

Research Article

Assessment and Characterization of the Traditional Parkland Agroforestry Practices in Mid and Lowlands of Bale: In the Case of Goro and Ginnir Districts

Hirpa Abebe^{1,*}, Bikila Mengistu², Wondmagegn Bekele¹, Zerihun Dibaba¹, Baca Bultuma¹

¹Oromia Agricultural Research Institute, Sinana Agricultural Research Center, Bale-Robe, Ethiopia

²Oromia Agricultural Research Institute, Fitcha Agricultural Research Center, North-Shewa, Ethiopia

Abstract

Agroforestry parklands are playing an important role, through trees and shrubs providing multiple products and important long-term ecological benefits. Purposive sampling methods were applied to select districts, PAs and farmers which mostly used parkland agroforestry practices. Based on information delivered from informal assessment result, formal survey was done with selected 84 HHHs (sample size) for the study purposes. Based on the existences of long lived parkland agroforestry practice and associated challenges four PAs from Ginir and Goro districts of Bale Zones were selected purposively with assistance of district agriculture office expertise and DAs. Survey results showed the presence of 17 woody species of trees and shrubs representing eleven (11) families at the study areas. Of seventeen (17) woody plant species retained/planted and managed on parklands, 82.4% were native. Fabaceae was the most dominant woody species family which accounted about 41.2% of the total number of species recorded. The *Croton macrostachyus* Hochst., *Faidherbia albida*, *Cordia africana* Lam., *Acacia abyssinica* Hochst., *Juniperus procera* Hochst and *Acacia* species were the most frequently observed multipurpose woody species in the study area. Almost all of the respondents did practise different types of management activities or practices for the woody species they owned in parkland of the study areas. This finding revealed that pollarding (33.45%), coppicing (21.08%), branch pruning (35.56) and the rest thinning and protection woody species management practices were applied to the scattered trees on croplands of the study areas. On other side, respondents stated that the major challenges for the improvement of parkland agroforestry practices in the study area were instability of rain fail or drought (34.52%) and shortage of farmlands (21.43%). The finding of this study showed that agricultural landscapes (Parkland agroforestry practices) were the home/host of reasonable number of native woody species flora conservation or it's almost the remnants of the natural vegetation. Therefore, further need for more comprehensive analysis of the multiple benefits and services provided by parkland trees located on farmlands or the interaction effects of the agroforestry components on soil fertility improvement, crop yields and quality in the future.

Keywords

Agroforestry, Parkland, Parkland Management, Woody Species

*Corresponding author: eirpa2000@gmail.com (Hirpa Abebe)

Received: 8 January 2024; **Accepted:** 26 January 2024; **Published:** 17 April 2024



Copyright: © The Author(s), 2024. Published by Science Publishing Group. This is an **Open Access** article, distributed under the terms of the Creative Commons Attribution 4.0 License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

1. Introduction

Agroforestry parklands, broadly defined as areas where scattered multipurpose trees occur on farmlands as a result of farmer selection and protection, are widespread throughout the world.

Parklands agroforestry land use practice is characterized by well-grown scattered trees on cultivated and recently fallowed land on permanent manner. On a land area basis, they may represent one of the most extensive farming systems in the tropics. Among the benefits, the trees offer shade to grazing animals, protect crops against strong wind bursts, provide tree pruning's for firewood, and are a roost for insect or rodent-eating birds [1]. Canopy cover of the trees in parklands averages from 5 to 10% of the total land with variations mainly due to farmer attitudes toward trees in cultivated fields. Parklands are best developed near the villages, as here they can be well protected and managed [2]. This parkland agroforestry system is the most dominant agroforestry practice in the semi-arid and sub humid zones of Ethiopia. This native tree species are widely grown scattered according to some systematic patterns on bunds, terraces or field boundaries.

In parkland agroforestry in order to support the system and to get benefit, useful trees are encouraged to grow in the arable fields and pastures. The trees are chosen for their general usefulness, providing multiple products such as fodder, fruit, timber, fuel wood, medicinal products, etc. In addition, there are important long-term ecological benefits: the trees reduce erosion, help maintain soil fertility, and improve the microclimate for crops, reducing the incidence of wind and providing shade. Parkland trees are scattered far apart, so that they do not compete with their neighbors [2]. Trees offer stability in dry periods, as they are less vulnerable to drought and there must be drought resistant. In pastures trees are a stable component, providing forage in the dry season when fodder is scarce.

Interaction is a natural process which is observed in many parts of living things and can be defined as the effect of one component of a system on the performance of another component and/or the overall system [3]. Agroforestry systems are broadly categorized into two groups: 1) simultaneous systems, in which trees and crops are grown together in different spatial arrangements; and, 2) sequential systems, in which trees and crops are grown in rotation. Simultaneous systems include trees on croplands (parkland), hedgerow intercropping (HI), intercropping in perennial-tree-crop stands and multi-strata systems, where as sequential systems include rotational bush fallow or planted tree fallows followed by crops [4]. Some systems, such as taungya, rotational HI, and relay planted tree fallows in crops combine the features of both simultaneous and sequential systems. Interactions between woody and non-woody (herbaceous or annual crop) components is the key to the success of all agroforestry systems. Therefore, a better understanding of the interactions

provides a strong for improvement of traditional, as well as modern agroforestry system.

Soil fertility can be improved through organic and inorganic way. The organic way is improving the soil fertility by using biological material (plant and animal residue) through natural process. Whereas the inorganic way is improving the soil fertility status by using artificial or chemical fertilizer. Parkland agroforestry is also one of the land use system which improve soil fertility though natural way. One of the major advantages of including trees in crop cultivation is to enhance the soil physical, biological and chemical property [5]. Trees on the farm increase soil fertility by increasing soil organic matter and pumping soil nutrients from below the crop rooting zone and help recycle nutrient within the system. The fertility effects of trees on crop growth is based on the mineralization of nutrients from leaf and root litter and build up of soil organic matter [6].

Since Agroforestry parkland practice is one part of agroforestry it has long history in Ethiopia. This practice involves the growing of individual trees and shrubs in wide spaces in croplands. Dispersed trees grown in farmlands characterize a large part of the Ethiopian agricultural landscape [7]. Trees would be grown in a scattered form over a crop field, usually between 1–20 trees per hectare to minimize impact on the companion crop. In such mixed intercropping in order to reduce the impacts of tree on the crop, lopping and pollarding of trees would be practiced. Some good examples of this practice in Ethiopia are including *Cordia Africana* intercropping with maize in Bako and western Ethiopia *Acacia albida*-based agroforestry in the Hararghe Highlands and Debrezeit area [8]. In addition to this in the rift valley parts of the country the system is the most common cultivation method which is very familiar to the farmers. This system can be known by potential for supplying fodder, poles, farm equipment, fuel wood, and agricultural improvements [9].

