



Assessment of Parkland Tree Species and Their Management Practice in Ana Sora District of Guji Zone, Southern Ethiopia

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The study was conducted to identify parkland tree species and their management practice by smallholder farmers in Ana Sora District of Guji Zone, Southern Ethiopia. The study was conducted by using multistage sampling methods. In the first stage one district was purposively selected based on the potential of park land tree species. Then, from the district by using simple random sampling methods two kebeles were selected and purposively from 40 farm lands an assessment of parkland tree species were conducted. In this study, 31(thirty one) tree species were identified in parklands of the study area and majority of them were indigenous tree species. In terms of parkland tree species preferences, *Schefflera abyssinica*, *Hagenia abyssinica*, *Milletia ferruginea*, *Cordia africana* and *Croton macrostachyus* were the most preferred top five tree species of the study area respectively. This study also showed that, farmers practiced thinning, pruning and pollarding management activities for better growth of underneath crops, to transfer the biomass of the trees to the crop fields and for various products of the trees. Moreover, smallholder farmers of the study area were obtained different services and products such as bee forages, shade,

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construction material, soil fertility improvement and fuel wood from parkland tree species either retained or planted on their farm lands. However, parkland tree species of the study area were faced various constraints. Therefore, attention should be given on conservation of parkland tree species and farmers should be encouraged by the government through research and extension services and supplying by planting materials to improve the significant of ecological and productive role of parkland tree species of the study area.

Keywords: Constraints; management practice; parkland tree; preference; service and products.

1. INTRODUCTION

“Parkland agroforestry practice is a traditional land-use system that involves the retention and introduction of woody perennials, particularly trees, in agricultural fields and managing them in combination with crops and livestock, with the main aim of benefiting from the positive ecological and economic interactions that take place between the components” [1-2]. “The system provides environmental services and off-farm products that are either traded or used to confer multiple livelihood and environmental benefits; this can alleviate malnutrition, hunger and poverty in resource poor smallholder farmers” [3-4]. “Moreover, park land trees control the water table, break the strong winds, sequester carbon and mitigate floods” [5].

“Parkland tree species in agroforestry system also improve the nutrient balance of soil by reducing unproductive nutrient losses from erosion and leaching and by increasing nutrient inputs through nitrogen fixation and increased biological activities by providing biomass and suitable micro-climate for under story crops” [6]. “The higher crop yields obtained nearer to trees in parkland agroforestry systems as compared to where trees have been removed as in the case of tree fallows is a proof of the contribution of trees to soil fertility improvements” [7-8].

“In parkland practices, the main goal of practicing agroforestry systems is domestication of selected trees for enhancing soil productivity through a combination of multipurpose selected tree species and food crops on the same farmland” [9]. “The effect of parkland agroforestry trees on associated crop productivity is based on cumulative effect from both above and below ground component interaction especially in simultaneous type of agroforestry system” [10]. “In addition, the influence of parkland agroforestry trees on crop yield depends on management variables, canopy and root

architecture, spatial and temporal arrangement, age and size of the tree and ecological type” [11].

“In Ethiopia, the integration of tree and shrub species into agriculture emerged long time ago and the practice has developed into a number of distinguished traditional agroforestry systems in different parts of the country mainly in southern and south western Ethiopia” [12-13]. “Furthermore, scattered parkland tree species grown in farmlands characterize a large part of the Ethiopian agricultural landscape and it is the most dominant agroforestry practice in the semi-arid and sub humid zones of the country” [14].

In Ethiopia, the contribution of parkland agroforestry tree species to satisfy the needs and demands of the small holder farmers’ households are very significance. Some of the major roles they play includes: heating, cooking, household utensils, cultural values, provision of pollen and nectar for honey production, construction of houses and handles of farm implements [15], soil fertility improvement, economic benefits, fodder values, employment opportunities and contribute to regional and national economy [16].

Parkland trees on farms are integral parts of smallholder farming systems in Ethiopia. Despite their substantial economic and ecological roles, parkland trees have received disproportionately little scientific attention in Ethiopia [17]. Similarly, in Ana Sora District of Guji Zone, in Southern Ethiopia, a practice of parkland agroforestry land use systems of combining different trees and food crops on the same farm lands are very common. However, there is no documented study on parkland agroforestry practice of the study area. Therefore, the objectives of the study were to identify commonly used parkland tree species and their management practice in Ana Sora District of Guji Zone, Southern Ethiopia.

