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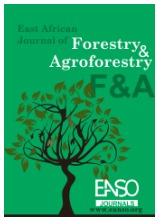

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Original Article

Coffee Shade Tree Selection Criteria and Management Techniques in Smallholder Coffee-Based Agroforestry System in Gomma Woreda, Southwest of Ethiopia

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ABSTRACT

To maintain the balance of productivity and increase coffee yield in the coffee agroforestry system, understanding the selection and management practices of shade trees is crucial. The purpose of this study was to examine shade tree selection factors and farmers management methods in a smallholder coffee-based agroforestry system in Gomma woreda, south-west Ethiopia, along an elevation gradient. Upper, middle, and lower gradients of the elevation were stratified, and two villages were randomly chosen from each elevation group. A total of 115 households were selected for interviews to examine coffee shade tree management practices and selection criteria. Moderated interviews that included both closed- and open-ended questions were administered. The information was gathered on the farmer's understanding and practice with regard to coffee shade tree selection and management. Result found that there is no correction between respondents age, sex and coffee shade management practices in study site. Farmers preferred both indigenous and exotic shade tree species such as 20% Cordia africana, 20% Albizia gummifera, 19%Croton macrostachyus, 5.2% Persea americana, 13% Grevillea robusta, and 3.5% Mangifera indica for coffee shade. Shade tree selection was based on tree height, origin, leaf size, shade quality, and leaf decomposition rate attributes.. Farmers also valued coffee shade trees for other additional ecosystem goods and services such as fruit, timber, construction wood, soil fertility maintenance, fodder, soil, and water conservation. Coffee shade tree provided both economic re-turn and biological conservation in study site.

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INTRODUCTION

Different regions of Ethiopia have adopted traditional agroforestry system to increase the potential for land use and diversify rural livelihood income (Vanderhaegen *et al*.,2015). For example, a coffee-based agroforestry system uses trees and coffee plants in combination to produce advantages for the economy, the environment, and society (Vanderhaegen et al., 2015). In the South and south-west of Ethiopia, where it has a long history of use, this coffee-based agroforestry system has significantly contributed to the preservation of the variety of woody species and the averting of climate change (Mittermeier *et al.*, 2011).

Mainly, coffee-based agroforestry systems are conducted in Ethiopia on farmlands, home gardens, and backyards (Abebe, 2005). Coffee shrubs are typically produced in systems where shade tree species predominate in the higher strata, while other food crops are predominately grown beneath the coffee (Gillison *et al.*, 2004). Farmers match the best coffee output with the production of tree products by managing the shade tree canopy (Me'ndez *et al.*, 2006). In a coffee-based agroforestry system, the majority of shade tree species are primarily managed for their ecological benefits and to supply necessary household services (Yitebitu, 2009). According to (Dobo & Asfaw, 2018) finds report that farmers in south Ethiopia use coffee shade trees for construction, fuel wood, food security, income generation, and agricultural sustainability.

A number of factors, including household management techniques, land tenure, cultural background, availability of local markets, population pressure, and tree species characteristics affect farmers' preferences for shade tree species (Asfaw & Green, 2007) and, based on their effect on coffee productivity, tree height, and leaf and crown features, growers maintain shade trees in their coffee plantations. Farmers in Southwest Ethiopia choose some tree species as coffee shade trees while removing others, a practice they feel has a negative impact on the growth and productivity of the coffee shrubs (Muleta *et al.*, 2011).

Virginie et al. (2016) states that farmers apply fertilizer, liming, manure addition, weeding, soil management, soil hoeing, coffee pruning, irrigation, and perform thinning, pruning, lopping, and pollarding among other management practices for coffee shade trees to coffee yield.(Aschalew & Zebene, 2018) also noted that farmers in the Guji Zone have their own expertise in caring for shade trees for coffee plants, taking into account thinning, pruning, pollarding, coppicing, and other tending procedures. Farmers also used techniques to manage shade trees in the Kelem-Wollega zone, including weeding out undergrowth, intercropping, debarking, cutting side branches, pruning, replanting, and natural regeneration.

