commonly planted near homes or on non-farming land. Farmers with large landholdings can benefit substantially from selling vegetables and *eucalyptus* wood. Consequently, households with larger land areas are more likely to plant extensive *eucalyptus* woodlots, supporting related research (Edesa, 2021) that highlights the positive economic impact of farm woodlots on rural incomes.

3.3. Community perception on Income generated from *eucalyptus* tree

The study's findings revealed that farmers in the region earn an average of 8,601.07 Birr annually from biomass, with earnings ranging from 5,000 to 25,000 Birr (Figure 6). This income appears to motivate farmers to continue cultivating *eucalyptus*, as it provides a stable revenue source. However, despite its profitability, *eucalyptus* woodlot production is hindered by the high transportation costs associated with moving the wood from farms to markets. As a result, the profits from *eucalyptus* products remain relatively low once these distribution costs are considered.

These results are consistent with Abebaw and Dea, (2016), which suggests that the proximity of farmers to markets significantly influences their decisions and profitability from *eucalyptus* plantations. Farmers closer to markets incur lower transportation costs and thus enjoy higher profit margins, while those further away faces increased expenses, which reduce overall profitability. In conclusion, while eucalyptus cultivation offers financial benefits, the study emphasizes that transportation costs are a critical factor affecting the net income generated from eucalyptus woodlots.

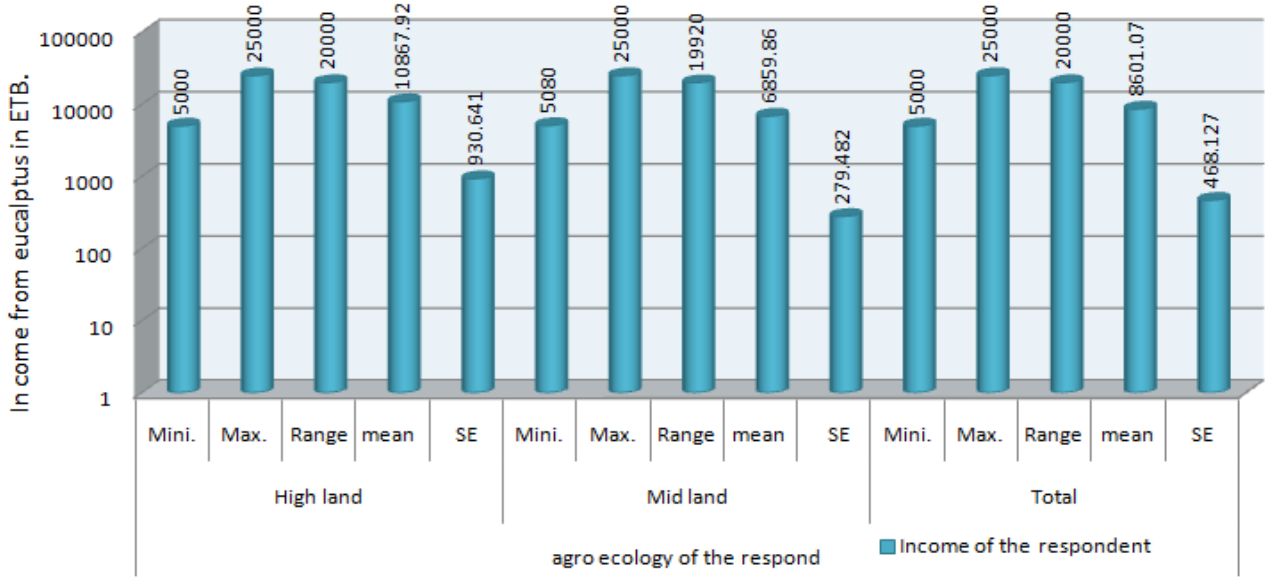


Figure 7. Income of the respondent generated from *Eucalyptus* (Field Survey 2023/24)

The survey data show that income from *eucalyptus* cultivation varies across agro-ecological zones. In the highlands, 35.3% of respondents reported earning between 6001–7000 units annually, while 26.5% earned more than 7000 units. In the midlands, 72.2% of respondents earned between 6001–7000 units, and 22.2% earned between 5001–6000 units. The data also indicate that 22.1% of highland respondents obtained additional income from other uses of *eucalyptus*, compared to only 4.2% in the midlands. Overall, the most common income level in both areas was between 6001–7000 units, highlighting the strong economic contribution of *eucalyptus* cultivation **(**Table 4).

