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Management Practices and Economic Contribution of Eucalypts Woodlots to the Rural Household Livelihoods: The Case of Cheha District, Southern Ethiopia

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ABSTRACT

In Ethiopia rural households growing Eucalypts at farm level in the form of woodlot become popular and Eucalyptus woodlot products play a significant role in household economy in particular and economic development of the nation in general. This study was conducted in Cheha districts in the Guraghe zone to assess the farmers' management practices and analyze the socioeconomic contribution of Eucalypts woodlot to the livelihood of the rural households in the area. Economic data was collected by employing a formal survey using a structured questionnaire. Woodlot inventory was conducted on farmers' eucalyptus woodlots to identify the existing trees' frequency distribution by diameter classes that indicated economic value. The latest version of Stata, version 13, SAS version 9.1, sigma plot version 12, and Microsoft Excel were used to analyze the data. The result of the study revealed that most of the sampled farmers in the study area had Eucalypts woodlot, targeting either to earn more income or to increase the productivity of the land which has denied growing cereal crops and pastures. Most of the farmers considered Eucalypts as one of the major sources of income and risk aversion. Excluding household consumption, the aggregate cash income contribution of Eucalypts woodlot products to rural households was more than 34% for midland and 37% for highland agro-ecologies. Further studies are needed on the management aspect of Eucalypts woodlots for the productivity of allocated land.

INTRODUCTION

The introduction of eucalypts by Europeans to East Africa seems to have followed the seriousness of forest decline and the emergence of wood deficit in these countries (FAO 2009; Forests and Papers, 2011). In Africa, South Africa has the largest area under *Eucalypts* plantations, about half a million hectares. The rapid expansion of Eucalypts in most tropical countries has been due to its fast-growth nature and browse-resistance, ability to coppice, and straightness of the stems (Boulay et al., 2012; Vance et al., 2014; Whittock et al., 2003) and the wide range of products, including firewood, charcoal, building materials, fencing posts, transmission poles, pulpwood, timber and plywood (Neonila & Zibtsev, 2010; Oballa et al., 2010).

In Ethiopia, *Eucalypts* was first introduced in 1895 by King Menelik the 2nd to address the ever-increasing demand for construction poles and firewood, especially in Addis Ababa (Birara et al., 2019). Currently, *Eucalyptus* is an integral part of the Ethiopian farming system as an economically important tree species (Jaleta et al., 2016; Pohjonen & Pukkala, 1990), and the most widespread are *Eucalyptus camaldulensis, Eucalyptus citriodora, Eucalyptus globulus, Eucalyptus regnans, Eucalyptus saligna*, and *Eucalyptus tereticornis* (Shi et al., 2012). These plantations cover 506, 000 hectares in Ethiopia (Forests and Papers, 2011) and inhabitants are dependent on them as a source of subsistence and cash income (Asfaw, 2012; Tadesse & Tafere, 2017). However, from those listed above, *Eucalyptus globulus* in the highlands and *Eucalyptus camaldulensis* in the lowlands have been easily adapted and they are also the most

preferred species by Ethiopian farmers (Adimassu et al., 2010).

Previously farmers grew and expand Eucalyptus on marginal croplands, farm boundaries, and home gardens as agroforestry practice (Kebebew, 2010). However, current trends show the transition of annual and perennial croplands into Eucalyptus woodlots (Jenbere et al., 2012; Lemenih & Kassa, 2014). Furthermore, smallholders tend to establish Eucalyptus plots in their productive lands (Gebretsadik, 2013; Mekonnen, 2012). Some of the reasons for the transitions are the justifiable income, land certification, minimal operational costs than crop production, fast growth, declining farm productivity, rising agricultural input costs (Kebebew, 2010), and due to growing economy and increased demand for wood products, it remains to be the desired species that grow fast and produce wood to meet the demand of wood for fuel, construction, and furniture materials (Aklilu et al., 2019; Seng Hua et al., 2022). On the other hand, the production and commercialization of raw materials for the pulp industry with Eucalyptus plantations provide an economic view (Dessie, Abtew, and Koye, 2019; Silva, Elias, and Miranda, 2020).

Thus, the introduction of this fast-growing species in Ethiopia is considered to be effective and perhaps partly safeguarding the huge wood demand in the country for energy and construction wood (Birara et al., 2019; Shi et al., 2012). Similarly, smallholder farmers in Southern Ethiopia of the Guraghe highlands are growing Eucalypts woodlots as a major tree species on their farmlands. However, hard to find sufficient information on the potential livelihood contribution of the expanding Eucalyptus plantation in terms of woodlot management practices and income generation in the study area. Therefore, this study aimed to scrutinize the applied management practices for these plantations and their contribution to the local livelihoods.

MATERIALS AND METHODS

Study Area

The study was conducted in Cheha District, Guraghe Zone, Southern Nation Nationalities, and People Regional State. It is about 186 km Southwest of Addis Ababa and 30km from the Zonal capital town of Wolkete. The district town is known as "Emdibir". The geographical location of the study area is between 8° 00' 18" and 8° 15' 28" N and 37° 35' 46" and 38° 03' 59" E and the average elevation ranges from 1500-2800 meters (Profiles 2009; Wereda, Zone, and Semere, 2019).

The agro-climate classification of the district covers Dega (20%) and Woynadega (80%) areas and the rainfall is bimodal. The short rainy season ("Belge"), which extends from March to May allows the production of crops such as Wheat, Barley, and potato. While the long rainy season ("Meher") which extends from June to mid-September supports the production of almost all crops grown in the area. The mean annual rainfall ranges between 900–1500 mm, while the mean, maximum, and minimum annual temperature of the District are 22.5ºc 27 ºc, and 18 ºc, respectively (Profiles, 2009; Wereda, Zone, and Semere, 2019).

The soils of the study area are light brown, black, and reddish with loamy-clay textural classes. They are fertile and are highly suitable for cereal and vegetable production**.** However, there is severe erosion in the area due to the undulating nature of the landscape and the poor land management practices of the farmers (Adimassu et al., 2010). Since the landscape has lost its natural vegetation, the soils of surrounding hills are eroded and degraded, with frequent rock outcrops (Profiles, 2009; Wereda, Zone, and Semere, 2019). The landscape varies from undulating highlands to gentle gradients and plains in the lowlands. The mid-altitude of the landscape has a unique climatic opportunity for the cultivation of a wide variety of crops (Profiles, 2009). Farmers grow eucalypts around homesteads, farm boundaries, and on-farm woodlots for various purposes. Correspondingly, native trees such as *Acacia* spp., *Croton macrostachyus, Cordia africana*, *Ficus sur*, and other shrubs are rarely obtainable in the landscape of the study area. Forest coverage in the District consists of communal forest (37.1 ha), conserved natural forest and bush land (753 ha), and Bamboo (80 ha) (Profiles 2009; Wereda, Zone, and Semere, 2019).