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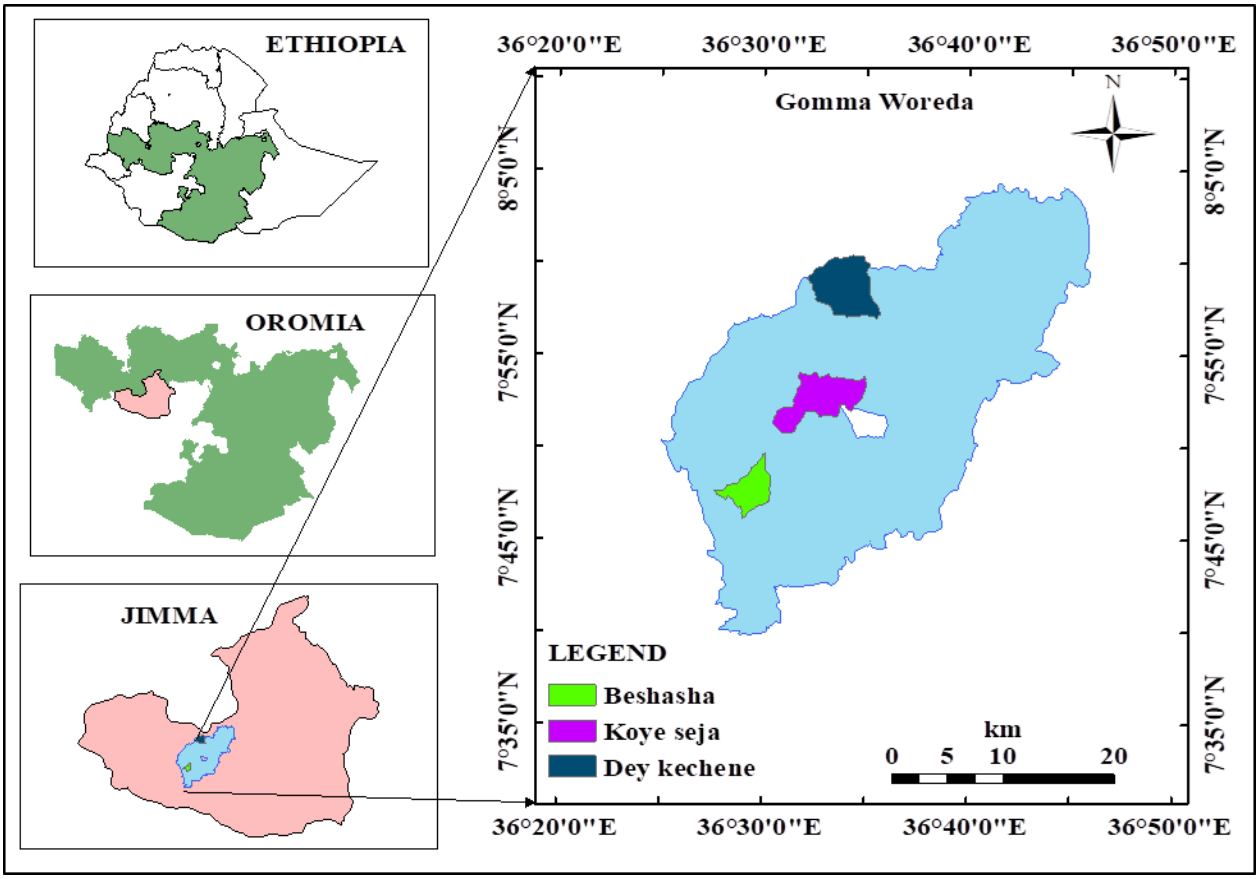
Despite the fact that coffee shade tree production and management have been performed for generations in various regions of Ethiopia, there are very few systematic research on the selection standards and management techniques in Southwest Ethiopia's forest coffee growing areas (Muleta *et al.*, 2011). Additionally, there is little scientific information about the selection criteria and traditional management practices for coffee shade tree species in the study area where community members manage coffee shade trees to increase coffee yield. Therefore, this study investigated local community indigenous knowledge on coffee-based agroforestry system; coffee shade tree selection standards and management techniques in Gomma woreda, Jimma Zone, south-west Ethiopia.

MATERIALS AND METHODS

Description of the Study Area

The study was conducted in Gomma woreda, Jimma Zone, Oromia Region, Southwest Ethiopia. Gomma Woreda is one of the 17 Woreda in the Jimma Zone known for predominantly growing coffee (JZARDO, 2008). It is located 403 km south-west of Addis Ababa and about 50 km west of Jimma town. Geographically, it lies between 6°49′–9°10′ N and 34°30′–38° E *(Figure 1)*. Gomma Woreda is bordered to the south by Seka Chekorsa, to the south-west by Gera, to the north-west by Setema, to the north by Didessa, to the north-east by Limmu kosa, and to the east by Mana woreda. One of Ethiopia's biodiversity hotspots for coffee is located in this woreda. There are five urban and 34 rural peasant associations (IPMS, 2007).