The study's findings revealed that *eucalyptus* plantations, particularly along roadsides, are highly valuable due to the growing demand for construction materials, especially poles, in urban areas. For farmers in the study region, *eucalyptus* provides higher returns than other livelihood options such as animal husbandry, crop farming, or non-farm activities, according to

survey data, FGDs, and key informant interviews. This is attributed to *eucalyptus*'s low labor requirements, resistance to diseases and pests, rapid growth, and its ability to be managed by individuals of all ages, including children, women, and the elderly. These results are consistent with Abiyu *et al.,* (2016), which found that *eucalyptus* plantations are more profitable than other smallholder farming practices in Ethiopia. *Eucalyptus* has become a key income source across various regions, often ranking as the second-largest contributor to rural household incomes. Its ease of cultivation, coupled with strong market demand, makes *eucalyptus* a sustainable and profitable alternative to traditional farming. Consequently, *eucalyptus* cultivation has become an essential component of rural livelihoods, offering significant economic benefits for farmers nationwide.

Table 4.Money who make from eucalyptus per year b/n agro ecology of the respondents

income categories	agro ecology of the respondents				Total percentages (140respondent)	
	High land(68 respondent)		Mid land(72 respondent)			
	N	%	N	%	N	%
5000	5	7.4	0	0.0	5	3.6
5001-6000	6	8.8	16	22.2	22	15.7
6001-7000	24	35.3	52	72.2	76	54.3
>7000	18	26.5	1	1.4	19	13.6
other use	15	22.1	3	4.2	18	12.8

3.3.1. Community perception of Eucalyptus as Energy source (fuel wood and charcoals)

The survey results indicate that *eucalyptus* plantations make important economic and ecological contributions in *Amuru* District, particularly in *Haro Walo, Ejere Goromti, Nafuro*, and *Makano Kebeles*. Respondents reported that *eucalyptus* serves as a key source of fuel, and that collecting fallen material allows households, especially low-income families, to save time. The data further show that this time-saving benefit helps households meet their energy needs while reducing labor burdens.

The survey data show that 71.4% of respondents rely on eucalyptus wood for fuel, making it the region's primary energy source. Other fuels, such as animal dung (10%), crop residue (9.3%), leaves (6.4%), and charcoal (2.9%), are used less frequently (Table 4). Charcoal is mainly employed during the summer for cooking and coffee preparation. This aligns with

findings by Seware *et al.*, (2021), which also highlighted the reliance on solid fuels in rural areas, influenced by factors like age, education, household size, and electricity access. Beyond fuel, *eucalyptus* provides a range of resources, including building materials, furniture, food, and tools for soil and water conservation. In areas lacking alternative fuel sources, *eucalyptus* is indispensable for cooking and heating, with many households benefiting from it at little to no cost. The study also uncovers the socioeconomic dynamics around eucalyptus fuelwood collection. In areas like *Obora* district, where natural forests are scarce, eucalyptus plantations have become a profitable business. Women in rural areas gather eucalyptus fuelwood, selling it to urban markets. Two main groups of women were identified: those who purchase and resell eucalyptus wood from rural areas, and those who directly gather and sell it. Eucalyptus is especially valued for charcoal production, a key resource for smelting iron, with species like *Eucalyptus globulus* and *Eucalyptus camaldulensis* being preferred for this purpose.

In conclusion, *eucalyptus* cultivation in the study area has proven to be economically sustainable and has some ecological benefits. Survey responses, FGDs, and key informant interviews indicated that while the primary uses of *eucalyptus* are construction, fuel, and income generation, farmers also recognize its minor role in environmental conservation. For example, *eucalyptus* is planted along farm boundaries to reduce soil erosion, provides shade for crops and livestock, and in some cases contributes to soil and water protection. These practices, although less prominent than other uses, demonstrate that *eucalyptus* cultivation can support both livelihoods and the environment. Its widespread use in various forms fuel, building materials, and charcoal underscores its critical role in improving rural livelihoods and addressing energy and economic challenges in the region.