2. MATERIALS AND METHODS

2.1 Description of the Study Area

The study was conducted in Guji Zone, Southern Ethiopia. Specifically it was conducted in Ana Sora District of Guji Zone. Ana Sora District is found at a distance of 414 km from Addis Ababa, capital city of Ethiopia. Astronomically, the study district is located with in the latitude of 6°20'30"-5°57'30" North and longitude of 38°39'30"-38°57'30" East (Fig. 1). The study district receives an annual rain fall of about 1400-1800 mm and the annual temperature of the district ranged from 17.5c⁰-28c⁰ and the altitude ranges from 1900-2850 meters above sea level. The district is classified under 26 rural kebeles and 4 rural town. The district is characterized by mixed economic activities, mainly agricultural practices which constitute the major livelihood of the people. It produces diverse cereal crops such as maize, teff, bread wheat and food barley and highland pulse crops like faba bean and field pea and other horticultural and root crops.

2.2 Methods of Data Collection

Both primary and secondary data were collected to accomplish the objectives of the study. Secondary data were collected from agricultural

offices, journals and reports. Primary data sources were respondents in the study area that was collected by questionnaires. In addition, primary data were collected through focus group discussions, field observations and intensive interviews with key informants. The assessment of parkland tree species was undertaken by using multistage sampling methods. The first stage was, the study district is purposively selected based on the potential of parkland agroforestry practice. Then, by using simple random sampling methods from the study district two kebeles were selected and purposively 40 farm lands were visited and an inventory of the tree species commonly growing on parklands of the study area were conducted.

2.3 Data Analyses

The collected and arranged data was analyzed by using the software programs Microsoft Excel and Statistical Packages for Social Sciences (SPSS) version 20. Based on the data gathered descriptive statistical tools like frequency and percentage were used and represented by figures, tables and graphs. The qualitative data collected during focus group discussion, key informant interview and personal observations were analyzed through description, narrating and interpreting the situation contextually.