Cheha District is a densely populated area. The livelihood profile is classified under the "Guraghe-siltie Enset-cereal-Chat-livestock" based livelihood. However**,** the generating amount of cash is quite low due to the limited landholdings of households for farming (crop and livestock) practices. The population is partly dependent on remittances from household members working outside their living

area. Furthermore, future livelihoods are under pressure from rapid population growth and shrinking landholdings of many households (Profiles, 2009).

Research Design

Various research approaches were utilized to obtain the required primary and secondary data to address the study objectives. A reconnaissance survey and informal discussions with a few farmers, rural development agents, kebele leaders, and forestry and agricultural personnel were conducted to get the overall picture of the study area to facilitate the actual study. Through household and biophysical surveys, major socioeconomic activities and management of eucalyptus woodlots were identified. These are the farming system, Eucalypts plantation activities, market, and livelihood strategies of the farm households in the context of the study area's specific biophysical, social, and cultural settings. Additionally, key informant interviews and focus group discussions were employed. The relevant primary data collections were complemented with secondary data gained from relevant published and unpublished sources.

Sampling and Sample Size

Cheha district has consisted of thirty-nine kebeles of which the study focused on purposively selecting two kebeles named, "Yefersye" from the midland and "Moche" from the highland agro-ecologies of the district. The basis for this selection of sample kebeles was based on the intensive expansion of Eucalypts woodlots on the agricultural land of the households. Moreover, the sampling strategy employed in the study was stratified random sampling based on wealth categories that were locally developed by key informants and kebele leaders. The household respondents from each wealth category were selected randomly. The sample size of respondents was calculated by the simplified formula of Yemane (1967) with a 95% confidence level and 0.05 level of precision.

$$n = \frac{N}{1+N(e^2)}$$

Where n is the sample size, N is the population size (total number of household heads), and e is the level of precision.

Table 1. Selected kebeles and number of households sampled for the study

HHs	Kebeles		Total number of HHs
	Yefersye	Moche	
Agroecology	Midland	Highland	
Total HH	500	540	1040
Sampled HH	50	54	104

Two separate focus group discussions were conducted in each kebele, one with agricultural office experts and another with farmers, and each group contained six to eight members. Knowledgeable individuals on the expansion and contribution of Eucalypts woodlots were selected. The discussions were guided by a facilitator. Key informants of 10 to 15 individuals were selected based on the level of expected knowledge about the local conditions, livelihoods, and their long residence in the local area.

The woodlots, in each wealth category of households were counted and diameters were measured from all trees. The diameter classes were determined according to the economic value of trees by farmers and estimated the concentration of diameter class distribution across wealth categories.

HHs Survey, KII, and FGD

Data from the household survey were collected using a structured and semi-structured questionnaire. The collected data are household demographic and socio-economic conditions including market information, livelihood strategies, and Eucalypts woodlot management practices. Enumerators were trained to conduct the survey and the questionnaire was pretested before the actual survey to get feedback from the few households independent from the actual samples and the feedback correction was made based on the information received. FGDs have identified and described the shared information of livelihood systems in the communities, such as Eucalypts woodlot management practices, their expansions, and contributions. Key informants were organized

and collected additional relevant data which are missed during a household survey and FDGs.

Data Collection

Both qualitative and quantitative data were collected in this study. These required data were collected from both primary and secondary sources. The primary data was the main source of data obtained from sample households, focus group discussions and key informants. Whereas, secondary data were collected from the relevant sources of published and unpublished documents.

Data Analysis

The collected data were analyzed using Microsoft Excel, Stata version 13, sigma plot version 12, and SAS version 9.1, Statistical Software. Descriptive statistics such as mean, percentage, and frequency were employed.

RESULTS AND DISCUSSION

Household (HH) Characteristics

Household characteristics comprise the household demographic (gender, age, education, and marital status) characteristics and livelihood assets. About the gender of household respondents, 85.6% of the overall interviewed respondents were male-headed. The mean family size in the midland agroecology was 5.91 and 5.74 in the highland agroecology, and the overall mean family size was 5.83 persons, which is higher when compared to the regional (5.5 person per HHs) and the national rural family size (5.1 persons per HHs). Regarding the educational status of household respondents, about 61% of HHs in the midland agroecology and 38.9% in the highland agroecology lack formal education while the remaining attended primary, secondary, and preparatory levels of education.

Livelihoods Assets

Land Holding

Land and livestock ownerships were some of the major livelihood assets of households. The findings reported that variations appeared in the ownership of land by HHs. These variations ranged between 0.38 and 3ha (the mean was 1.01ha) in the highland while between 0.56 and 3ha (1.23ha) in the midland. Moreover, variations in the landholding of households are also outlined among wealth categories in different agroecology. In the midland, the land holding was 0.78ha for the poor, 1.12ha for the medium and 1.93 ha for the rich. While in the highland land holding was 0.69ha for the poor, 1.08ha for the medium, and 1.95ha for the rich.

Livestock Rearing

The major livestock in the district were cattle, sheep, and horses. The number of livestock in the sample households is estimated to be 2.41 in the highland and 3.88 in the midland agroecology, in terms of tropical livestock unit (TLU).

Eucalyptus Woodlots

The other important HHs livelihood asset was Eucalyptus woodlots in the study area. The land allocation for the woodlots differed between agro-ecologies and among wealth categories. The allocated plots for woodlots in the midlands were slightly larger in size (mean, 12.21% of the total land owned) as compared to those in the highlands (9.10%). Regarding wealth status, rich households allocated relatively larger plots of land to eucalyptus woodlots compared to the middle and poor. Among wealth categories, rich households in both agro-ecologies had larger woodlots as compared to poor and medium households.