This parkland agroforestry system is the most dominant agroforestry practice in the semi-arid and sub humid zones of Ethiopia. This native tree species are widely grown scattered according to some systematic patterns on bunds, terraces or field boundaries. Native tree species to be promoted for this purpose include: *A. abyssinica*, *A. bussei*, *A. etbaica*, *A. Sieberiana*, *A. tortilis*, *Acacia seyal*, *Balanites aegyptiaca*, *Faidherbia albida*, *Zizyphus spina-christi*. The suggested species can provide fuel wood, charcoal, shade, construction materials and farming implements, and fodder for livestock. Furthermore, farmers in these areas also confirmed their role in soil improvement and conservation. Their other uses include providing bee fodder, traditional medicine (only *A. tortilis*, *B. aegyptiaca* and *Zizyphus spina-christi*) and human food (only *B. aegyptiaca* and *Zizyphus spina-christi*) [10]. Therefore, this study was planned to assessment and characterization of the Traditional parkland agroforestry uses practices and to identified the com-

mon tree species which was indigenously used in parkland of study areas.

1.1. Statement of the Problem

Parkland agroforestry practices are one of the land uses in mid and lowland areas of Bale. Even if parkland agroforestry land use is common, but it is not characterized and also the type of tree species which was used for this parkland agroforestry practices is not identified. To expand and to fill the gap of this practices the characterization and identification of the system was mandatory.

1.2. Objective

To Assessment and characterization of the Traditional parkland agroforestry uses practices and to identified the common tree species which was indigenously used in parkland land use of study areas.

2. Materials & Methods

2.1. Description of the Study Area

The study was conduct in Ginir and Goro districts, Bale and East Bale zones, Oromiya Regional State of Ethiopia. East Bale zone which is about 540 km from Addis Ababa and 140 km from Bale zone capital (Robe). Ginir is geographically located between latitudes 7°12'00" to 7°2'00" N and 40°40'00" to 40°56'00" E longitude (Figure 1). The topography of the area is generally characterized by flat, gentle slope to undulating terrain, with an altitudinal range of 1184 to 2363 m.a.s.l. The area is characterized by a bimodal rainfall pattern and distribution, and average annual rainfall is 900 mm. Goro district is located in the midlands agro ecology areas of Bale with a bimodal rainfall pattern. The locations are known for mixed farming systems, where cereal is the dominant cultivated crop. Agriculture is the main source of livelihood in the both districts and it is characterized by mixed crop-livestock production system that is predominantly rain-fed.

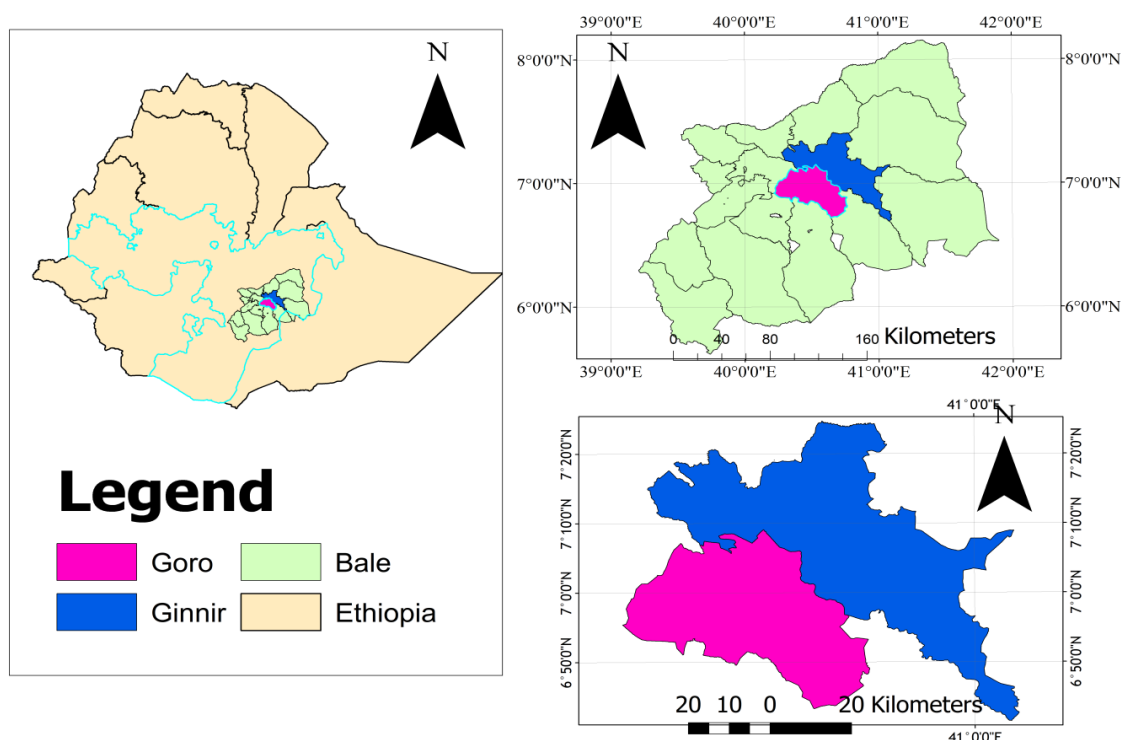


Figure 1. Study areas map.

2.2. Sampling Method

Purposive sampling methods were applied to select districts, Kebeles farmers which mostly used this parkland agroforestry practices. Based on information delivered from informal assessment result, formal survey was done with selected 84 HHHs (sample size) for the study purposes.

2.3. Study Design

Based on the existences of long lived parkland agroforestry practice and associated challenges four kebeles (Ebisa and Akash from Ginir and Gare and WaltaiChafa from Goro) of two districts of Bale Zones were selected purposively with assistance of district agriculture office expertise and Das.

2.4. Data Analysis

Quantitative data from household questionnaire survey were collected, coded, encoded into the computer, and statistically analyzed by using SPSS 20.0 version.

3. Results and Discussions

3.1. Socio-Demographic Features of the Respondents Households

Descriptive statistics were run to observe the distribution of the independent variables. The factors socio-economic and institutional characteristics of the respondents, such as age, gender, family size, level of education, marital status, household heads family members, current occupation of HHHs, duration of residence, and HH source livelihood/income depend on, etc., were analyzed. The demographic features of the household in the study area were presented in Table 1. From a total of 84 households interviewed for this study, total 96.4% of the households were male-headed while the rest were female household headed.

The age of the household head is an important characteristic that is useful to describe households and provide an indication about the age structure of the sample and the population as a whole. The age of the sampled household heads ranged from 25 to 80 years, thus those farmers aged 26 to 50 years contributed 50%. Similarly, those aged greater than 51 years had 46.4%, while the rest 3.6% less than 25 year aged. The family size of the respondent in this study is considered as the number of individuals who resides in the household on a full-time basis. The family size ranged from 2 to 15, with an average family size of 7 persons per household. Most of the time, the large family size was assumed as an indicator of labor availability in the family to use integrated agroforestry practices. Education is very important for farmers to understand and interpret the agricultural information coming to them from any direction. From the total respondents, 19% cannot read and write, 33.33% read and write, 25% primary 1st cycle (grade 1 to 4) complete, 17.9% were a 2nd cycle (grade 5 to 8) and the rest 4.8% were high school (10 to 12) and above. This is because education enhances the ability to derive, decode, and evaluate useful information for agricultural production (Table 1 and Figure 2).