Figure 1: Map of the study villages



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The Study Area's Topography & Climate

Gomma woreda is located between 1387 and 2870 meters above sea level (m a.s.l). The major part of the Woreda is situated between 1387 and 1643 meters above sea level, while the rest of the area lies between 1849 and 2067 meters above sea level (WAO,2021). Few locations in the woreda, though, are between 2229 and 2870 meters above sea level. This woreda is divided into three agro ecological zones: 4% lowland or kola, 88% mid-high land (woina dega), and 8% highland (dega) (IPMS, 2007). The average annual rainfall in the region is between 800 and 2000 mm, and the Woreda's mean minimum and maximum temperatures range from 7 to 12 and 25 to 30 respectively (JZARDO, 2008). Rainfall in the woreda is bimodality distributed, with the minor rains occurring in March and April and the major rainy season from June through October. Hence, the volume and distribution of rainfall have no effect on crop and livestock productivity (IPMS, 2007).

Soil

The most prevalent soil type, Nitisols, covers around 90% of the woreda. Nitisols are deep, reddish-brown, clayey soils with relatively high organic matter content and a crumb and sub-angular blocky structure (FAO, 2017). Furthermore, these soils are young and typically acidic. Accordingly, growers cultivate plants that can withstand acid. The soils of Gomma have a pH that ranges from 4.5 to 5.5. However, minimum is the most typical issue connected to aluminum and magnesium poisoning (IPMS, 2007).

Land Use

The Woreda's four main land use types are grazing land, agriculture, and forest. In the woreda, approximately 60.7% of the land is arable or cultivable, 8.1% is used for pasture, 4.6% is used for forest, and the remaining 20.1% is regarded as swampy, mountainous, or otherwise unusable. Spices and fruits are significant cash crops (IPMS, 2007). In Gomma, coffee is the main cash crop, with more than 50 square kilometers dedicated to its cultivation. In this woreda, coffee is grown under various species of trees that provide shade. The three main crops grown in the region are sorghum (Sorghum bicolor L.), haricot beans, and maize (Zea mays) (JZARDO, 2008).

Demographic Characteristics

The woreda has a total population of 216,662, of which 110,448 are men and 106,174 are women, and 5.99% live in cities (CSA, 2009). Gomma is the second most densely populated woreda in Jimma Zone with a size of 96,361.72 ha (94.4 km^2). The majority of the inhabitants are Muslim, with 83.9% of the population reporting they observed this belief, while 14.7% of the population practices Ethiopian Orthodox Christianity and only 1.34% areprotestant (CSA, 2009).

Means of Livelihood

The livelihood many of community in woreda depend on is coffee production, and the vast majority of producers, it is their primary source of income. Due to this, coffee cultivation accounts for roughly 86.7% of communities' principal source of income. Additionally, honey, *Catha edulis*, crops, fruit tree, livestock production, timber, and other non-timber forest products are source of income and offer additional livelihood support for local communities. These goods can be used for household use, earning money, or both. Coffee, Catha edulis, and honey are used only to generate cash (Ayelech, 2011).

Sampling and Data Collection Method

Sampling Technique

Multi stage sampling method was used to collect data on tree shade selection criteria and management practice. At the first stage, Gomma woreda was selected purposively for being known as coffee growing area in the Jimma Zone. At second stage, the study site was divided into three

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categories based on elevation, lower (1300-1643 m), middle (1849-2067 m) and upper (2229- 2870) to obtain homogenous units. At third stage, kebele found in each elevation categories stratified into coffee producer and non –coffee producer (GWAO, 2021). At fourth stage, after stratification, three kebeles namely; Dey kechene, from the lower, Koye seja from the middle , Beshasha from the upper were selected randomly as coffee-growing kebeles; and two village from each kebele were selected randomly (*Table 1*).