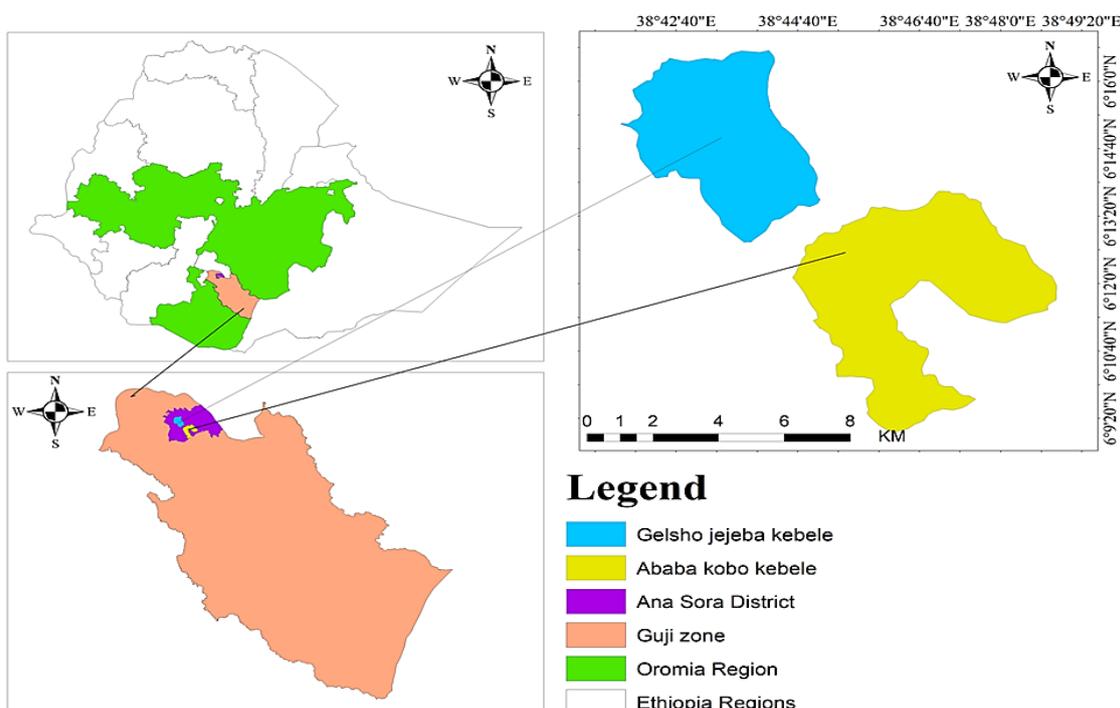


Fig. 1. Map shows the location of the study area

3. RESULTS AND DISCUSSION

3.1 Socio-economic Characteristics of the Respondents

The socio-economic features of the sampled households indicated that about 87.5% (N=40) of the respondents were males and the remaining 12.5% of the respondents were females (Table 1). In terms of age category, the majority of (32.5%) and (30%) of them had ages between 40-50 and 30-40 years old respectively (Table 1). Concerning, educational status, the majority of sampled respondents (30%) were 2nd cycle (Grade 5-8). However, (20%), (17.5%) and (12.5%) of the respondents educational status were 1st cycle (Grade 1-4), high school (Grade 9-12) and uneducated respectively (Table 1). Marital status also showed that the majority of sampled respondents were married (95%), and the remaining (5%) of the respondents were divorced and single (Table 1). With regard to religion of the sampled respondents, all of them

were protestants and in terms of their family size, (20%) and (13%) of the respondents have (8-12) and (4-8) family members respectively (Table 1). Based on the results of this study, respondent households have different land holding size. The mean land holding size of the sampled households at the study sites were 0.54 ha and it was a major fixed asset for farmer’s in the study area (Fig. 2).

3.2 Farmers Source of Income Generation in the Study Area

The findings of the current study showed that, farmers of the study area have different source of income generation. Accordingly, the majority (55%) of the respondent households source of income generalization were crop, livestock and coffee. Where as, source of income generation of the remaining (33%) and (12%) respondent households of the study area were crop and livestock and only crop production respectively (Fig. 3).

Table 1. Socio-economic status of respondent households, in Ana Sora District of Guji Zone, Southern Ethiopia

Sex	Freq.	%	Marital Status	Freq.	%	Educational Status	Freq.	%
Male	35	87.5	Single	1	2.5	Uneducated	9	12.5
Female	5	12.5	Married	38	95	Read and write	2	5
Total	40	100	Divorced	1	2.5	1 st cycle (Grade 1-4)	8	20
Age	Freq.	%	Total	40	100	2 nd cycle (Grade 5-8)	12	30
<30	8	20	Religion	Freq.	%	High school (Grade 9-12)	7	17.5
30-40	12	30	Protestant	40	100	Diploma	2	5
40-50	13	32.5	Family size	Freq.	%	Total	40	100
50-60	3	7.5	4-8	13	32.5			
>60	4	10	8-12	20	50			
Total	40	100	>12	7	17.5			
					5			
			Total	40	100			