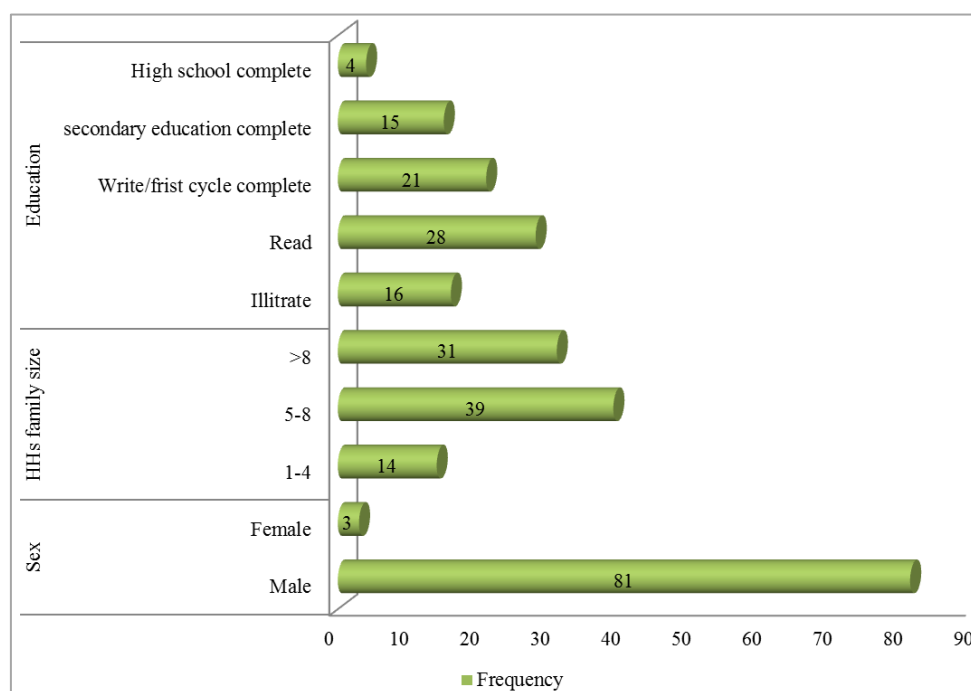


Figure 2. Socio-demographic Features (1).

With regard to marital status, from the total sample, 1.2% was single while the rest (98.8%) were married. The proportion of married respondents was much larger than the remaining marriage categories. Agriculture was the primary and current occupation almost for all of the households, which represents about 98.8%. From the agriculture HHHs liveli-

hoods/income sources depends on 17.9%, 81% cereal crop production and mixed or agroforestry (crop +livestock and fruit trees products) respectively and the rest was depend on livestock rearing according to the respondent response (Table 1 and Figure 3).

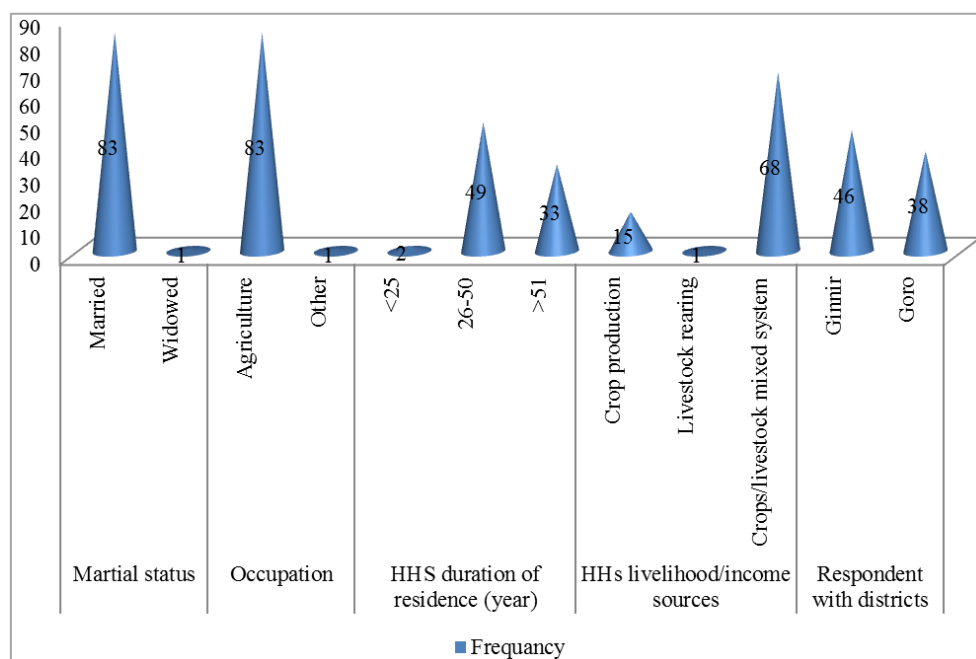


Figure 3. Socio-demographic Features (2).

Overall, respondents perceived that agroforestry farms are slightly more important than conventional farms in producing ecological benefits. What differentiates agroforestry from other land uses is the deliberate inclusion of woody perennials

on farms, which usually leads to significant economic and/or ecological interactions between woody and non-woody system components.

Table 1. Socio-demographic profile of respondents of the study areas.

No	Socio-Demographic Profiles		Frequency	Percentage (%)
1	Sex	Male	81	96.4
		Female	3	3.6
2	Age	<25	3	3.6
		26-50	42	50
		>51	39	46.4
3	HHs members	1-4	14	16.7
		5-8	39	46.4
		>8	31	36.9
		Illiterate	16	19.04
4	Educations status	Read	28	33.33
		1 st cycle complete	21	25
		2 nd cycle complete	15	17.9
		High school	4	4.8
5	Marital Status	Married	83	98.8
		Single	1	1.2
6	Occupation	Agriculture	83	98.8
		Others	1	1.2

Nº	Socio-Demographic Profiles		Frequency	Percentage (%)
7	HHs duration of residence (year)	<25	2	2.4
		26-50	49	58.3
		>51	33	39.3
8	HHs livelihood/income sources based on	Cereal crop production	15	17.9
		Mixed or Agroforestry (crop + livestock + trees/slurps)	68	81
		Livestock rearing	1	1.2
9	Respondent with districts	Ginir	46	54.8
		Goro	38	45.2
		Total	84	100

3.2. Woody Species Identification, Preference and Management

3.2.1. Identified Woody Tree/Shrub Species of Parkland Agroforestry at Study Area

Farmers have reasons why they retain/plant different tree/shrub species on their farm. The motives for retain-

ing/planting different woody species depend on the uses or benefits that they provide to the household. During this HH survey study result showed 65.5%, 1.2% and 33.3% of respondents' preferred or highly selected indigenous, exotic and both indigenous plus exotic woody species for their cropland respectively (Figure 3). This result is less number of species with findings of E. Guyassa et al. who found 40 woody species in the different agro-ecosystems in the Tigray region [11].