The total number of Eucalypts trees owned by households and counted on their respective allocated lands varied with agro-ecologies and across wealth categories. During the survey, midland HHs on average owned 512 (3133 trees/ha) (Figure 2) while in the highland 573 (3439 trees /ha) were counted (Figure 3). Regarding wealth categories, the possession of trees in the allocated lands of HHs was increasing with the status of wealth categories. Thus, better-off HHs usually owned a greater number of trees, 662 (3513 trees/ha) in the midland (Figure 1) and 829 (4308 trees/ha) in the highland (Figure 2).

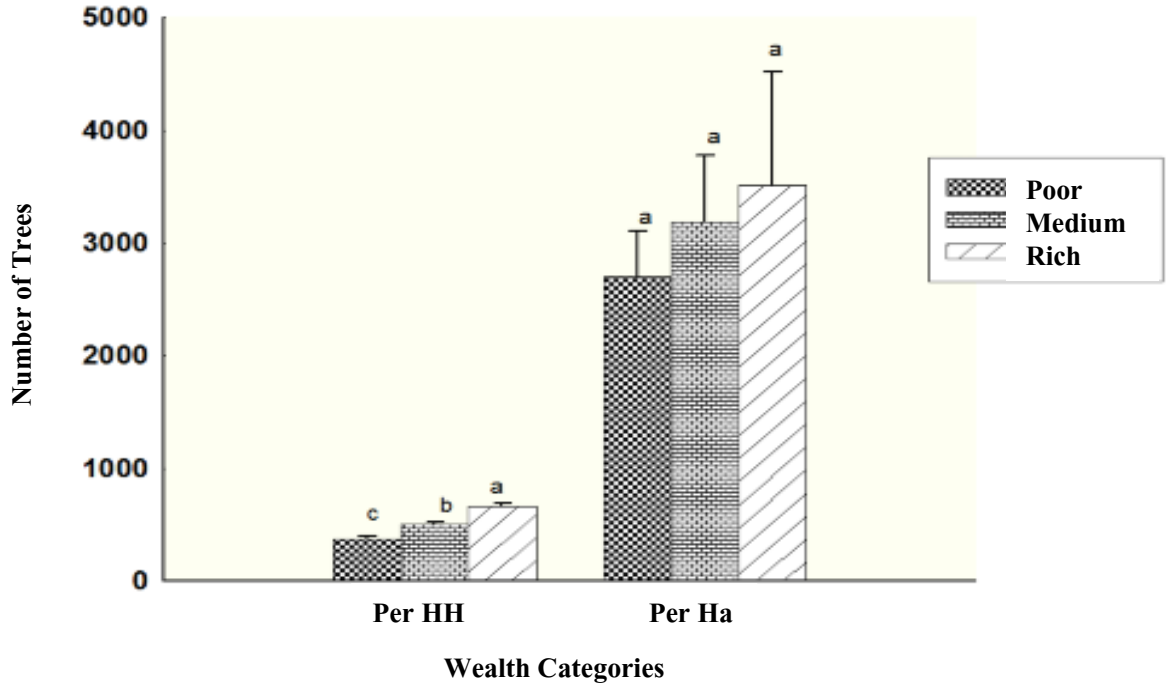

Figure 1. The average number of trees (and SE) per HH and per hectare in the midland agroecology of Cheha Districts, SNNPRS, Ethiopia.

On the other hand, poor and medium HHs in midland owned 372 (2701 trees/ha) and 503 (3186 trees/ha) respectively. Similarly, in the highland, the poor had 358 (2842 per ha) Eucalypts trees and the medium had 533 trees (3168 trees/ha). These show that in both agroecological zones the richer households allocated larger proportion of land for Eucalypts woodlots because they have sufficient land to set aside for the emerging economic advantage of the HHs.

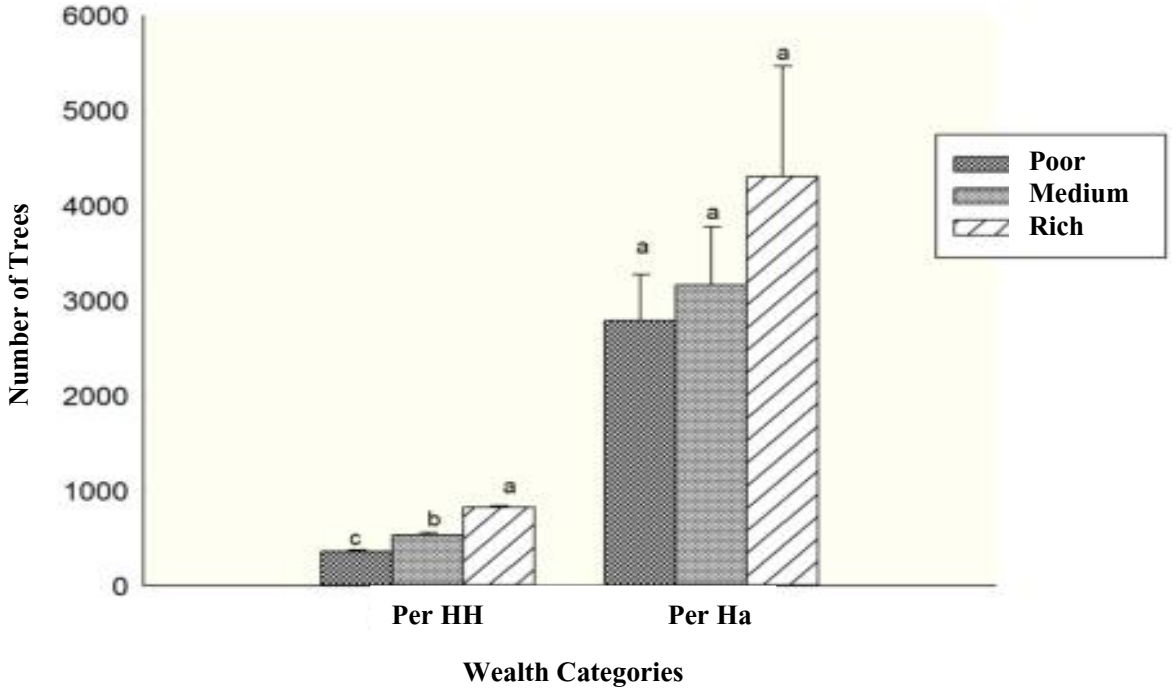

Figure 2. The average number of trees (and SE) per HHs and per hectare in the highland agroecology of Cheha District, SNNPRS, Ethiopia

The distribution of diameter classes of Eucalypts trees across wealth categories and agroecology is depicted in Figure 3 and 4 below. In both agro-ecologies, the diameter class of 4cm–7.99cm was dominating in all wealth categories. However, statistical variation of the mean number of trees for this dominant diameter class was seen only in the highlands between the rich and poor, and the rich and medium wealth categories of HHs. In general, the distributed number of trees in each diameter class was increasing with wealth status except in both agroecology of the lowest diameter class. The largest disparity of diameter class distribution in the numbers of trees between rich and the other two categories were investigated in the diameter classes of 8-9.99cm and 10-13.99cm. So, the overall trend of this distribution across categories in the highland agroecology shows that the rich HHs retained Eucalyptus trees on the allocated plots until they attain the required merchantable size (large diameter) for high economic return while both poor and medium HHs harvest and sale trees at the early stage with low market value to fulfill their immediate needs (Figure 3 and 4).