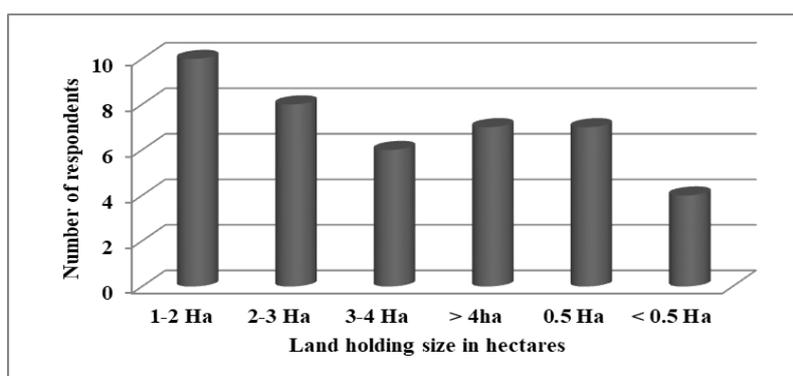


Fig. 2. Farmers land holding size

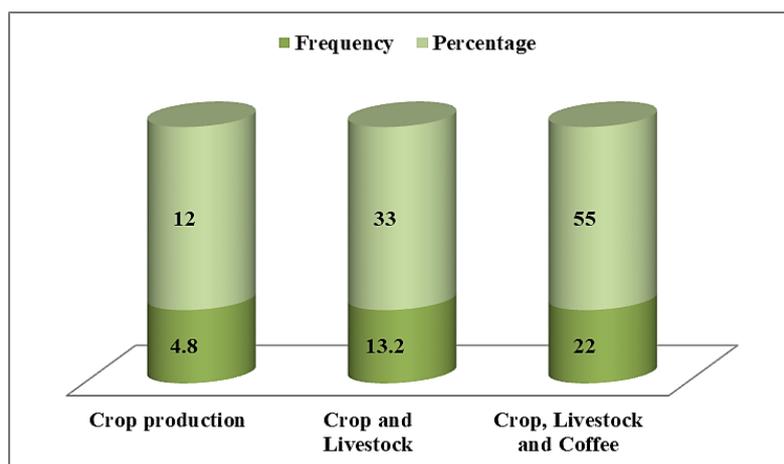


Fig. 3. Farmers source of income generation

3.3 Tree Species Identified on Parkland Agroforestry practice of the study Area

Parkland tree species also known as scattered trees in croplands are a very common type of agroforestry system in the tropics and characterized by well known scattered trees on cultivated and recently fallowed lands [18]. Similarly, smallholder farmers of the study area have culture of tree planting and managing naturally grown indigenous tree species are widely adopted by farmers, as a dominant feature of agricultural landscapes. Based on the findings of this study, 31 (thirty one) parkland tree species belonging to 26 families were identified in the study area (Table 3).

As compared to previous findings conducted in different parts of Ethiopia, the number of identified parkland tree species of the current study is higher than the study results of [19-21]. In their study results, recorded 15 tree species on croplands, 16 tree species on parklands and 17 scattered tree species on crop lands of Tigray region, Hawassa Zuria and Gemechis District of West Hararge Zone respectively. However, the number of identified parkland tree species of this study is lower than the study results of [22-23]. In their study results conducted at semi-arid East Shewa and Arsi Negelle reported 77 and 32 tree species on farmlands respectively.

This variation in parkland tree species composition in different parts of the country could be attributed to agro-ecological characteristics which particular parkland tree species adapt, age of parkland tree species, socio-economic factors affecting tree planting and retaining, and farmers

management strategy of parkland tree species. In agreement with this study, previous studies from other areas of the country confirmed that tree species composition, and structure can be varied because of elevation variation, soil type and management approaches applied by the local people in agroforestry practices [24-25].

3.4 Preferences of Parkland Tree Species of the Study Area

In parkland agroforestry practice, specific characterizes of tree species are very important for selection of tree species to be planted or retained on the farmlands are considered certain criteria ranging between the utility, drought resistance, nature of the tree species, compatibility with under story crops and multipurpose values of the tree species. Smallholder farmers of the study area have long relied on parkland tree species for different products and services. In this regard, farmers' preference criteria of the parkland tree species of the study area were mainly based on their timber and construction value, fuel wood, beehive construction, bee forages and soil fertility attribute of the tree species. Similar to this study finding, [25] indicated that tree services and products most preferred by farmers were fuel wood, fodder, soil fertility and erosion control, fruits and pole for construction. Furthermore, [10,26] reported that fodder value, fuel wood, construction material, live fences and soil fertility improvements are the most preference criteria of on farm tree species by smallholder farmers.

In this study, from the commonly used and identified parkland tree species of the study area, small holder farmers have their own preferences

of tree species. Accordingly, ten key informants were participated to rank the 10(ten) most preferred parkland tree species according to their preference criteria. The values were five for the most preferred parkland tree species and one for the least preferred parkland tree species by key informants. Finally, total score given by key informants were added and then ranked to identify the most preferred parkland tree species of the study area. Based on their total score, *Schefflera abyssinica*, *Hagenia abyssinica*, *Millettia ferruginea*, *Cordia africana* and *Croton macrostachyus* parkland tree species were ranked 1st, 2nd, 3rd, 4th and 5th respectively (Table 2).

3.5 Farmers Management Strategies of Parkland Tree Species

3.5.1 Establishment of tree species in Parkland agroforestry practice

Smallholder farmers of the study area indicated that majority of their owned parkland tree species are naturally regenerated. Based on the findings of this study, 75% of the respondent households parkland tree species are naturally retained tree species and only 25% of the respondent house holds parkland tree species are self established. This idea also supported by key informants. In terms of parkland tree species source of planting material, (40%), (32%) and (28%) of the respondents revealed that their sources were from natural forest, own nursery and government nursery respectively (Fig. 4).The outcomes was consistent with that of [27] who found that in East Hararghe's smallholder coffee farmers used a variety of tree seedling sources, including their own sources, neighboring farmer, and government nursery site.

3.5.2 Management practice for tree species in parkland agroforestry system

In the study area, farmers conducted different management practices for parkland tree species either retained or planted in their farm lands in different season of the year. This study showed that, the majority (52.5 %) of the park land tree species were obtained various management practices during wet season. However, the rest of (22.5%) and (25%) of parkland tree species of the study area were acquired different management practices in dry season and year round respectively (Table 4).