Table 5. Main source of fuel at study area

Variables		agro ecology of the respond				Total	
	descriptive	high land		mid land		percentages	
		N	%	N	%	N	%
What is your main source of household fuel?	Wood	41	60.3	59	81.9	100	71.4
	charcoal	4	5.9	0	0.0	4	2.9
	Animal dung	9	13.2	5	6.9	14	10.0
	leaves	9	13.2	0	0.0	9	6.4
	Crop residual	5	7.4	8	11.1	13	9.3

Source: Field Survey (2021/22)

3.3.2. Community perception of *Eucalyptus* as timber

The survey data show that 99.3% of respondents plant *eucalyptus* primarily for farm implements, construction, and firewood, indicating its wide use in both agricultural and household activities. In contrast, only 0.7% of respondents reported planting *eucalyptus* for soil and water conservation. This suggests that while the tree is widely valued for practical purposes, its role in environmental management is less recognized by farmers.

The study also reveals that eucalyptus species, such as *Eucalyptus globulus* and *Eucalyptus camaldulensis*, are favored for their rapid growth. These species reach mechanical maturity and a suitable lumber size for sawmilling in just 10 to 15 years, a much shorter period compared to other tree species. The fast growth of *eucalyptus* does not compromise the quality of its timber, making it an attractive option for farmers seeking quick returns. In contrast, indigenous species like *Cardia africana* and *Podocarpous* require 25 to 40 years to reach the desired size for lumber production. This highlights the economic advantages of *eucalyptus*, which provides faster returns and is more immediately useful for construction and farming.

Overall, the findings underscore that *eucalyptus* cultivation meets both short-term needs (e.g., firewood and construction) and long-term economic goals (e.g., timber production). The minimal focus on soil and water conservation, as observed in the survey data, was further explored through interviews and FGDs. Participants explained that *eucalyptus* is primarily valued for construction, fuel, and income, while its potential for environmental benefits is less recognized. However, this limited use for soil and water conservation highlights an opportunity to promote *eucalyptus* as a tool for sustainable land management**,** thereby enhancing both its ecological and socio-economic value in the community.

3.3.3. Community perception of *Eucalyptus* as construction and poles

The survey, focus group discussions (FGDs), and key informant interviews (KIIs) reveal the diverse and essential uses of *eucalyptus* in the study area. The data show that 58.6% of respondents use *eucalyptus* for home construction, while 87.14% reported selling *eucalyptus* or its parts for products such as *cefeka, mager, weraj*, and *quwami*, highlighting its importance as a source of income. In addition, 35.7% of respondents use *eucalyptus* wood for household fuel

needs. Smaller proportions reported other uses, including fencing (3.6%), agricultural tools (1.4%), and soil and water conservation (0.7%) (Table 5).

Information from focus group discussions (FGDs) and key informant interviews (KIIs) shows that, beyond its primary uses, *eucalyptus* contributes modestly to agricultural practices. Farmers reported planting it along farm boundaries as live fences, using it to provide shade for crops and livestock, and occasionally to reduce soil erosion and protect farmland. Although these roles are less prominent than its main functions, they still add value to farming systems. Participants also emphasized that *eucalyptus* supports household needs by providing income to cover expenses such as *taxes*, school *fees*, healthcare, and contributions to local organizations like *iddir, ekub, mahber*, and *zikkir.*

Table 6.Purpose of the *Eucalyptus* tree plantation

Variables	Descriptive	agro ecology of the respond				Total percentages	
		high land		mid land			
		N	%	N	%	N	%
purpose of the *Eucalyptus* tree	for construction	34	50.0	48	66.7	82	58.6
	For sale	53	78	69	95.8	122	87.14
	For farm tools	2	2.9	0	0.0	2	1.4
	Fence	4	5.9	0	0.0	4	2.9
	For fuel wood	27	39.7	24	33.3	51	36.4
	For soil and water conservation	1	1.5	0	0.0	1	0.7