Table1: Kebele selected for sampling along elevation gradients in Gomma Woreda

Elevation gradient	Kebele	Village
Upper	Beshasha	Tabba kollo
		Echemo kararo
Middle	Koye seja	Koye sayyo
		Cida bero
Lower	Dey kechene	Gota Misoma
		Hunda oli

Data Collection Method

Primary data was collected on shade tree management practice for each selected kebele. Semi-structured interviews with a mix of closed- and open-ended questions were used to gather information on the farmer's understanding of and practice with regard to choosing and managing coffee shade trees (*Table 2*). The questions about coffee shade tree management practices cover shade tree selection criteria, management techniques, and knowledge of coffee shade tree species' roles in various contexts. The questionnaire was initially created in English before being translated into Afan Oromo to prevent information impurity during data collecting and to increase the validity of the data.

In order to strengthen the data gathered from the HHs interviewed, a total of six focus group talks with a total of eight participants were held. The members were randomly selected from the household members. Size for households interviewed was determined according to Kothari, (2004) sampling formula was used for each selected kebele.

$$\frac{z(\frac{a}{2})^2 * p(1-p) * N}{d^2 * (N-1) + z2 * p * q} \qquad \text{(Equation 1)}$$

Where: n= the desirable calculated sample size, Z ($\propto$/2) =1.96 (95% confidence level for two side), p= proportion of population and barriers (50%), d= degree of accuracy desired setting at (9%), q=probability of failure,

$$ni=\frac{Ni*n}{N} \qquad \text{(Equation 2)}$$

Where, ni = The sample size proportion to be determined, Ni = The population proportion in the stratum,n=The sample size,N= the number of population

Table 2: Throughout the study sites, the proportional number of homes and sample size were determined

Name of kebele	No. of household	Sample size
Beshasha	657	25
Koyeseja	1482	55
Deyekechene	930	35

Source: GWAO (2021)

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Data Analysis

Primary data collected on shade tree management from HHs was analyzed by categorizing age of the household heads in to young (28-45) and old (above 45 years old age. Chi-square (x^2) tests were perfomed on the relationship between the respondents' wealth, sex, and education and (i) management practice, (ii) coffee shade tree selection criterion, and (iii) preferred shade trees management technique using (SPSS) software version 20's. Frequencies and percentages were used to describe present associated descriptive data.

RESULTS AND DISCUSSION

Selection Guidelines for Coffee Shade Trees and Management Techniques

All interviewed farmers (115) had shade trees growing in their coffee plantations. The majority (85%) of the farmers considered it a necessary component of their livelihood strategy. The female-headed households represented 17% of the selected households for the study. The ages of household heads ranged from 28-45 years (61%) and over 45 (39%). The respondents' education status were-79 (69%) can read and write, 21 (18%), were formal education and 15 (13%) cannot read and write. seventy- five percent of the farmers owned 1-2 ha landholding size and the remaining 26% had more than 2ha and 70%(80)farmers were medium wealth status in study area those selected for interview (*Table 3*).

Table 3: Characteristics of the farmers interviewed

Characteristics of the farmers		Frequency of response (%)
Sex	Male	83%
	Female	17%
Age	28-45	61%
	>45	39%
Education status	Read and Write	69%
	Cannot read and write	13%
	Formal Education	18%
Land holding size	1-2 ha	74%
	>2ha	26%
Wealth status	Rich	18%
	Medium	70%
	Poor	17%

In the study area, there was no significant association was revealed between tree shade management, criteria, and preference with household head sex and education. Shade tree management and selection criteria were not affected by the farmer's sex, education and wealth. But the wealth of respondents were significantly associated with shade tree preference indicating that households selected coffee shade trees according to their wealth status in the research space. This result was consistent with (Hundera, 2016) who found no correlation between respondents' age and sex and coffee shade management techniques or selection criteria for shade tree species, or their preferred shade species (*Table 4*).

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Table 4: The effect of sex, wealth and education of respondent on shelter tree selection and management techniques in coffee-based agroforestry systems in study area.