Key informants and respondent households indicated that, farmers of the study area have practiced branch and shoot pruning and pollarding management activities during wet season for the purpose of soil fertility improvement. For example, *Croton macrostachyus*, *Cordia africana*, *Hagenia abyssinica*, *Ficus sur*, and *Schefflera abyssinica* commonly used park land tree species were acquired management activities in wet season for soil fertility enhancements. In support of this study, [26] reported that farmers practiced pruning activities largely for the purpose of soil fertility improvement through transferring the biomass to the crop fields by applying their leaves as a mulch and makes nutrient available to the crops, besides reducing the competition of the trees for water and light and for other purposes.

In addition, all of the respondents and key informants in the study area indicated that, farmers practiced branch pruning of the following parkland tree species such as *Maesa lanceolata*, *Syzygium guineense*, *Vernonia amygdalina* and *Vernonia auriculifera* for animal feed and fuel wood purposes during dry season of the study area. In terms of different management practices conducted by farmers of the study area, (45%) and (40%) of the respondents were used thinning and pruning, and pruning activities respectively (Table 4). Whereas, 10% of the respondents were used thinning, pruning and pollarding management activities and only 5% of the respondents were used thinning management practice (Table 4).

Key informants and respondents of the study area mentioned that, in parkland agroforestry system farmers practiced thinning and pruning activities to minimize shade effects of tree species on under story crops and for the purpose of fuel wood and construction material. In line with this study, in their earlier study results [15-16] reported that to reduce light competition with the undergrowth and provision of usable products farmers practiced different tree management activities. Moreover, farmers of the study area employed pollarding management practices to control shade effect of the tree branches on under story crops and for better growth of the new shoots vital for construction purposes. In conformity with this study, [15,28] indicated that pollarding management practices are very significant to control the level of shade on coffee and Enset and to promote the formation of shoots useful as construction poles/timber production.

Table 2. Farmers preference criteria of park land tree species in Ana Sora District of Guji Zone, Southern Ethiopia

Park land Tree species	Farmers preference criteria of parkland tree species						Total score	Rank
	Construction	Timber	Fuel wood	Shade	Bee forage	Soil fertility improvement		
<i>Schefflera abyssinica</i>	5	4	5	5	5	5	29	1 st
<i>Hagenia abyssinica</i>	5	5	5	5	3	5	28	2 nd
<i>Millettia ferruginea</i>	4	3	5	5	3	5	25	3 rd
<i>Cordia africana</i>	5	5	3	4	3	3	23	4 th
<i>Croton macrostachyus</i>	3	2	5	4	3	4	21	5 th
<i>Syzygium guineense</i>	3	3	4	4	2	3	19	6 th
<i>Podocarpus falcatus</i>	4	4	3	3	2	2	18	7 th
<i>Ekebergia capensis</i>	3	3	3	3	3	2	17	8 th
<i>Ficus sure</i>	2	3	3	4	2	2	16	9 th
<i>Prunus africana</i>	2	3	4	3	1	2	15	10 th

Table 3. Tree species identified in park land agroforestry practice in Ana Sora District of Guji Zone, Southern Ethiopia