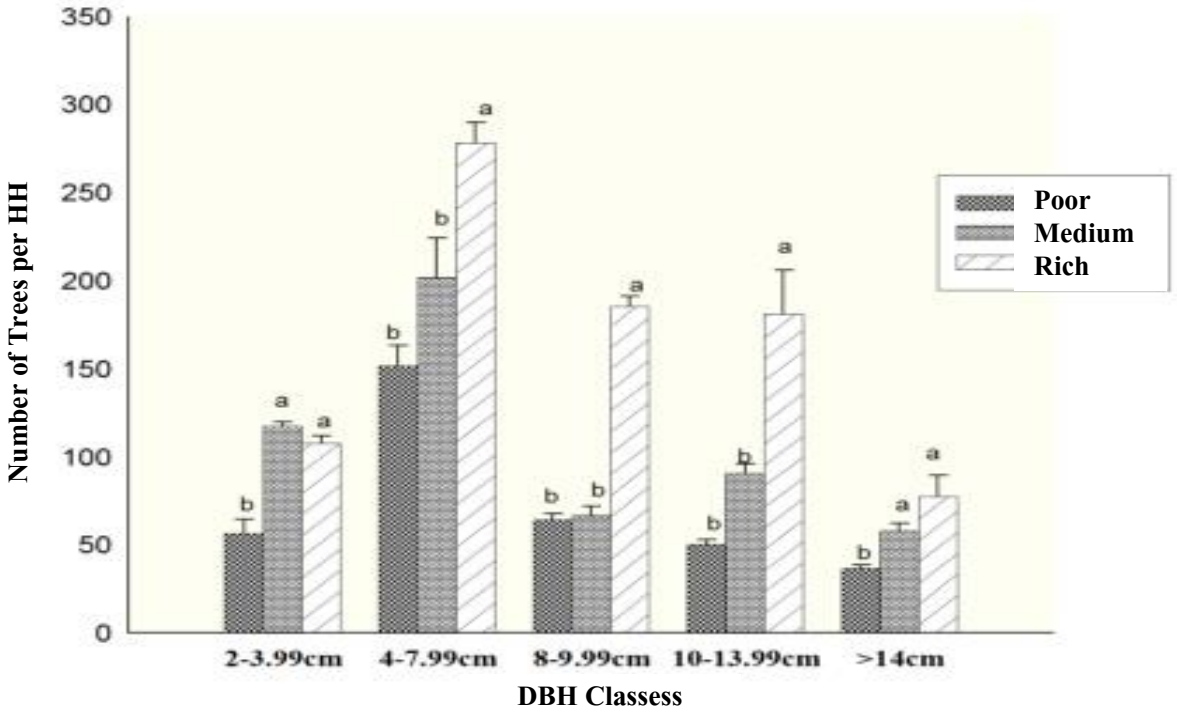

Figure 3. Diameter class distribution of Eucalypts across wealth categories in the highland agroecology of Cheha district, SNNPRS, Ethiopia

Similarly, in the case of midland agroecology, a greater number of trees were found within the diameter class of 4.0-7.99cms, while the least number of trees were in the diameter class of above 14 cm (Figure 4). In a similar fashion as the highland did, in the Midlands, across wealth categories. The trees in each diameter class increased with wealth status except in the lowest diameter class of 2.0-3.99cm. Moreover, in this agroecology, the largest disparity in the distribution of trees was recorded, between the rich and the other categories (medium and poor), in the two diameter classes of 8.0-9.9cms and 10.0-13.99cm (Figure 3).

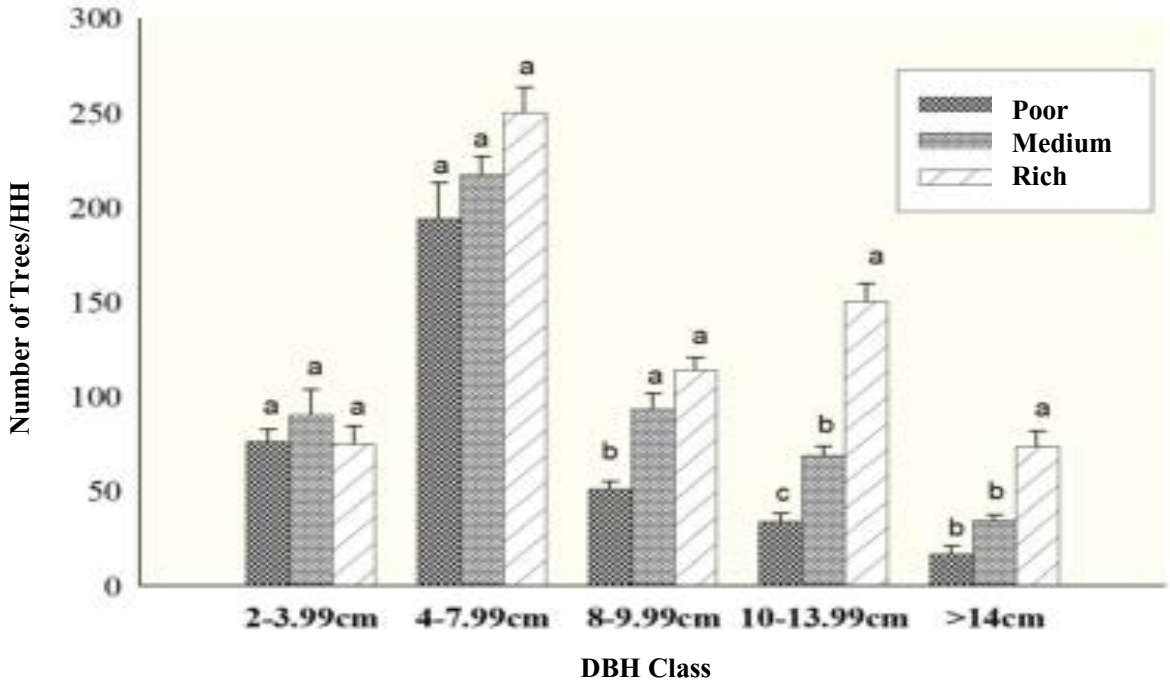

Figure 4. Diameter class distribution of Eucalypts across wealth categories in the midland agroecology of Cheha district, SNNPRS, Ethiopia