Correlation	Chi-square *value*	df	Asymp.sig. (2-sided)
Sex vs Management	6.11	1	0.52
Preference	7.48	1	0.75
Criteria	1.66	1	0.79
Education vs Management	20.23	1	0.12
Preference	21.47	1	0.49
Criteria	2.96	1	0.93
Wealth vs Management	22.93	1	0.34
Preference	111.8	1	0.000
Criteria	9.61	1	0.65

Farmers Perspective of Planting of Preferred Tree Species

To plant the preferred tree species in their coffee farm, smallholder farmers in the study area have access to a variety of seedling sources. As a result, 68% of the households surveyed had grown tree seedlings at their own nursery. However, only about 19% of respondents said they purchased tree seedlings from government nurseries (*Table 5*). Furthermore, 13% of respondents received tree seedlings from nearby farmers. The outcome was consistent with that of (Aschalew & Zebene, 2018), who found that farmers in the Kelem Wollega and Guji Zones of Oromia, Ethiopia, frequently received shelter tree planting material from government nurseries, self-established farms, nearby neighbors, and natural forests. Furthermore, Zekwan et al. (2020) noted that East Hararghe's smallholder coffee farmers used a variety of tree seedling sources, including their own sources, neighboring farmer, and government nursery site.

Table 6: Farmer seedling source for planting in the study site

Source planting seedling	HHs response
Government nursery	22(19%)
Own source	78(68%)
Neighboring farmer	15(13%)

Farmers' Preferences of Shade Tree Characteristics

The majority of interviewed farmers in Gomma Woreda (82.4%) responded that trees that have 10-15 m height (intermediate height) were preferable for coffee shade (*Table 6*). The main principal justifications for preferring trees with intermediate heights were 1) coffee shrubs are better shaded by tall shrubs than by tall trees with high crowns, and 2) pollarding and trimming are easier. The tall and short trees were not preferred by most of farmers, since the short trees do not provide adequate shade for coffee shrubs and the tall ones were complex during management practice such as pruning and pollarding. This finding was in line with (Hundera, 2016) that 92% responded preferred intermediate height for coffee shade in south Ethiopia.

In the study area, nearly all (96%) favored light shade quality for coffee cultivation. Only few of respondents (4%) stated that shade quality did not matter. The main reason given by the respondents for the preference of light shade quality was that coffee requires light to produce and mature. This result was consistent with the finding of (Albertin & Nair, 2004) that the overwhelming most of interviewed farmers (89.4%) preferred light, and

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only a few (5.3%) stated that shade quality did not matter in the Nicoya peninsula, Costa Rica. The majority of the farmers surveyed (61%) regarded small leaves as the most crucial characteristics (*Table 6*). Small leaves are less erosive than larger leaves because they create smaller raindrops, and their rapid rate of breakdown increases soil fertility. They also let more light through than larger leaves do. However, 39% of interviewed farmers preferred larger leaves because they can use them as source of fuel and protects the coffee from high-intensity sunlight damage than smaller leaves. Beer (1987) also reports that smaller leaves are preferable for reducing erosion, and the technical division of coffee producers. And (Albertin & Nair, 2004) state small leaves decompose faster than large ones in Nicoya peninsula, Costa Rica.

The majority (73%) of farmers preferred native tree species for shade over exotics because the farmers have experience with native species than non-native. However, 22% of study area farmers preferred non–native tree species because the exotic species, especially the fruit trees, provide short- to midterm income. This finding agrees with the findings of (Albertin & Nair, 2004) where 41.3% of farmers preferred native shade trees and 2.7 preferred non –native shade tree species at Nicoya peninsula, Costa Rica. Due to the requirement for shade during the dry season when deciduous trees shed their leaves, most farmers (70%) preferred evergreen trees to deciduous ones. However, the findings of (Beer, 1987), stated that farmers do not consider evergreen growth to be a critical characteristic and some farmers even prefer deciduous trees over evergreen because of their role in reducing soil erosion by providing mulching to soil and overall soil improvement. All of the farmers in the research area chose trees that produced trash with a faster decomposition rate. Farmers feel that species with a faster decomposition rate can contribute to a greater improvement in soil fertility than species that degrade slowly. This finding is consistent with Hundera (2016), which found that most farmers chose species with a faster disintegration rate.

Table 7: Farmers' Preferences of Shade-Tree Characteristics in Gomma Woreda

Characteristics of trees	Preference	No responses frequently (%)
Tree height	Short (<10m)	9(7.6%)
	Intermediate (10-15m)	95(82.4%)
	Tall (>15 m)	11(10%)
	It does not matter	0
Shade quality	Ligh	110(96%)
	Dense	0
	It does not matter	5(4%)
Origin	Native	80(73%)
	Non-native	24(22%)
	It does not matter	6(5%)
Deciduous or evergreen	Evergreen	81(70%)
	Deciduous	24(21%)
	It does not matter	10(9%)
Leaf size	Small	70(61%)
	Large	45(39%)
	It does not matter	0
Leaf decomposition rate	Fast	115(100%)
	Slow	0
	It does not matter	0