3.4. Community perception on Social benefits of *eucalyptus* tree

3.4.1. Community development work and other important issues of societies

The empirical findings of this study highlight the significant social and economic benefits of eucalyptus trees for communities in the study areas. *Eucalyptus* plays a key role in funding community development projects, such as building bridges, *kebele* houses, health posts,

schools, and farmer union stores. Additionally, it contributes to food security by enabling residents to cover costs for timber, housing, and fertilizers, particularly during shortages. For example, in the 2023–24 cropping season, farmers with eucalyptus woodlots could sell trees to buy fertilizer, ensuring food security for their families. In contrast, those without *eucalyptus* had to sell food grains or livestock at inflated prices to illegal traders, leading to severe food insecurity. *Eucalyptus* plantations provide resilience against agricultural failures and financial risks, acting as a vital asset for farmers. Income from *eucalyptus* sales significantly supplements the annual cash income of poorer households, helping cover essential expenses such as food. Findings from the household survey, FGDs, and key informant interviews indicate that *eucalyptus* provides multiple social benefits, and many residents increasingly see it as a form of "green savings" and a safety net during adverse conditions. These findings support the work of Munuyee *et al.,* (2018), who highlighted eucalyptus as an economic safety net, referring to it as a "divine gift" that helps alleviate poverty. The study emphasizes the multifaceted value of eucalyptus, not only as a financial asset but also as a crucial resource for social and economic stability, providing both immediate and long-term benefits to rural communities.

3.4.2. The social benefits of *eucalyptus* from the perspective of the local society's culture

The empirical findings of this study highlight the cultural and practical significance of eucalyptus in the local community. *Eucalyptus* is not only regarded as a financial asset but also as a symbol of economic stability and social respect. Owning a eucalyptus woodlot is seen as a form of financial security, facilitating access to loans and financial assistance. In contrast, individuals without a woodlot face greater difficulty securing such support, emphasizing the economic importance of eucalyptus ownership.

In addition to its economic value, eucalyptus provides various practical benefits. The results of the study, obtained from household survey responses, FGDs, and key informant interviews, revealed that The tree also serves as a natural pest repellent, with many people using its leaves to deter insects and preserve food like *enjera*. Furthermore, *eucalyptus* leaves are utilized in traditional medicine to treat foot ailments, headaches, asthma, coughs, and toothaches.

These findings are consistent with the work of Derbe *et al*., (2018), which underscores the cultural and practical importance of eucalyptus in rural communities. Overall, the study

highlights how *eucalyptus* serves not only as a financial asset but also as a vital component of the cultural and health practices in the community, offering a wide range of benefits beyond its economic value.

3.4.3. Community perception on Social benefits of *Eucalypts* for firewood charcoal and poles

Information from focus group discussions (FGDs) and key informant interviews (KIIs) highlights the economic and social benefits of *eucalyptus* cultivation for rural communities, particularly women. Participants reported that income from *eucalyptus* sales helps families cover food and other essential expenses, contributing to financial stability. Women explained that having access to *eucalyptus* wood significantly reduces the time and physical effort required to collect firewood, which otherwise involves long and tiring journeys. Those without eucalyptus trees face greater challenges, while women with *eucalyptus* benefit from a more accessible and convenient fuel source, easing the labor burden on both themselves and children.

The time saved from gathering firewood enables women and children to engage in more productive activities, such as education, improving their overall well-being and empowering them. This shift enhances educational opportunities for children and supports long-term social and personal development. Additionally, *eucalyptus* leaves, twigs, and bark are used as fuelwood, underscoring the tree's critical role as a sustainable energy resource in rural areas. The benefits of *eucalyptus* cultivation extend beyond its economic value, offering social empowerment and improving living conditions for women and children. In conclusion, the study highlights *eucalyptus* cultivation's dual role in providing economic relief through income generation and social empowerment by reducing burdens on women, improving access to education, and enhancing the overall quality of life in rural communities.

3.4.4. Benefits of *Eucalypts* for Honey production

The findings of this study, based on key informant interviews and focus group discussions, highlight the largely untapped potential of *eucalyptus* trees for honey production in rural areas where they are not widely cultivated. Respondents noted that *eucalyptus* trees have long flowering periods, especially during the dry season after agricultural harvests, when nectar is otherwise scarce. The abundant pollen and nectar produced by many eucalyptus species make them an excellent resource for honey production. This finding reflects community perceptions

gathered during the study rather than direct survey responses on honey use, as few respondents reported utilizing eucalyptus for honey production.