Management and Marketing Practices of Eucalypts Woodlots in the Households

Sources of Eucalypts seedlings were mainly from private and government nurseries and marketplaces. The findings indicated that 79% of HHs were producing their own seedlings to establish their own woodlots, whereas 20% of them were purchasing from marketplaces and the remaining of them used government nurseries. The survey results also revealed that most of the HHs (97%) have established their own woodlots using bare-rooted seedlings due to unbearable additional costs. However, as the KIs stated the survival rate of seedlings has been unsatisfactory.

In the study area, HHs usually prepare planting sites before planting time. Usually, May have been the right month of the year to commence site preparation (cleaning and digging holes) for planting. The method of preparation of planting sites varied from farmer to farmer, some do complete hoeing and repeating three times before planting and others were simply digging holes in a specified spacing.

Across HHs, the spacings for planting seedlings were irregular and varied from 0.5m to 1m. The majority of HHs adopted a spacing between 0.5m*0.5m to 0.7m*0.7m for planting during woodlot establishment (Table 2).

Table 2. Common spacing adopted by HHs in the study area

No.	Spacing	Percent
1	<0.50*0.50m	3
2	0.51*0.51m to 0.70*0.70m	42
3	0.71*0.71m to 0.99*0.99m	39
4	>1*1m	16

Source: authors' survey

The survey result shows in both agroecologies the niche of tree planting was roadsides (17%), crop fields (27%), grazing land (24%), unproductive degraded land (21%), and along the river (11%). The size of woodlots ranged between 0.01–1.5 ha across HHs.

The practice of woodlot establishment methods of the HHs was similar across agroecology. Step by step on annual bases and complete planting at once are the methods of establishing woodlots. In the midland, a greater number of HHs (41%) were practicing step-by-step methods in a smaller plot every year compared to the highland HHs (35%). On the other hand, more HHs (65%) in the highland were engaged in a complete planting manner at once compared to the

59% of households in the midland. In both agro-ecologies, the preference of HHs to establish woodlots at once was due to a lack of land and planting knowledge, on the other hand, they dividing their lands for allocating smaller plots for woodlots was targeting a continuous annual harvest to satisfy the required income demand.

In relation to the post-planting management of Eucalyptus woodlots, the majority of households were not satisfactorily engaged in silvicultural practices in both agro-ecologies. In addition, FGDs and KIs interviews also revealed that government extension services are minimal in terms of forestry and lack of training on planting and marketing is also crucial in the study to manage quality woodlots.

For harvesting woodlot more than half (56%) of the woodlot owners used a selective cutting (felling) system while the rest (44%) used clear cutting system. However, the majority of woodlot owners, 70% in the highland and 73.6% in the midland, and mainly the poor households did not harvest in accordance with their established objectives. For the majority of households (64.5%), the harvesting system did not consider the coppicing of the stump. They considered the immediate cash needs and market prices. Most of the HHs (69%) in the highland and midland agro-ecologies harvested Eucalypts whenever there was a need for wood for personal consumption and for sale any time of the year.

In relation to the final harvesting, the majority of HHs (77%) waited 4-7 years to get the first harvest of Eucalyptus with an average diameter size of 5-8cm. While the rest practice either before the 4^{th} year of age with a minimum diameter of 3cm or after the 7^{th} year of age with a maximum diameter of >14cm, for household wood consumption. Moreover, out of the 77% of HHs, about 41% and 36% of them are keeping the woodlots for 4-5 years and 6-7 years to get the first harvest, respectively.

Marketing and generating cash were other important dimension of HHs besides the use of wood for subsistence. Thus, the majority (78.6%) of HHs obtained market information from forest product traders while the rest (21.4%) from their neighbors. The most preferred trading practice for wood products, by 63.9% of woodlot owner HHs, was on the stumpage area while others (36.1%) sale at the roadsides. Among the roadside seller, three fourth were poor HHs. Additionally, the study revealed that about 55.5% of HHs woodlot in the highland and 70% in the midland sell their forest products by the method of stand estimation while the rest sell per piece of the product. Based on FDG, KIs, and market surveys the prices of Eucalypts products have been determined by the various assortments and considering their quality as straightness and the required standard heights.

Household Livelihood Strategies

The livelihood activities of the sample households were both on-farm and off-farm. On-farm activities are the major means of subsistence and cash for the households in the farming system. These activities include production of annual and perennial crops and livestock rearing. In the midlands, the major annual crops grown were maize, teff, wheat, barley, and potato. From perennial crops, enset, chat, coffee, and Eucalyptus are recognized. On the other hand, in the highlands, wheat, barley, faba bean, and potato are the major crops grown. Perennial crops are enset and Eucalypts woodlots in the highlands. Livestock rearing in both agro-ecologies has been a common practice and most HHs are keeping cattle, small ruminants (sheep and goats), equines (donkeys and horses), and poultry for own use and sale. Off-farm activities were also one of the important livelihood activities in both agro-ecologies. The survey result showed that most sample households (75.9%) in one way or another participate in off-farm and non-farm livelihood activities. Remittance, petty trading, and handcrafting are also important incomes for the HHs.

Household Income Sources and Their Relative Contribution

The survey result showed that the main sources of cash income for all wealth categories of HHs were annual crops, perennial (chat and coffee) crops, livestock, non/off-farm work, and the sale of wood products from Eucalyptus woodlots. The major cash income sources and their relative shares to households are depicted in (Table 3). On average, HHs in the highlands have received a large share of cash income from Eucalypts products (37.7%), followed by annual crops (23.5%) and off-farm activities (21.4%). Similarly, in the Midlands, the major sources of cash income were the sale of Eucalyptus (34.9%), and coffee and chat (24.5%). Thus, the contribution of Eucalyptus woodlots for

rural households is statistically varied across agro-ecologies and wealth categories especially between the rich and the other two categories in both agroecologies (Table 3). Conversely, other interesting results also revealed for off-farm cash income of households in both agro-ecologies and identified statistically higher cash income for poor and medium households than that of the richer.