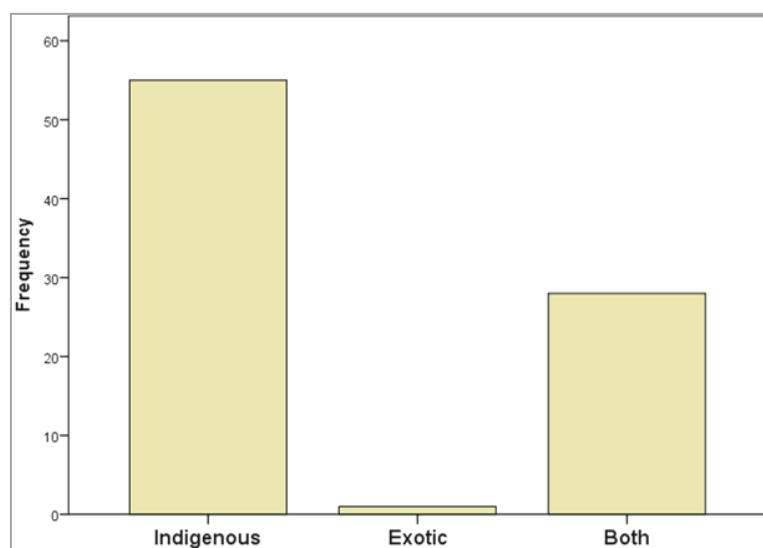


Figure 4. Woody tree/shrub species selected by the farmers of the study areas.

Survey results showed the presence of 17 woody species of trees and shrubs representing eleven (11) families at the study site (Table 2). Of seventeen (17) woody plant species retained/planted and managed on parklands, 82.4% were native. The result indicated the effectiveness of the conservation of larger proportion of native flora in the parkland agroforestry practices. In line with the current finding, [12] studied the species composition of agroforestry practices in Dollo Menna

district, South Eastern Ethiopia and found that only 15% were exotic species. Similarly, [13] studied the woody species of diversity of agroforestry practice of Gununo watershed, Woliata zone, Ethiopia and reported that out of a total of 32 woody species 69% were native to the area. At the family level, Fabaceae was the most dominant family, represented by seven (7) woody species (41.2% of the total number of species recorded), reason for this might be that the households' pref-

erence is inclined towards growing of leguminous plant species in their farm land, while the rest families were represented by one species each. The *Croton macrostachyus* Hochst., *Faidherbia albida*, *Cordia africana* Lam., *Acacia abyssinica* Hochst., *Juniperus procera* Hochst and *Acacia spp*s (Dodoti). were the most frequently observed multipur-

pose woody species on parkland in the study area. Most of the woody species retained by farmers in parklands were remnants of the natural vegetation, which covered the area before the settlements appeared. In contrast, *Calpurnia aurea* Benth., *Acacia lahai*, *Ficus vasta* and *Erythrina brucei* Schweinf. were rarely observed (Table 2, Figures 5 & 6).

Table 2. Woody perennial species and corresponding families identified in parkland agroforestry system in Bale zone, Southeast Ethiopia.

	Scientific name	Family name	Frequency			% of frequency
			Ginir	Goro	Total	
1	<i>Croton macrostachyus</i> Hochst.	<i>Euphorbiaceae</i>	46	15	61	28.37
2	<i>Cordia africana</i> Lam.	<i>Boraginaceae</i>	37	4	41	19.07
3	<i>Faidherbia albida</i>	<i>Fabaceae</i>	26	14	40	18.60
4	<i>Acacia abyssinica</i> Hochst.	<i>Fabaceae</i>	16	7	23	10.70
5	<i>Juniperus procera</i> Hochst.	<i>Cupressaceae</i>	7	4	11	5.12
6	<i>Acacia spp</i> s (Dodoti)	<i>Fabaceae</i>	-	12	12	5.58
7	<i>Combretum molle</i> R. Br ex G. Don	<i>Combretaceae</i>	-	5	5	2.33
8	<i>Balanites aegyptiacus</i> L.	<i>Balanitaceae</i>	-	5	5	2.33
9	<i>Acacia lahai</i>	<i>Fabaceae</i>	-	2	2	0.93
10	<i>Acacia tortolis</i>	<i>Fabaceae</i>	-	2	2	0.93
11	<i>Erythrina brucei</i> Schweinf.	<i>Fabaceae</i>	-	2	2	0.93
12	<i>Olea africana</i> Mill.	<i>Oleaceae</i>	1	2	3	1.40
13	<i>Ficus vasta</i>	<i>Moraceae</i>	2	1	3	1.40
14	<i>Calpurnia aurea</i> Benth	<i>Fabaceae</i>	-	1	1	0.47
15	<i>Eucalyptus globulus</i> Labill.	<i>Myrtaceae</i>	2	-	2	0.93
16	<i>Giravila robusta</i> A. Cunn	<i>Proteaceae</i>	1	-	1	0.47
17	<i>Casuarina equisetifolia</i> L.	<i>Casuarinaceae</i>	1	-	1	0.47

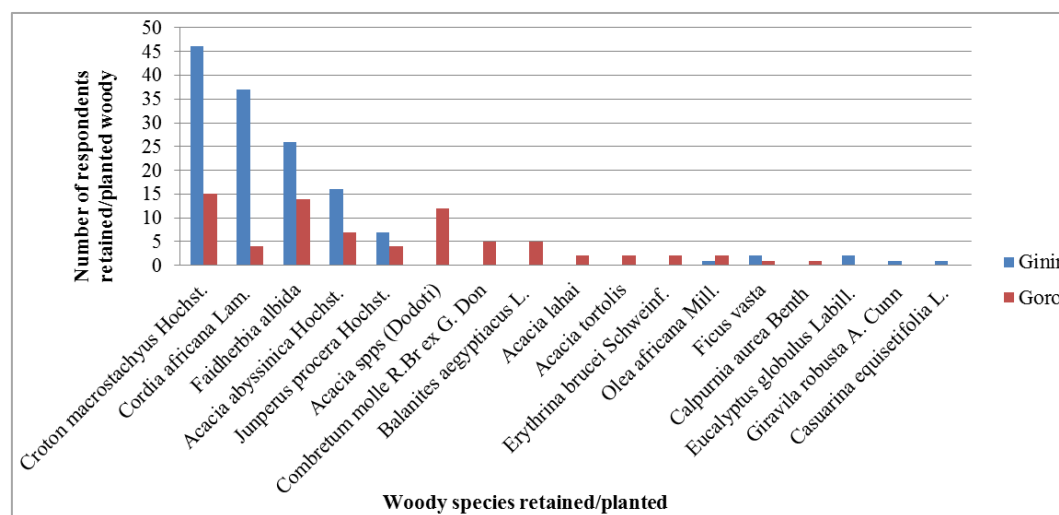


Figure 5. Retained/planted of woody species in the study parkland versus Districts.