In regions with established *eucalyptus*-based apiaries, the honey produced is highly valued and in strong market demand. However, the study reveals that this economic potential remains underutilized in areas where *eucalyptus* trees are not commonly planted. This presents a valuable opportunity for rural communities to diversify their income by cultivating *eucalyptus* for honey production. Farmers could tap into a profitable market for high-quality honey, benefiting both economically and environmentally through sustainable agricultural practices.

Overall, the study emphasizes the untapped opportunities eucalyptus trees offer for honey production. By increasing awareness and strategically planting *eucalyptus* for apiaries, farmers can improve biodiversity, create new income streams, and address seasonal nectar gaps, ultimately strengthening local economies and supporting agricultural sustainability.

3.5. Community perception on Ecological benefit of *Eucalyptus* tree

The empirical findings of this study reveal both the environmental benefits and concerns associated with *eucalyptus* cultivation, showcasing a divided perspective among respondents. Based on survey responses, interviews, and focus group discussions, a majority of respondents (67.8%) recognized the positive environmental impacts of eucalyptus trees, particularly in soil and water conservation. During interviews and FGDs, many respondents demonstrated an understanding of how *eucalyptus* helps prevent soil erosion, maintain soil moisture, and improve local microclimates. Some respondents also indicated that they plant *eucalyptus* not only for economic benefits but also for these environmental advantages, showing that awareness of ecological benefits influences their planting decisions. (Table 6). *Eucalyptus* is valued for reducing pressure on natural forests, aiding in soil recovery, preventing erosion, and conserving soil and water.

Additionally, these trees help improve air quality by producing oxygen, fixing carbon, and capturing CO2. They are also effective in saline and waterlogged areas and support adaptable wildlife, such as birds. However, 32.2% of respondents highlight potential negative effects on the environment. Concerns include reduced agricultural yields, lower soil moisture, and diminished water availability. Some respondents report that *eucalyptus* cultivation has led to lowered water tables, which results in reduced stream and river volumes, particularly in the dry

season. While *eucalyptus* offers economic benefits, these respondents warn of potential ecological harm, especially in regions already facing water scarcity and land degradation.

This finding, obtained from key informant interviews and focus group discussions, shows that while eucalyptus is praised for reducing soil Salinization through transpiration, some respondents emphasized the need to drain swampy areas to prevent mosquito breeding and address land degradation, thereby improving conditions for wildlife and vegetation. These mixed views, gathered from qualitative discussions, reflect an ongoing debate among the community regarding the balance between the economic benefits and ecological risks of *eucalyptus* plantations. These findings align with previous research by Bayle (2019), highlighting the environmental benefits of *eucalyptus*, and Yirdaw,(2001), who identified the presence of allelopathic chemicals in eucalyptus that can negatively affect soil and plant growth. In conclusion, this study demonstrates that while eucalyptus offers several ecological benefits, it also presents potential environmental challenges. It underscores the need for further research and careful management strategies to maximize the tree's ecological value while minimizing its adverse impacts.

Table 7. Ecological benefit of *Eucalyptus* tree in the study areas.

Variable	Descriptive	Agro ecology of the respond					
		High land		Mid land		Total percentages	
		N	%	N	%	N	%
own land	Yes	68	100	72	100	140	100
	No	0	0	0	0	0	0
prefer to grow *eucalyptus*	Yes	68	100	72	100	140	100
	No	0	0	0	0	0	0
Do you plant *Eucalyptus* on your land?	Yes	68	100	72	100	140	100
	No	0	0	0	0	0	0
Soil water conservation	Yes	21	80.8	19	57.6	40	67.8
	No	5	19.2	14	42.4	19	32.2

Source: Field Survey (2023/24)

3.6. Community perception of *Eucalyptus* on socioeconomic benefits and its impact on environment

The empirical findings of this study reveal a deeply positive perception of eucalyptus trees, particularly among those who own and cultivate them. A substantial 59.8% of respondents reported having prior knowledge or experience with *eucalyptus* production, demonstrating their familiarity with the tree's diverse uses, including its medicinal properties (Table 7).