No	Scientific name	Local name	Family	Services and Products of the Trees
1	<i>Schefflera abyssinica</i>	Gatamee	Araliaceae	Bee forage ,soil fertility, shade
2	<i>Hagenia abyssinica</i>	Heexoo	Rosaceae	Timber,construction, soil fertility,bee forage
3	<i>Syzygium guineense</i>	Baddeessaa	Myrtaceae	Construction, charcoal, food
4	<i>Croton macrostachyus</i>	Bakkanniisa	Euphorbiaceae	Beehive, medicinal value, soil fertility
5	<i>Millettia ferruginea</i>	Dhadhatuu	Fabaceae	Construction, fuel wood,shade
6	<i>Maytenus arbutifolia</i>	Kombolcha	Celastraceae	Fuel wood, charcoal
7	<i>Vernonia amygdalina</i>	Eebicha	Asteraceae	Soil fertility
8	<i>Erythrina abyssinica</i>	Waleensuu	Fabaceae	Soil fertility
9	<i>Podocarpus falcatus</i>	Birbirsaa	Podocarpaceae	Timber, construction,shade
10	<i>Cordia africana</i>	Waddeessa	Boraginaceae	Timber, construction,soil fertility
11	<i>Ekebergia capensis</i>	Anoonuu	Meliaceae	Beehive, fuel wood
12	<i>Bersama abyssinica</i>	Lolchiisaa	Meliantaceae	Fuel wood
13	<i>Cupressus lustanika</i>	Gaattiraa faranjii	Cupressaceae	Timber, construction,shade
14	<i>Dombeya torrida</i>	Daannisa	Sterculiaceae	Bee forage, fuel wood
15	<i>Maesa lanceolata</i> Forsk.	Abbayyii	Myrsinaceae	Fuel wood
16	<i>Myrica salicifolia</i> Hochst.	Reejjii	Myricaceae	Fuel wood, fencing
17	<i>Juniperus procera</i>	Gaattiraa	Cupressaceae	Timber, construction
18	<i>Eucalyptus camaldulensis</i>	Baargamoo diimaa	Myrtaceae	Timber, construction
19	<i>Grevillea robusta</i>	Giraaviilaa	Proteaceae	Timber, construction, shade
20	<i>Ficus sur</i>	Harbuu	Moraceae	Beehive, soil fertility,shade
21	<i>Vernonia auriculifera</i>	Sarajjii	Assteraceae	Food, fuel wood
22	<i>Prunus africana</i>	Sukkee	Rosaceae	Construction,shade
23	<i>Ehretia obtusifolia</i> Hochst. ex DC.	Me'ee	Boraginaceae	Beehive, construction
24	<i>Crabbea velutina</i> S.Moore	Gudubaa	Acanthaceae	Timber, construction
25	<i>Pinus patula</i>	Shiwaashuw wee	Pinaceae	Timber, construction
26	<i>Polyscias ferruginea</i>	Talaa	Araliaceae	Beehive, bee forages
27	<i>Teclea nobilis</i> Del.	Hadheessa	Rutaceae	Construction
28	<i>Galiniera coffeoides</i>	kudhumii	Rubiaceae	Bee forage
29	<i>Pittosporum viridiflorum</i> Sims.	Gaaloo	pittosporaceae	Bee forage, Shade
30	<i>Fagaropsis angolensis</i>	Sisaa	Rubiaceae	Medicinal value, construction
31	<i>Euphorbia candelabrum</i> Kostshy	Adaamii	Euphorbaceae	Soil fertility, fencing

3.6. Services and products of parkland tree species of the study area

Parkland trees are used to satisfy the needs and demands of the households such as used for

energy sources, soil fertility improvement, provision of pollen and nectar for honey production, construction materials, economic benefits, fodder values and shade for underneath crops and animals.

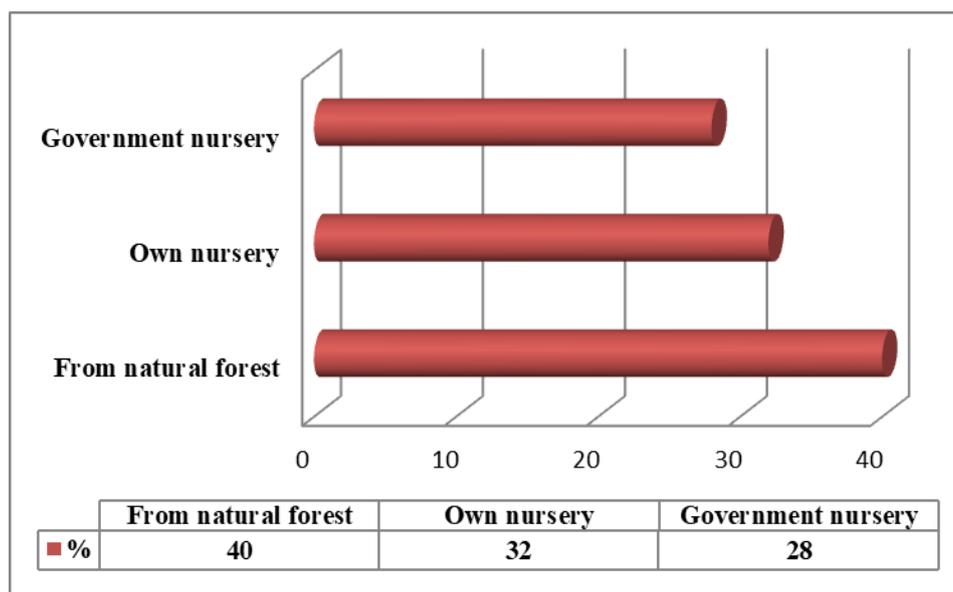


Fig. 4. Farmers source of planting material

Table 4. Farmers management practice and season of management practice of park land trees in Ana Sora District of Guji Zone, Southern Ethiopia