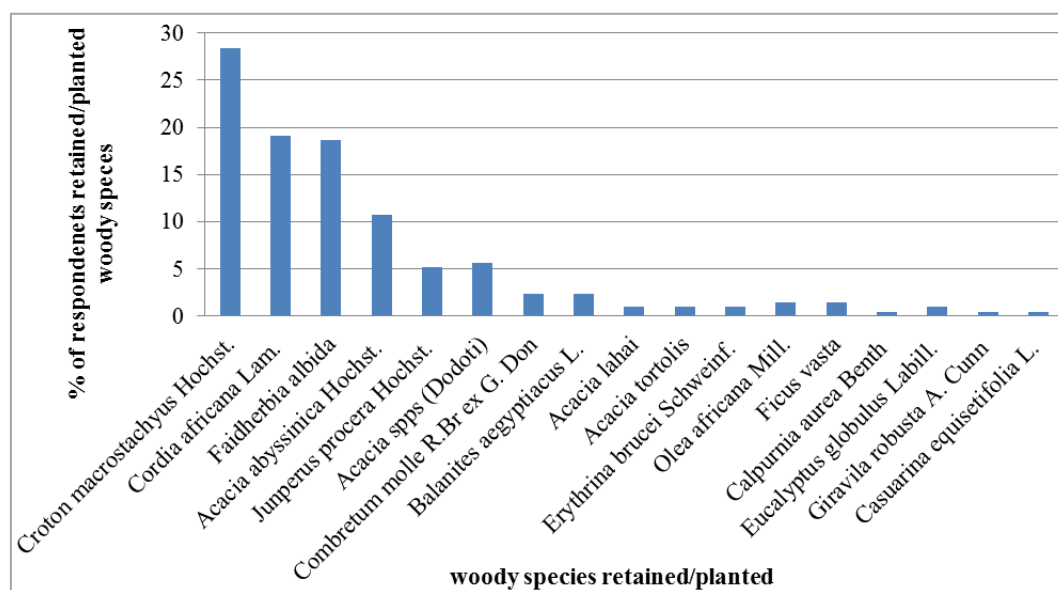


Figure 6. Retained/planted of woody species in the study parkland as the all.

3.2.2. The Immediate Uses/Purposes of Woody Species on Farm (Cropland)

The agricultural land use practices in the study area involve mixed farming system that include crop production, animal-rearing and tree/shrub planting and management. According to the result of respondent farmers derive sources of

their livelihoods about 98.8% from on-farm activities (agriculture production) and the rest from off-farm activities. Major sources of livelihood (income source) from on-farm activities include crop cultivation/production 17.9%, animal-rearing 1.2% and mixed (crops +livestock +woody fruit tree/shrub species) system 81.0% were respectively according to the respondents responded (Figure 7).

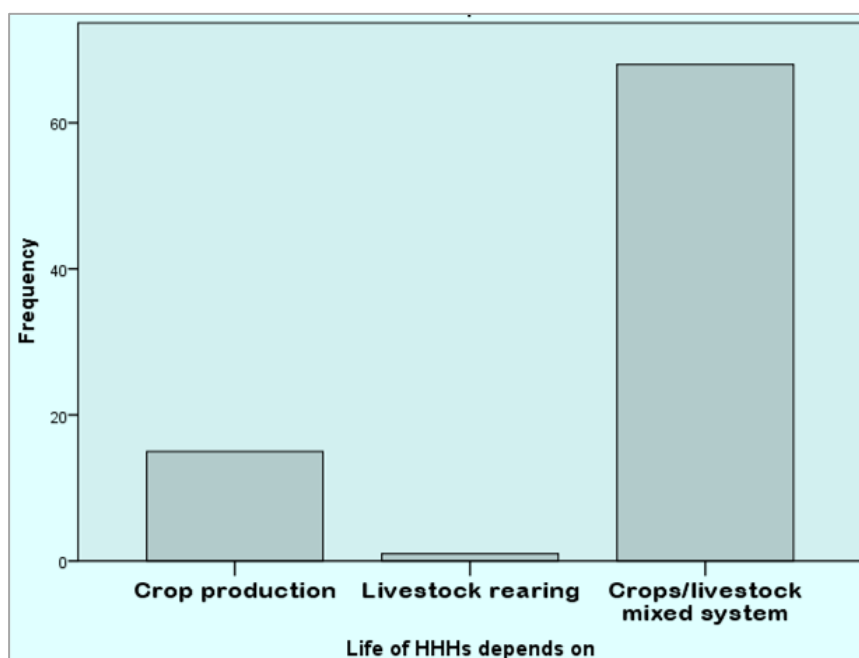


Figure 7. The main and major income sources of respondents HHHs of the study areas.

The result of this study showed that people retain/plant trees intentionally to obtain different economic and social benefits from the trees. Major benefits they obtain from trees

retained/planted woody species on their crop land include according to the respondents were fuel wood, shade (bee keeping), construction (timber, fencing), fodder and soil fer-

tility improvement. One woody species in cropland have more than two to three benefits/uses (Table 3 & Figure 8). This

finding is in line with other studies elsewhere in Ethiopia on scattered tree species on parklands [14, 15].

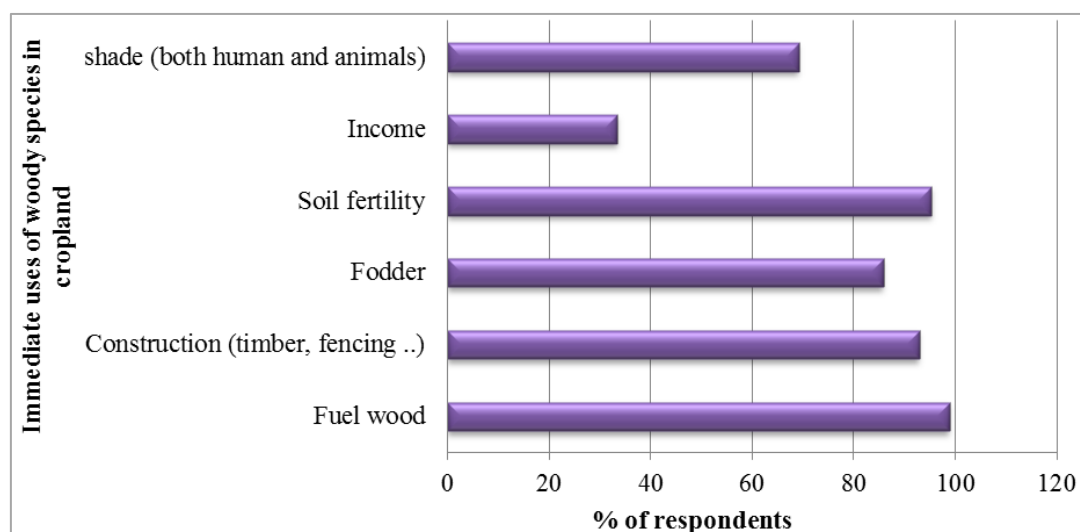


Figure 8. Immediate uses/purposes of woody species in cropland of the study areas.