Table 3. Mean annual household cash income by livelihood activities

Agro-ecology	Wealth	Sources of income in (ETB)									
		Annual Crop		Perennial crop (Chat & coffee)		Livestock		Off-farm		Eucalypts woodlot products	
		Mean± SE	%	Mean± SE	%	Mean± SE	%	Mean± SE	%	Mean± SE	%
Highland	Poor	1364±239^{b}	16.9	-	-	756±186^{b}	9.37	2893±337.90^{a}	35.8	3053±1034.35^{b}	37.8
	Medium	2757±433.75^{a}	23.5	-	-	1604±292.53^{b}	13.7	3350±654.51^{a}	28.6	3995±807.20^{b}	34.1
	Rich	3427±932.92^{a}	27.7	-	-	3183±1150.4^{a}	25.8	680±488.26^{b}	5.5	5052±1380^{a}	41
	Overall	**2199±259.42**	**23.5**	**-**	**-**	**1416.5±228.6**	**17.2**	**2292±331.64**	**21.4**	**2197.68±556.72**	**37.7**
Midland	Poor	1647±333.71^{b}	14.9	2554±625.7^{b}	23.1	1064.6±567^{b}	9.62	2576.11±547^{a}	23.3	3223±924.5^{b}	29.1
	Medium	1757±438.68^{b}	10.2	4869±1144^{a}	28.4	2656.96±580^{a}	15.2	2421.47±477^{a}	14.1	5460±1048.50^{b}	31.8
	Rich	4084.6±791.5^{a}	21.4	5084±1411^{a}	22.2	2253±613^{a}	9.8	1442±654.25^{b}	6.3	9160±1752.68^{a}	40
	Overall	**2333.6±335.2**	**16.2**	**4510±690.8**	**24.5**	**2137.90±359**	**11.7**	**2207±319.48**	**12.6**	**4131.68±689.67**	**34.9**

Note: Different letters following vertical mean values indicate significant differences between wealth categories within each agro-ecologies ($P<0.05$) at the study area

Management Practices of Eucalypts Woodlots

Appropriate management techniques could improve the social, economic, and environmental consequences of the use of Eucalyptus in Ethiopia (Aklilu et al. 2019; Region and Mekonnen 2010; Romero and Feijoo 2009). In the study area, almost all HHs established Eucalyptus woodlots (0.0l to 1.5 ha per HHs) mainly for subsistence and cash income generation. The survey result shows that acute land shortage and decline of crop and livestock productivity, most of the households have converted croplands (27%), grazing lands (24%), and unproductive degraded lands (21%) to Eucalyptus woodlots.

With regard to HHs methods of woodlot establishment, lack of knowledge and extension services by the government (survey results and FGD) negatively affected the desired annual income generation. Thus, more than half of the woodlot owners have established their own woodlot at once on their allocated land area. While few were decided by dividing their allocated land for Eucalyptus woodlots into smaller units and establishing them step by step annually to get a continuous annual harvest, which is important for proper management of woodlots and securing the regular yearly income generation. Participants of focus group discussions also confirmed the advantage of annual planting of Eucalypts by dividing allocated land into smaller units of land. Similar studies, from the central part of Ethiopia and South Wollo revealed that households had no government extension services related to woodlot management to promote productivity (Jenbere et al., 2012; Lemenih & Kassa, 2014). Conversely, without government intervention, the expansion of woodlots made progress independently based on the available market in the local area. Most of the woodlot owners were unsure about the proper management of their trees. Most of the HHs were practicing irregular patterns of spacing between seedlings during planting. The majority of HHs used bare-rooted planting material for the plant. Which, contributed to low survival rates of Eucalyptus seedlings and became costly to farmers in repeat planting plots with new seedlings in the same planting areas. Findings also show that most woodlot owners traditionally practice irregular spacing of seedlings and overstocking of Eucalypts woodlots is common (Derbe et al., 2018; Ferraco et al., 2019; Gebretsadik, 2013). Therefore, this is an indication of the diagnostic factors that need improvement through capacity building (awareness and training) on the management aspects of establishment and post-planting management (for example weeding at the early age of the woodlots, thinning and coppice management are missing) of woodlots to improve the quality and quantity of wood products targeting to enhance the amount of income generated within the expected frame of rotation from the woodlots. Similarly, proper management plantation helps to improve

environmental and socioeconomic benefits (Alemayehu & Melka, 2022; Kuppusamy et al., 2019).

With respect to the number of Eucalyptus trees managed in the allocated plots of households across wealth categories, the rich always have more trees compared to the medium and poor categories. However, in terms of the density of trees in hectare bases, no differences were revealed across wealth categories. This indicates that poor categories of households with limited allocated land possess a high density of Eucalyptus plots than the rich and middle categories. Similarly, HHs with small landholdings have established more Eucalyptus woodlots with higher density than HHs with sufficient landholding (Abiyu et al., 2016; Birhanu & Kumsa, 2018). Moreover, the frequency in diameter class distribution of trees across wealth categories shows that the rich HHs retained large diameter classes of trees and have high economic returns than the poor had, in most cases, poor households harvest small trees at low prices to respond partly the cash demand for severe food gap they have. Similar findings elsewhere in Ethiopia were also reported (Daba, 2016; Mekonnen, 2012; Zegeye, 2010).

The survey witnessed that rich HHs are so careful and market sensitive than other households in managing and harvesting Eucalyptus woodlots since they can afford to keep for the required rotation targeting to earn higher incomes. However, the poor households select and harvest individual trees whenever they are in need of cash without considering the optimal financial HHs in the highland parts of Ethiopia usually harvest trees when immediate financial problems arise such as the death of plowing oxen and crop failure in the household (Otuba, 2012; Region & Mekonnen, 2010).