Eucalyptus is viewed as an invaluable resource, with many residents referring to it as a "gift from God" and recognizing its significance for their livelihoods and well-being. Beyond its physical utility, eucalyptus symbolizes financial security and modern thrift, with its presence facilitating access to loans, highlighting its cultural and economic importance in these communities. The study shows that eucalyptus is regarded as beneficial across both highland and midland agro-ecological zones, with 100% of respondents acknowledging its value. No key differences were observed between zones, likely because its economic benefits, low-maintenance nature, and environmental advantages are widely recognized, and farmers in both areas have similar awareness and cultural acceptance of eucalyptus cultivation. The study is in line with a recent study conducted in the Jimma District of Northeastern Ethiopia which found that approximately 65.3% of farmers held a positive perception of eucalyptus plantations, recognizing their significant contribution to household income (Kebede& Chen, 2023). Similarly, research in the Gurage Zone of Ethiopia revealed that while households acknowledged the economic benefits of eucalyptus, they were also aware of its potential negative environmental consequences, including soil degradation and water depletion. Despite these concerns, farmers continued to plant eucalyptus to meet immediate cash and fuelwood needs, demonstrating a complex relationship between economic reliance and environmental apprehension (Kerbo, 2023).

Table 8.Community Perception of *Eucalyptus* Tree

Results of Questions asked during socioeconomic survey in percentages								
Agro ecology	Total number of respondents	is eucalypts use full		Future plan for *eucalypts* plantation		Effect of eucalypts on c		
						crop		
		Yes	No	Get coppice	Replace with other trees	Yes	No	Y
High land	68	100%	0%	100%	0%	60.3%	39.7%	94
Mid land	72	100%	0%	100%	0%	26.4%	73.6%	47

3.7. Hydrological impact of *Eucalyptus* tree

The findings of this study, derived from survey data analysis supported by FGDs and KIIs, indicate that respondents expressed greater awareness of the benefits of *eucalyptus* than of its potential negative impacts, especially regarding the hydrological cycle. This imbalance may be explained by the fact that many rural households directly experience and value the visible benefits such as income, soil conservation, and forest pressure reduction while the negative effects, particularly hydrological impacts, are less immediate and less understood by the community. (Table 9). While there are concerns about the tree's high water consumption, respondents emphasize *eucalyptus's* positive role in improving groundwater levels and moisture retention. *Eucalyptus* trees are valued for their ability to maintain soil moisture and recharge aquifers. The tree's structure, including its crown, branch arrangement, and leaf form, helps reduce evaporation, contributing to increased groundwater levels an important asset in water-scarce areas.

However, some respondents, informed by training and experience, cautioned that *eucalyptus* can negatively affect water resources when planted near wetlands or water source. Due to its high water consumption, particularly during dry periods, eucalyptus can lead to desiccation, reducing water availability for other vegetation and irrigation. This competition for water may lower the water table and disrupt the local hydrological cycle. These findings align with previous research by Jaleta *et al.*, (2016), which highlights the tree's water-intensive nature, and Rassaeifar *et al.,* (2013), who discuss both the positive and negative ecological impacts of eucalyptus, such as nutrient depletion, acidification, and excessive water use.

In conclusion, while eucalyptus trees provide significant ecological benefits in water retention and groundwater replenishment, there are concerns about their impact on water resources in certain areas. These mixed perceptions underline the importance of careful management and strategic planting to maximize the benefits while minimizing potential negative environmental effects.

Table 9.Hydrological impact of *Eucalyptus* tree

Variables	Description	Agro ecology of the respond				Total percentages	
		High land		Mid land			
		N	%	N	%	N	%
previous additional knowledge	Yes	29	42.6	50	78.1	79	59.8
	No	39	57.4	14	21.9	53	40.2
positive effect on the hydrological cycle	Yes	64	94.1	34	47.2	98	70
	No	4	5.9	38	52.8	42	30
negative effect on the hydrological cycle	Yes	4	5.9	38	52.8	98	42
	No	64	94.1	34	47.2	70	30

4. Conclusions and Recommendations

The findings, based on descriptive statistics supported by interviews and FGDs, revealed that eucalyptus cultivation is highly preferred by farmers due to its socioeconomic importance. Farmers primarily grow eucalyptus to cover household expenses such as government taxes, school fees, construction needs, and community contributions. Over the past decade, plantations in the district expanded by 96%, from 28.375 hectares in 2014 to 745.654 hectares in 2023. Nearly all respondents (99.3%) reported cultivating eucalyptus for its economic value, with 58.6% using it for home construction, 71.4% for fuel, and 87.14% for market products. Eucalyptus is also culturally significant, with 87.2% of respondents viewing it as a remedy for ailments, a symbol of modern savings, and a divine gift that provides financial security. However, 40.2% of growers reported negative effects, particularly hydrological issues such as drying of nearby water sources when trees are planted around wetlands and swamps.