The finding of this study is in line with the findings of [16, 17] who reported reasons for retaining different woody species to depend on the tangible uses and services that they render to the household.

Table 3. Lists of Immediate uses/purposes of woody species in cropland of the study areas.

S/n	Use categories	Number of households interviewed (n=84)		Types of trees/ shrubs*
		Number	%	
1	Fuel wood	83	98.81	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 16, 17
2	Construction (timber and fencing) and farm tools	78	92.85	2, 3, 4, 5, 7, 10, 12, 16, 17
3	Shade and medicinal uses	58	69.05	1, 2, 4, 11, 12, 13, 16,
4	Soil fertility	80	95.23	1, 2, 3, 4, 6, 8, 9, 10, 13
5	Fodder & Bee keeping	72	85.71	1, 2, 3, 4, 6, 8, 9, 10, 11, 13
6	Income	28	33.33	2, 5, 12, 13, 15, 16

*Legend: 1. *Croton macrostachyus* Hochst., 2. *Cordia africana* Lam. 3. *Faidherbia albida*, 4. *Acacia abyssinica* Hochst. 5. *Juniperus procera* Hochst. 6. *Acacia* spp (Dodoti), 7. *Combretum molle* R. Br ex G. Don, 8. *Balanites aegyptiacus* L. 9. *Acacia lahai*, 10. *Acacia tortolis*, 11. *Erythrina brucei* Schweinf. 12. *Olea africana* Mill. 13. *Ficus vasta*, 14. *Calpurnia aurea* Benth, 15. *Eucalyptus globulus* Labill. 16. *Giravila robusta* A. Cunn 17. *Casuarina equisetifolia* L.

According to this survey study result woody tree/shrub species growing stages more important for soil and crop improvement in cropland were maturity stages (98.8%) and the rest were stapling stages (Figure 9). The reasons for this effect can differ, but a key feature of agroforestry systems with

high increases in yield is that the trees contributes to improving soil fertility by replenishing nutrient levels through organic matter and nitrogen fixation, or by reducing the loss of organic matter and nutrients through erosion control and promotion of nutrient recycling [18].

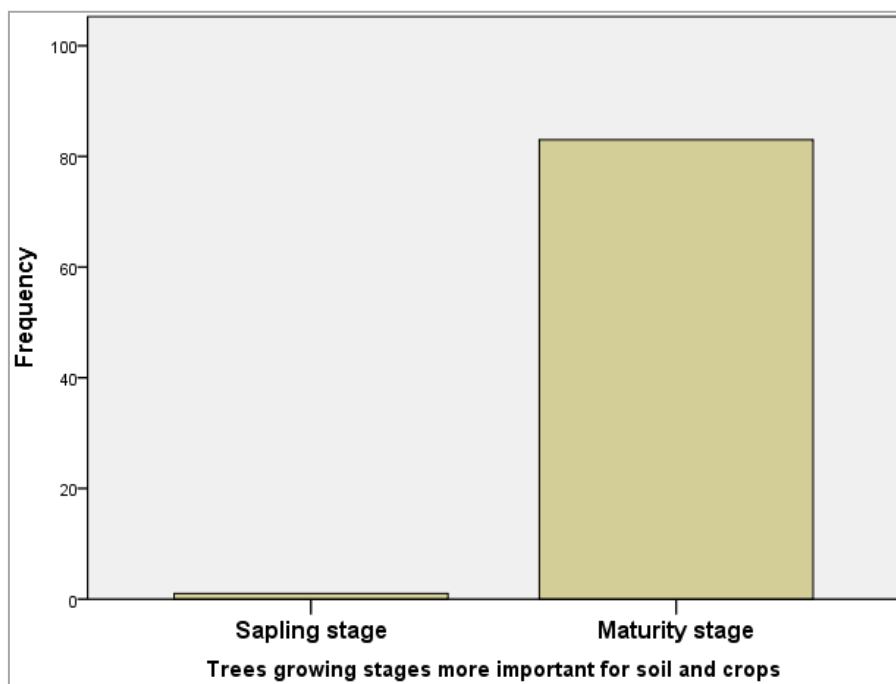


Figure 9. Woody species growing stages more important for soil fertility improvement and crops yields increments.

3.2.3. Management of Woody Species in Cropland/Parklands

Farmers not only have the knowledge of different woody species management practices but also they have the knowledge of which woody species require the different set of management practices and appropriate time. Almost all of the respondents did practise different types of management ac-

tivities or practices for the woody species they owned in the study areas. This finding revealed that pollarding (33.45%), coppicing (21.08%), branch pruning (35.56) and the rest thinning and protection woody species management types/practices were applied to the scattered trees on croplands of the study areas (Table 4 & Figure 10). Similar woody species management practices were reported in other parts of Ethiopia [16, 17, 19].

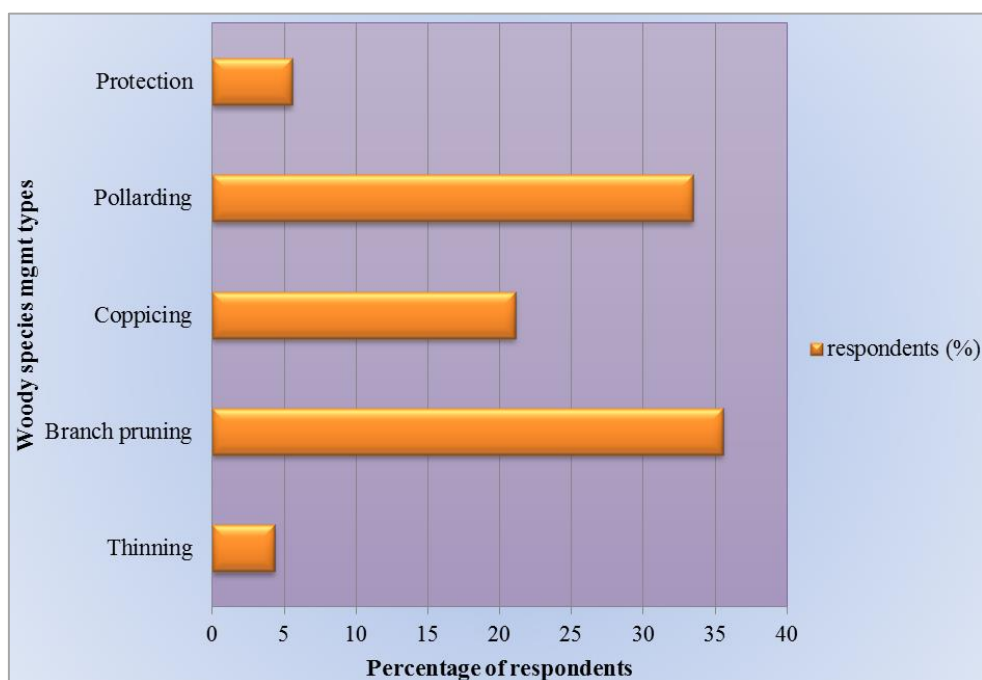


Figure 10. Parkland agroforestry woody species management practices as reported by HHs in the study areas.