Farmers management practice of parkland trees	Frequency	Percentage	Season of parkland trees management practice	Frequency	Percentage
Thinning	2	5	Wet season	21	52.5
Pruning	16	40	Dry season	10	22.5
Thinning and Pruning	18	45	Year round	9	25
Thinning, Pruning and Pollarding	4	10	Total	40	100
Total	40	100			

3.6.1 Soil fertility improvement

The domestication of soil improving trees commonly known as multipurpose trees for enhancing soil productivity through a combination of selected trees and food crops on the same piece of a farm field is one of the reasons for practicing agroforestry [29]. Similarly, farmers of the study area have culture of tree planting or conserving those naturally regenerated tree species on their farm lands for the purpose of soil fertility improvement. This study showed that, farmers have practiced branch and shoot prunings of *Cordia africana*, *Croton macrostachyus*, *Erthrina abyssinica*, *Hagenia abyssinica* and *Schefflera abyssinica* parkland tree species for the purpose of soil fertility improvement through transferring the

biomass of the trees to the crop fields. In agreement with this study, previous study results conducted by [30-31] in different parts of the country showed that parkland tree species modify soil moisture availability through increased infiltration and their fallen leaves are commonly used as a fertilizer in farming systems. Furthermore, [32] reported that small shoots of species such as *Ficus sur* and *Cordia africana* plays a role in soil fertility management for trees integrated into agroforestry systems to conserve soils and add organic matter.

3.6.2 Timber and construction purposes

In Ethiopia, fast growing indigenous tree species are being increasingly integrated in the traditional land-use practices, mainly for timber, pole and

construction wood [33-34]. This study also showed that, from indigenous and exotic parkland tree species either planted or retained on farmers lands, *Crabia velutina*, *Cupresus lustanica*, *Eucalyptus camaldulensis*, *Hagenia abyssinica*, *Grevilla robusta*, *Juniperus procera*, *Podocarpus falcatus* and *Pinus patula* were the most commonly used tree species for timber and construction purposes. In support of this study, in Gemechis District of Harerge Zone and in Jimma South West Oromia farmers maintained scattered tree species on their crop fields, mainly for its wood products and indigenous trees are the most preferred species for the construction of doors, windows and other construction materials [26,35]. Moreover, in the Dawro Zone of Southern Ethiopia, local people use tree species such as *Cordia africana*, *Ficus vasta* and *Croton macrostachyus* for building and furniture purposes [36].

3.6.3 Fuel Wood

In Ethiopia majority of the rural population relies on biomass energy sources for every energy necessities. Fuel wood is the most important source of household energy for rural communities of Ethiopia and therefore, there is a need to integrate trees with food crops in the land use system. In the study area, smallholder farmers are highly depended on fuel wood for cooking, heating and lighting. From the identified parkland trees of the study area, the following tree species such as *Bersama abyssinica*, *Mytenus arbutifolia*, *Maesa lanceolata*, *Milletia ferugenia* and *Myrica salifolia* are commonly used for fuel wood. In line with this study, smallholder farmers of Gedeo Zone, Southern Ethiopia largely used *Millettia ferruginea* and *Prunus africana* indigenous tree species for fuel wood [15,37].

3.6.4 Shade for underneath crops and animals

In parkland agroforestry practice the role of tree species serving as a shade for underneath crops and animals are very significant. The survey results showed that, *Cordia africana*, *Ficus sur*, *Millettia ferruginea* and *Podocarpus falcatus* parkland tree species are serving for coffee shade.

In addition, the following exotic and indigenous parkland tree species such as *Grevilla robusta*, *Pinus patula*, *Cupresus lustanica*, *Schefflera abyssinica*, *Ficus sur* and *Pittosporum*

viridiflorum are commonly used for animal shade.