Beyond household benefits, eucalyptus contributes to reducing pressure on natural forests, rehabilitating degraded lands, and conserving soil and water, while also providing habitats for wildlife. Negative effects, however, are largely linked to poor management rather than inherent

species characteristics. Proper silvicultural practices such as site selection, spacing, harvesting techniques, and rotation schedules—are essential to mitigate challenges. Perceptions of eucalyptus impacts were influenced by factors such as education level, settlement history, plantation site, and proximity to infrastructure, all of which affect household choices regarding woodlot establishment. An increasing number of farmers are replacing arable land with eucalyptus because of its high profitability, minimal labor needs, and strong urban market demand for poles, particularly along roadside areas. Nevertheless, community opinions remain mixed: while some recognize its ecological contributions, others raise concerns about its less well-understood hydrological effects, including the drying of wetlands and the depletion of groundwater resources.

Overall, eucalyptus has significantly improved rural livelihoods and local economies by supplying construction materials, charcoal, and fuelwood, while also offering ecological benefits when planted in appropriate locations. Its rapid growth, adaptability, and capacity to thrive on degraded lands make it a strategic resource in addressing declining natural wood supplies and growing energy demand. Despite these advantages, the study emphasizes that sustainable management and improved market linkages are critical to balance socioeconomic gains with environmental integrity. In this sense, eucalyptus remains both a livelihood asset and an environmental challenge, requiring policies and practices that enhance its benefits while minimizing adverse impacts.

To maximize the benefits obtained from eucalyptus while minimizing environmental harm, the study recommends creating awareness and promoting extension education for farmers and stakeholders about proper eucalyptus management, including site selection, planting spacing, and harvesting techniques. Technical training should emphasize both the advantages and limitations of eucalyptus cultivation, guiding land allocations for plantations and encouraging the adoption of environmentally friendly eucalyptus species. To mitigate negative impacts and enhance benefits, growers should prioritize planting eucalyptus on degraded lands, steep slopes, waterlogged areas, and roadsides while employing sustainable management practices. Farmers, being integral to balancing community needs and environmental health, should be valued as key contributors to eucalyptus-related decisions, and forestry extension agents should collaborate closely with them. Additionally, the government should invest in road infrastructure to reduce transportation costs, enabling households to better benefit from eucalyptus woodlot products, and develop technical manuals on *eucalyptus* management and utilization. Expanding

eucalyptus plantations as woodlots is also recommended to alleviate pressure on natural forests and support sustainable forestry practices. While the study provides important insights, several areas remain unexplored and warrant further investigation including long-term ecological impacts, water resource dynamics, economic trade-offs, socio-cultural perspectives, climate change mitigation potential, sustainable management practices, Policy and governance frameworks, health and livelihood diversification are required.

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Conflict of interest

The authors declare no conflict of interest related to this paper.

Consent to Participate

All participants were informed about the purpose, procedures, potential benefits, and possible risks of the study prior to their participation. Participation in the study was entirely voluntary, and participants were informed of their right to refuse participation or withdraw from the study at any time without any penalty or loss of benefits. Written (or verbal, where applicable) informed consent was obtained from all participants before data collection. Confidentiality and anonymity of participants were assured, and all information provided was used solely for research purposes.

Consent for publication

The authors have agreed to submit and approved the manuscript for submission.

Data availability

Data will be available on request from correspondent author

Authors' contribution

M.D. collected data and wrote the 1st draft Manuscript, S.M. supervised the data collection and Writing – review & editing.

Statement fo final approval

We, all authors have approved the final version of the manuscript for submission

Ethics approval and consent to participate

Permission to collect data was obtained from Ambo University Institutional Research Ethical Committee (AUIREC) through a written letter with reference number AUIREC /007/13/2022 and. Informants had agreed and signed the informed consent before starting the survey and the interview.

Clinical Trial Number

Not Applicable

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