General the objectives of applying the mentioned management practices above to managing woody species in their parkland according to the respondents were to increase growth, minimize competition and for diverse purposes in-

cluding fuel wood, construction materials, fodder, soil fertility improvement or to reduce negative interactions between components and maximize the system's overall products/values per land management unit.

Table 4. Number of sampled HHs respondents (%) mentioning reasons and type of management practice used for woody species at the study site.

S/no	Species	Types of management practices used for woody species responded by respondent (%)					Mgmt Used	Reasons/Purposes
		Thinning (a)	Branch Pruning (b)	Coppicing ©	Pollarding (d)	Protection (e)		
1	<i>Eucalyptus globulus</i> Labill.	5.2	0	73.6	0	5.2	a, c, e	GR, RC, FE, R
2	<i>Cordia africana</i>	3.4	30.2	41.5	26	4.2	b, c, d, e	RS, FW, FF
3	<i>Croton macrostachyus</i>	-	32	21	29.6	-	b, c	RS, FW, FR
4	<i>Ficus vasta</i>	-	48.2	-	31.6	-	b, d	RS, FW, FR
5	<i>Faidherbia albida</i>	-	38	-	25.6	-	b, d	RC, RS, FF, FW
6	<i>Acacia abyssinica</i> Hochst. (<i>A. species</i>)	-	21	-	38	-	b, d	RC, RS, FF, FW
7	<i>Juniperus procera</i> Hochst.	-	38	21	42	-	b, c, d	RC, RS, FF, FW
8	<i>Combretum molle</i> R. Br ex G. Don	-	28	43	-	-	b, c	RC, RS, FF, FW
9	<i>Balanites aegyptiacus</i> L.	-	21	-	46	-	b, d	RC, RS, FF, FW
10	<i>Erythrina brucei</i> Schweinf.	-	36.6	-	54.8	-	b, d	RC, RS, FF, FW
11	<i>Olea africana</i> Mill.	4.3	15	74	-	4.3	a, b, c, e	RC, RS, FF, FW
12	<i>Calpurnia aurea</i> Benth	-	34	-	64.6	-	b, d	RC, RS, FF, FW
13	<i>Giravila robusta</i> A. Cunn	-	23	-	34	-	b, d	RC, RS, FF, FW
14	<i>Casuarina equisetifolia</i> L.	-	0	73.6	0	5.2	c, e	RC, RS, FF, FW
	Av.	4.33	35.54	21.08	33.45	5.57		

Key: Management practices used=a=Thinning; b=branch pruning; c=coppicing; d=pollarding and e=protection; Purposes/reasons= GR= for growth; RC= to reduce competition; RS= to reduce shade; FW= for fuel wood; FF= for fencing; FR= for fodder

3.2.4. Criteria for Selection of Tree Species to Integrate with Croplands

Woody Tree/shrub species were an integral part of the farming system and farmers have long experience in integrating woody trees/shrubs species as their farming field in the study area. The 1st, 2nd, 3rd and the 4th woody species to integrate with crops in the study area were *Croton macrostachyus*, *Cordia africana*, *Faidherbia albida* and *Acacia abyssinica*, respectively (Table 2). Farmers select tree species suitable and adapted to agro ecology to growing niche and density of planting to minimize the effect of trees on crops.

For instance, trees that contribute positively to agricultural crops are grown dispersed in crop fields, while trees that compete with crops are planted separately to reduce the effect. According to this study result farmers apply a numbers of criteria to integrate woody trees/shrubs species on their farmlands, including fast growing, less compatibility with crops (long and straight rooted types..), multipurpose use-value (fodder, food...), increase soil fertility, timber quality, fast leaves decomposing ability and low branch volume (Figure 10). Similar findings were reported by [20] in crop-livestock- trees mixed systems in Lemo district Southern Ethiopian.

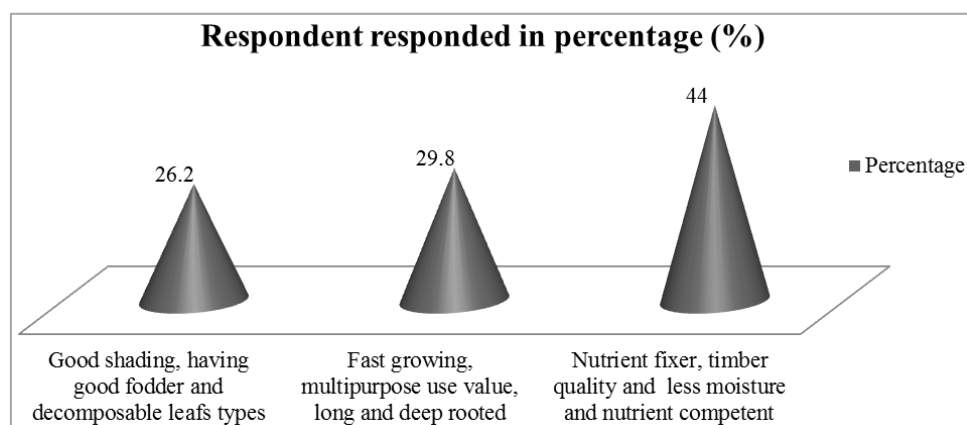


Figure 11. Criteria used for selection of woody species to integrate with croplands according to the responded of respondents in the study area.

3.2.5. Challenges for Managing Parkland Agroforestry Practices in the Study Area

Survey results showed that the study area was potential of parkland agroforestry practices and the finding revealed that, among the identified immediate importance's of parkland agroforestry at study area were fuel wood, construction materials provisions, shade, fodder and medium to long term were soil fertility improvement, crop yield increase, regulate climate of the area respectively were the major opportunities of parkland agroforestry practices in the study areas (Table 3 and Figure 9). On other side, respondents stated that the major

challenges for the improvement of parkland agroforestry practice in the study area were instability of rain fall or drought (34.52%), shortage of farmlands (21.43%), logging, shading effect and weed infestation (15.48%), impacts of wild animals/hosts for arboreal wild animals (birds, monkey, ape..) (9.53%) and late maturing (eating by cattle and birds) and leaf dropping on crops (8.33%) respectively (Figure 11). This finding is supported by [21-23] who reported the diversity of plant species in agroforestry is influenced by factors such as socio-economic status, garden size, rainfall pattern and management system (at upper catchment of lake Tana water shed and Walayta areas).