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During the interview, nine most preferred tree species growing in farm fields were identified. Most of the shade trees preferred by farmers were timber trees and few were fruit trees (*Table 7*). The selected shade tree species by the farmers were mainly indigenous and multi-purpose. Thus, the most preferred and dominant shade tree species include *Cordia africana, Albizia gummifera, Croton macrostachyus and Grevillea robust. In terms of preferred tree species, the majority of the trees found in the current study were previously reported by other studies*. For example, *C. africana* ((Muleta *et al.*, 2011), *C. macrostachyus* ((Aschalew & Asfaw, 2018); Tazebew & Asfaw, 2018) were reported as farmers preferred indigenous and multi-purpose coffee shade trees in different regions. In addition to this, *M. ferruginea and F. vast A. gummifera* (Muleta *et al.*, 2011); Anteneh et al., 2015;(Aschalew & Zebene, 2018); and One of the chosen and suited species of shade trees for coffee plants was *G. robusta*.

This finding was in line with (Albertin & Nair, 2004) which mentioned that leguminous trees as belonging to most preferred shade trees list among coffee growers, where the farmers considered that increase in soil organic matter as their favorable characteristics.Moreover, other earlier studies also confirmed that most preferred shade trees by farmers in the farm field contributed to the enhancement of coffee yield. For example, Ebisa (2014) reported the increase of coffee weight close *to C. macrostachyus and A. gummifera* tree base and the decrease across the distance from the tree trunk.

In the study area, farmers also preferred fruit trees to plant in their coffee systems because fruit trees provide food and income generation. Almost of fruit trees in the study site were *Persea americana (5.2%) and Mangifera indica (3.5%)* respectively preferred by the farmers. This finding was in line with (Albertin & Nair, 2004) who reported that farmers preferred fruit trees species as coffee shade because fruit trees provide short- to midterm income and majority of them were *Persea americana, orange, Citrus sinensis, Mangifera indica,* and *Musa paradisiaca.*

Table 8: Most common shade tree species in the study area

No	Scientific name of the species	Frequency of respondent
1	Cordia Africana	23(20%)
2	Albizia gummifera	23(20%)
3	Croton macrostachyus	22(19%)
4	Grevillea robusta	13(11.3%)
5	Persea Americana	6(5.2%)
6	Milletia ferruginea	8(7%)
7	Sesbana sesban	9(8%)
8	Ficus vasta	7(6%)
9	Mangifera indica	4(3.5%)

Besides providing balanced shade to coffee plants, the most of the farmers in the study site mentioned other desirable additional goods and services they services they obtained from shaded coffee systems, such as fruit, timber, fodder, construction wood, fuel wood, medicinal value, cash income sources, soil fertility improvement, soil and water conservation. As a result, almost all of the farmers who were interviewed employ coffee shade trees for other goods and services such as improving soil fertility (25) and providing wood (27), fuel (22) and fuel. The result of this study agrees with the finding of (Ashenafi *et al.*, 2014) who reported that desirable benefits derived from shaded systems

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include incorporation of organic matter to coffee farm, fire wood, timber value, construction and honey or bee production.

Additionally, the results are consistent with those of Bentley *et al*. (2004), who claimed that shade trees increase soil fertility and aid in preserving soil moisture for longer periods, providing farmers in Ecuador with significant benefits for understorey crops like cocoa and coffee. Zekwan.,*(*2020) also reported that (92.4%) respondent strongly stated the timber products that they derived from shaded coffee system and soil fertility maintenance through the addition of organic matter to coffee production systems as the principal reasons of using shade tree in their coffee farm in Eastern Hararghe.

Table 9: Other principal use, of shade tree species mostly mentioned by farmers in the study area

Other benefit of shade tree	Number of respondent in Frequency
Soil fertility improvement	25
Fuel wood	22
Timber	27
Medicine value	8
Fodder	7
Fruit	7
Construction purpose	10
Soil and water conservation	9

Management Practices on Shade Tree

In the study area, all of the respondents used management techniques for coffee shade trees. In order to (1) reduce competition for light or heavy shade and maximize shade for understory coffee plants; (2) maintain desired tree shape, including height and to increase quality of expected product; (3) maximize the new product for the next time by cutting away less productive wood which encourages the growth of new, vigorous stems and branches (*Table 9*).