3.6.5 Beehives construction and bee forage values

The contribution of parkland tree species for beehives construction and bee forage values for smallholder farmers of the study area is higher. Based on the survey results, for beehives construction indigenous tree species are mostly preferred by farmers of the study district. In this regard, *Croton macrostachyus*, *Ekerbergia capensis*, *Ficus sur*, *Millettia ferruginea*, *Pittosporum viridiflorum* and *Polyscias ferruginia* were used for beehives construction and beehives are hung on their branches. In support of this study, [15] reported that *Croton macrostachyus*, *Ficus sur* and *Millettia ferruginea* used locally to make beehives in Gedio Zone, Southern Ethiopia. Moreover, the findings of this study indicated that indigenous parkland tree species are used as honey bee forage for honey production. Based on the findings of this study, flowering of *Cordia africana*, *Croton macrostachyus*, *Hagenia abysiiinica*, *Schefflera abyssinica* tree species are important bee forage of the study area. Similarly, in other areas of the country tree species such as *Cordia africana*, *Croton macrostachyus*, *Schefflera abyssinica*, *Vernonia amygdalina* and *Vernonia schimperiin* are valuables fodder plants for honey bees [38-39].

3.7 Constraints of Parkland Trees of the Study Area

Key informants and respondent households stated that parkland tree species of the study area were faced many challenges. This study showed that, constraints of parkland trees of the study district were lack of extension services (20.3%), inadequate supply of seedlings (24.7%), expansion of agricultural lands (17.3%), small land holding size (18.5%) and harvesting of the trees for various uses (19.2%) (Fig. 5). In agreement with this study, [40] reported that lack of replanting, exotic tree expansion and small land size were the major challenges for the improvement of parkland agroforestry practice in Southern Ethiopia. Furthermore, in their earlier study results [22,41] indicated that the expansion of exotic trees, small size of individual land holdings, inadequate research and extension services, land and tree tenure insecurity and increased strategy towards market oriented mono-cropping were the major constraints that cause decrease of the indigenous tree species in farmland.

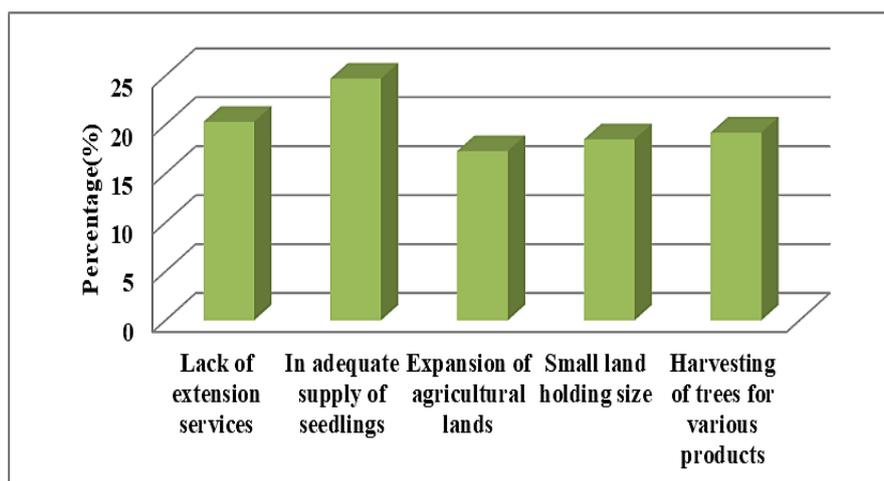


Fig. 5. Constraints of parkland tree species in the study area

4. CONCLUSION AND RECOMMENDATION

The present study has provided valuable information on the assessment of parkland tree species, farmers management practice, services and products of parkland tree species of the study area. The result of this study showed that 31(thirty one) parkland tree species were identified in the study area and majority of them were indigenous tree species. Smallholder farmers of the study area have their own preferences of parkland tree species based on the following criteria such as soil fertility attributes, construction values, bee forages, serving for shade and used for fuel wood for energy sources of households. Parkland tree species either retained or planted on the farmlands of smallholder farmers of the study area were obtained thinning, pruning and pollarding management practices for better growth of underneath crops, to transfer the biomass of the trees to the crop fields and for the purpose of fuel wood and construction material. Moreover, parkland trees contributed to soil fertility improvement, timber and construction values, bee forages, fuel wood and serving shade for under story crops and animals were some of the services and products of parkland trees for farmers of the study area. However, parkland tree species of the study area were faced a constraints such as expansion of agricultural lands, lack of extension services, in adequate supply of seedlings, small land holding size and over exploitation of the trees for various purposes. Therefore, attention should be given on conservation of parkland tree species and smallholder farmers of the study area could be

encouraged by the government through research and extension services and supplying by planting material of indigenous tree species to improve the significant of ecological and productive role of parkland tree species of the study area.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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