Contribution of Eucalypts to the Rural Livelihoods

Rural households depend on a number of income portfolios for living. In the study area, crop production (annual and perennial), animal husbandry, forest (particularly Eucalypts plantation) and non/off-farm/activities are the mainstay of livelihood strategies of the households. In the study area Eucalyptus woodlot production is expanding and becoming the leading source of livelihood in the local area. Eucalyptus provides a diverse contribution to rural households in terms of income generation, as alternative sources of energy, construction material (house and fencing), and for manufacturing furniture and farm implements.

The overall annual cash income of Eucalyptus in the highlands contributes considerably about 41% for the wealthy, 34% for medium, and 37% for the poor households, with an aggregate average annual income of 37%. Similarly, in the midland areas also it contributes about 40% for the wealthy, 31% for the medium, and 29% for the poor, with an average annual cash income (34%) of households. Similarly, in Arsi Zone and in North Shewa Eucalyptus woodlot products contribute 28% and 20% of the household's total cash income, respectively (Mekonnen, 2012). Similarly, (Warkineh et al., 2021) reported that in Ethiopia, planting eucalypts have a significant contribution to household income.

In the highland parts of Ethiopia, Eucalypts contribute about 50% of the total income of smallholder rural households (Kebebew, 2010; Jagger & Pender, 2000; Tadesse & Tafere, 2017). Eucalyptus products have substantial potential to raise farm households' incomes and in turn, reduce poverty, increase food security, and diversify smallholder farming systems in less-favored areas. Additional advantages of Eucalypts woodlots for the rural households in the study area is articulated in terms of energy use and construction material. The majority of eucalyptus woodlot products are used for energy sources and construction (Kebede, 2022) and many people in Ethiopia are absolutely dependent on Eucalyptus for fuel wood, construction wood, and income generation (Gil, Tadesse, and Tolosana n.d.; Pohjonen & Pukkala, 1990).

CONCLUSION

Eucalyptus provides superior and versatile benefits in short rotation and farmers often choose to plant eucalyptus in the form of woodlots in various niches, especially on farmlands of the study area. Households consider Eucalyptus woodlot as a form of financial security to bridge any form of unexpected shocks particularly when there is a shortfall in agricultural production and safeguard and minimize risk during food shortages.

However, the improved benefit of Eucalyptus woodlots in terms of cash to households should

depend on the proper woodlot management practices. In the study area, the management principles of Eucalyptus woodlots must be in place with the help of forest agencies in the government structure. Thus, proper planning and market accessibility are the most important dynamics in the production of Eucalyptus trees to enhance the income level of rural households particularly to support the poor categories with limited landholding in the study area rotation age.

REFERENCES

Abiyu, Abrham, Demel Teketay, Georg Gratzer, and Maru Shete. (2016). Tree Planting by Smallholder Farmers in the Upper Catchment of Lake Tana Watershed, Northwest Ethiopia. *Small-scale Forestry*, 15(2), 199–212.

Adimassu, Z, Aad Kessler, C Yirga, and Leo Stroosnijder. (2010). Mismatches between Farmers and Experts on Eucalyptus in Meskan Woreda, Ethiopia. *Proceeding of the conference on Eucalyptus species management, history, status, and trends in Ethiopia* (15-17 September 2010), Ethiopian Institute of Agricultural Research, Addis Ababa, Ethiopia.

Aklilu, Bajigo Madalcho, Lemma Bekele, Mesene Mena Merkineh, and Barana. (2019). Is the Expansion of Eucalyptus Tree a Curse or an Opportunity? Implications from a Dispute on the Trees Ecological and Economic Impact in Ethiopia: A Review. *Journal of Ecology and The Natural Environment*, 11(6), 75–83.

Alemayehu, Asabeneh, and Yoseph Melka. (2022). Small Scale Eucalyptus Cultivation and Its Socioeconomic Impacts in Ethiopia: A Review of Practices and Conditions. *Trees, Forests and People*, 8(May), 100269.

Asfaw, Araya. (2012). *Sustainable Household Energy for Addis Ababa*, 8, 1–11.

Birara Dessie, Abebe, Tadie Mire Abate, and Taye Melese Mekie. (2019). Eucalyptus: The Popular Exotic Tree Crop in Ethiopia. *Acta Scientific Agriculture*, 3(9), 50–56.

Birhanu, Silenat, and Fikadu Kumsa. (2018). Review on Expansion of Eucalyptus, Its Economic Value and Related Environmental Issues in Ethiopia. *International Journal of Research in Environmental Science*, 4(3), 41–46.

Boulay, Axelle, Luca Tacconi, and Peter Kanowski. (2012). Drivers of Adoption of Eucalypt Tree Farming by Smallholders in Thailand. *Agroforestry Systems*, 84(2), 179–89.

Daba, Mekonnen. (2016). The Eucalyptus Dilemma: The Pursuit for Socio-Economic Benefit versus Environmental Impacts of Eucalyptus in Ethiopia. *Journal of Natural Sciences Research*, 6(19), 127–37.

Derbe, Tegegne, Sisay Yehuala, and Genanew Agitew. (2018). Factors Influencing Smallholder Farmers Adoption of Eucalyptus Woodlot in Wogera District, North Gondar Zone, Amhara Regional State of Ethiopia. *International Journal of Scientific Research and Management*, 6(07).

Dessie, Abebe Birara, Asmamaw Alemu Abtew, and Abebe Dagnew Koye. (2019). Determinants of the Production and Commercial Values of Eucalyptus Woodlot Products in Wogera District, Northern Ethiopia. *Environmental Systems Research*, 8(1).

FAO. (2009). *The Socio-Economic and Environmental Issues, FAO Sub-Regional Office Eastern Africa*. (March): 40. http://www.fao.org/3/a-aq401e.pdf.

Ferraco, Henrique et al. (2019). Forest Ecology and Management Eucalyptus Growth and Yield System: Linking Individual-Tree and Stand-Level Growth Models in Clonal Eucalypt Plantations in Brazil. *Forest Ecology and Management*, 432(August 2018), 1–16.

Gebretsadik, Zenebe Mekonnen. (2013). Productivity of Eucalyptus Camaldulensis (Dehnh.) in Goro Woreda of Bale Zone, Ethiopia. *Research Journal of Agriculture and Environmental Management*, 2(9), 252–260.

Gil, Luis, Tadesse, Wubalem, Tolosana, Eduardo, and Lopez, Rosana. (2010). Eucalyptus Species Management, History, Status, and Trends in Ethiopia. *Proceeding of the conference on Eucalyptus species management, history, status, and trends in Ethiopia* (15-17 September 2010), Ethiopian Institute of Agricultural Research, Addis Ababa, Ethiopia.