This result was also consistent with the finding of Valencia *et al.* (2015) from Chiapas of Mexico who showed that the regulation of shade was closely associated with fostering high coffee yields and controlling pests because, diseases, such as fungus *Mycena citricolor*, were associated with high humidity environments caused by an insufficient light passage that dropped yields. Where it was essential to cut back on branches or trees to improve light availability, which in turn increased productivity. The findings of Getahun *et al.* (2016), which showed that farmers in Arsi-negelle woreda of East Arsi zone and Ginbo woreda of South West Ethiopia pruned native woody species and coffee shade trees to lessen the effect of shade on understory crops, to gain other benefits, and to increase the production of understorey crops, supported the findings of this study.

About 22% of the respondents who were interviewed said they used thinning operations for tree species that naturally regenerate in dense growth and for densely regenerated sprout from coppices. The reason was to reduce the nutrient competition between tree and coffee shrubs. This result was consistent with (Mesele, 2007) findings, according to which farmers in the Gedeo zone do thinning operations when the crowns of nearby tree species begin to close and cast a strong shade over understorey crops. Similar to this it was noted by, (Geeraert *et al.*, 2019) that Ethiopia had a long-standing custom of managing coffee fields for coffee production by thinning the canopy by the removal of specific tree species.

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Table 10: Common management practices on shade trees in the study area

Types of management practices	Responded of HHs in Frequency
Pruning	28(24%)
Thinning	25(22%)
Pollarding	5(4.5%)
Coppicing	4(3.5%)
Lopping	4(3.5%)
Pruning &thinning	38(33%)
Pruning, thinning and coppicing	7(6%)
Pruning &coppicing	4(3.5%)

In addition to the common management practice, other management practices are also employed on coffee tree species at seedling stage in different time at different frequencies. According to interviewed respondents and focus group discussion made between different management activities such as hoeing, weeding, watering, manuring (fertilizing) and protection (fencing) for the whole coffee farms including shade tree species in the study sites were employed (*Table 10*). All of the interviewed respondents (100%) employed hoeing in their coffee farms to conserve water and increases soil fertility for tree and coffee shrubs. Only 23% of respondents reported watering tree seedlings to promote growth and increase survival. The majority of the farmers (91%) apply manure to trees during the seedling stage to increase soil fertility and provide suitable environment for tree growth and coffee shrubs. All (100%) of the interviewed respondents employed weeding in their coffee farms at the different time and this helps to reduce nutrient competition.

This result agreed with that of the earlier investigation. For instance, all coffee farmers in Babo-Gembel woreda, Western Wellega Zone of Western Ethiopia, reported that hoeing was a common practice for managing their coffee shade tree species at seedling stage (Ewuketu *eta*l 2014). (Aboma, 2016), and Valencia et al. (2016) all reported similar findings. According to their findings, farmers weeded their coffee shade trees as part of a routine annual management procedure to make it easier to harvest coffee and lessen competition for coffee shrubs. Additionally, Mendez et al. (2009) reported that coffee and shade trees in western El Salvador were managed by using weeding techniques.

Table 11: Other management practice on shade trees species practice at seedling stage in the study area

Types of management practice	Reason for practice	Responded of HHs
Weeding	To reduce weed competition	115(100%)
Watering	To enhance growth	25(22%)
Manuring	To increases soil fertility	100(87%)
Fencing	To protect animal damage	42(37%)
Hoeing	To conserve water and increases soil fertility	115(100%)

CONCLUSION

Coffee-based agroforestry system is the largest land-use system in Gomma woreda, which provides significant rural livelihoods and land use management. The valued ecosystem service and goods of coffee shade trees by farmers included fruit, timber, construction wood, soil fertility maintenance, fodder and soil and water conservation. Shade tree management and selection

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criteria were not affected by the farmer's sex, education and wealth. But the wealth of respondents were significantly associated with shade tree preference.

A number of elements, including tree height, shade quality, tree origin, leaf size, and rate of leaf decomposition, had an impact on the selection of coffee shade trees. Coffee growers had profound management practices and skills for coffee shade tree species. Pruning, thinning, pollarding, coppicing, and lopping were popular management techniques used on different tree species to achieve varied objectives. Besides, farmers employed different management practice at different time such as hoeing, weeding, watering, manuring (fertilizing) and protection (fencing) to maintain the sustainable growth of shade trees.

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