Jagger, Pamela & Pender, John. (2000). The Role of Trees For Sustainable Management of Less-Favored Lands: The Case of Eucalyptus in Ethiopia. *EPTD Discussion Paper No. 65*. Environment and Production Technology Division International Food Policy Research Institute.

Jaleta, Daniel, Boniface Mbilinyi, Henry Mahoo, and Mulugeta Lemenih. (2016). Eucalyptus Expansion as Relieving and Provocative Tree in Ethiopia. *Journal of Agriculture and Ecology Research International*, 6(3), 1–12.

Jenbere, Dereje, Mulugeta Lemenih, and Habtemariam Kassa. (2012). Expansion of Eucalypt Farm Forestry and Its Determinants in Arsi Negelle District, South Central Ethiopia. *Small-scale Forestry*, 11(3), 389–405.

Kebebew, Zerihun. (2010). Eucalyptus in Rural Livelihood Safety Net Strategy in Coffee Growing Area: Case Study Around Jimma, Southwestern Ethiopia. *Research Journal of Forestry*, 4(4), 202–7.

Kebede, Tesfanesh Ababu. (2022). Analysis of Factors Affecting Local Household Income Derived from Eucalyptus Woodlot in Jamma District, Ethiopia. *Indonesian Journal of Social and Environmental Issues* (*IJSEI*), 3(3), 289–99.

Kuppusamy, Sowmya, Seenivasan Ramanathan, and Subramanian Sengodagounder. (2019). Biocatalysis and Agricultural Biotechnology Minicutting - A Powerful Tool for the Clonal Propagation of the Selected Species of the Eucalyptus Hybrid Clones Based on Their Pulpwood Studies. *Biocatalysis and Agricultural Biotechnology*, 22(September), 101357.

Lemenih, Mulugeta, and Habtemariam Kassa. (2014). Re-Greening Ethiopia: History, Challenges and Lessons. *Forests*, 5(8), 1896–1909.

Mekonnen, Zenebe. (2012). The Role and Management of Eucalyptus in Lode Hetosa District, Central Ethiopia. *Forests, Trees and Livelihoods*, 17(4), 309-323.

Neonila, Semashko, and Sergiy Zibtsev. (2010). Swedish University of Agricultural Sciences. Writing, 26(2014), 17–20.

Oballa, P. O., P. K. A. Konuche, M. N. Muchiri, and B. N. Kigomo. (2010). *Facts on Growing and Use of Eucalyptus in Kenya*. Kenya Forestry Research Institute (September), Nairobi, Kenya.

Otuba, Moses. (2012). Alternative Management Regimes of Eucalyptus: Policy and Sustainability Issues of Smallholder Eucalyptus Woodlots in the Tropics and Sub-Tropics. *Master Thesis*, Swedish University of Agricultural Science.

Pohjonen, Veli, and Timo Pukkala. (1990). Eucalyptus Globulus in Ethiopian Forestry. *Forest Ecology and Management*, 36 (1), 19-31.

Profiles, Livelihood Zone. (2009). *Livelihood Zone Profiles*. (January).

Region, Oromia, and Zenebe Mekonnen. (2010). Community Opinion, Marketing and Current Debates on Eucalyptus in Huruta District, Arsi Zone of Oromia Region, Ethiopia, *Proceeding of the conference on Eucalyptus species management, history, status, and trends in Ethiopia* (15-17 September 2010), Ethiopian Institute of Agricultural Research, Addis Ababa, Ethiopia, (i), 131–45.

Sara González-García, Almudena Hospido, Teresa Moreir, Romero, Javier, and Gumersindo Feijoo. (2009). Environmental Impact Assessment of Total Chlorine Free Pulp from Eucalyptus Globulus in Spain. *Journal of Cleaner Production*, 17(11), 1010–1016.

Semere, Mihert. (2019). Biomass and Soil Carbon Stocks Assessment of Agroforestry Systems and Adjacent Cultivated Land, in Cheha Wereda, Gurage Zone, Ethiopia. *Int. J. Environ Sci Nat Res.*, 20(4): 00119–0125.

Seng Hua, Lee, Lum Wei Chen, Petar Antov, Lubos Kristak, Paridah Md Tahir. (2022). Engineering Wood Products from Eucalyptus Spp. *Advances in Materials Science and Engineering*, (Special Issue), Advances in Wood Composites.

Shi, Zhongjie, D.P. Xu., Xiaohui Yang. (2012). Ecohydrological Impacts of Eucalypt Plantations: A Review. *Journal of Food, Agriculture and Environment*, 10(3–4), 1419–26.

Silva, Janderson De Oliveira, Jonas Elias, and Gabriel Magalhães Miranda. (2020).

Economic Viability in Eucalyptus Spp. Clonal Plantation for Production of Pulp. *Floresta e Ambiente*, 27(4).

Tadesse, Solomon Ayele, and Solomon Mulu Tafere. (2017). Local People's Knowledge on the Adverse Impacts and Their Attitudes towards Growing Eucalyptus Woodlot in Gudo Beret Kebele, Basona Worena District, Ethiopia. *Ecological Processes*, 6(1).

Vance, Eric D., Craig Loehle, T. Bently Wigley, and Philip Weatherford. (2014). Scientific Basis for Sustainable Management of Eucalyptus and Populus as Short-Rotation Woody Crops in the U.S. *Forests*, 5(5), 901–918.

Whittock, S. P., L. A. Apiolaza, C. M. Kelly, and B. M. Potts. (2003). Genetic Control of Coppice and Lignotuber Development in Eucalyptus Globulus. *Australian Journal of Botany*, 51(1), 57–67.

Zegeye, Haileab. (2010). Environmental and Socio-Economic Implications of Eucalyptus in Ethiopia. Eucalyptus Species Management, History, Status and Trends in Ethiopia. *Proceedings from the Congress held in Addis Ababa*. September 15th-17th, 2010 (September 2010), 184–205.

Zerga, Belay, Warkineh, Bikila, Demel Teketay, and Woldetsadik, Muluneh. (2021). Perceptions on Impacts of Competition of Eucalypt Plantations with Other Land Uses on the Rural Livelihood in the Western Gurage Watersheds. *Asian Journal of Plant Science & Research*, 11(6), 1–24.