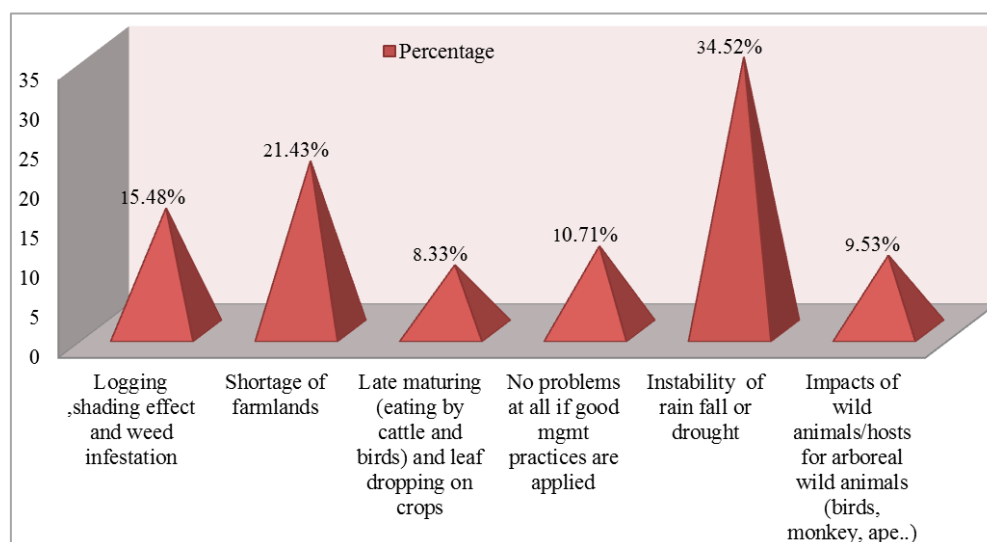


Figure 12. Major challenges of farmers in managing parkland woody plant species in study areas.

4. Conclusion and Recommendations

The finding of this study shown that agricultural landscapes (Parkland agroforestry practice) host reasonable number of native woody species flora conservation or it's the remnants of the natural vegetation which covered the area before the

settlements appeared.

Those retained and planted woody trees and/or shrubs in parkland agroforestry system were determined by the availability of the space, compatibility with agricultural crops and household objectives.

Fabaceae was the most species rich family owing to the

households' species preference in their farmland.

The foliage shedding characteristics of *woody species* attract the attention of farmers thus; retain it on their farmlands than any other species b/se those species did not interfere with agricultural crops and it gives an vast significance for sustaining soil fertility and provides animal fodder in the dry season.

Farmers used different mgmt practices at appropriate time for scattered woody species in cropland to reduce negative interactions between components and maximize the system's overall products/values.

On the other hand, the decline in number of woody species on the crop fields with age shows that those species preservation are not secured/not sustainable for the future or only temporary unless appropriate agroforestry practices/systems that are acceptable to the community will be implement and builds on the existing traditional (parkland) agroforestry practices.

Minimizing of challenges towards parkland agroforestry practices improvements have positive contributions for the local livelihood in terms of income, crop production, fertility of soil and other benefits for the study area in particular and for the country in general.

As a result, the policy aiming to increase tree cover should not only concentrate on large areas covered with trees but also should take into account scattered trees and small tree patches found on farmlands. Or it need good motivation on indigenous multipurpose woody species planting and conserving means in the croplands.

Hence, there are very limited studies found so far on parkland trees of Ethiopia; (study areas) there is a need further for more comprehensive analysis of the multiple benefits and services provided by parkland trees located on farmlands or the interaction effects of the agroforestry components on soil fertility improvement, crop yields and quality.

Acknowledgments

This work was financed and supported by Oromia Agricultural Research Institute, Sinana Agricultural Research center.

Conflicts of Interest

The authors declare no conflict of interest.

References

- [1] ICRAF, 2013. Agroforestry parkland in sub - Saharan Africa. Nairobi, Kenya.
- [2] Verheij, Ed. 2003 Agroforestry. Wageningen, Netherland. et rendements des mils *Pennisetum* au Sénégal. *Agronomie Tropicale* 6–7: 600–626.
- [3] Nair, PKR. 1993. An Introduction to Agroforestry. Kluwer Academic Publishers, Dordrecht, the Netherlands.
- [4] Sanchez, PA. 1995. Science in agroforestry. *Agroforestry Systems* 30: 5–55.
- [5] Rao, M. R., Nair, P. K. R. & Ong, C. K. 1998. Biophysical interactions in tropical agroforestry systems. International Centre for Research in Agroforestry, Kluwer Academic Publishers. Netherlands. *Agroforestry Systems* 38, 3–50.
- [6] ICRAF, 1996. Annual Report for 1995, pp 83–88, 64–69, 172–180, 207–210. International Centre for Research in Agroforestry, Nairobi, Kenya.
- [7] Badege, B. and Abdu, A. 2003. Agroforestry and Community Forestry for Rehabilitation of Degraded Watersheds in the Ethiopian Highlands. International Symposium on Contemporary Development Issues in Ethiopia, July 11–12, 2003, Addis Ababa, Ethiopia.
- [8] Hoekstra, D., E. Torquebiau and B. Bishaw, 1990. Agroforestry: potentials and research needs for the Ethiopian highlands. No. 21. ICRAF, Nairobi, Kenya. 115 p. <http://www.worldagroforestry.org>
- [9] Abebe, T. 2000. Indigenous Management and Utilization of Tree Resource in Sidama: In Mother Earth FTTP Newsletter. Human and Environment Lem, Vol. 4.3 (July–September).
- [10] Kindeya, G. 2004. The development of Agro forestry in the dry lands of Ethiopia. Paper presented in the dry lands agroforestry Workshop, 1–3 September 2004, Nairobi, Kenya. pp. 1–45.
- [11] E. Guyassa, A. J. Raj, 2013, Assessment of biodiversity in cropland agroforestry and its role in livelihood development in dryland areas: a case study from the Tigray region, Ethiopia, *J. Agric. Sci. Technol.* 9 (2013) 829–844.
- [12] Molla, A., & Kewessa, G. (2015). Woody Species Diversity in Traditional Agroforestry Practices of Dellomenna District, Southeastern Ethiopia: Implication for Maintaining Native Woody Species. *International Journal of Biodiversity*, 2015, Article ID: 643031.
- [13] A. Bajigo, M. Tadesse, 2015. Woody species diversity of traditional agroforestry practices in Gununo Watershed in Wolayitta zone, Ethiopia, *J. For. Res.* 4 (2015) 1–7.
- [14] Alebachew M. 2012. Traditional agroforestry practices, opportunities, threats and research needs in the highlands of Oromia, Central Ethiopia. *Intl Res J Agric Sci Soil Sci* 2 (5): 194–206.
- [15] Yusuf H, Solomon T. 2019. Woody Plant Inventory and Its Management Practices in Traditional Agroforestry of West Hararghe Zone, Oromia National Region State, Ethiopia. *Am J Environ Prot* 8 (5): 94–103. <https://doi.org/10.11648/j.ajep.20190805.11>
- [16] B. Lamage, A. Legesse, 2018. Management and socioeconomic determinants of woody species diversity in parkland agroforestry in Tembaro District, Southern Ethiopia, *Biodivers. Int. J.* 2(5) (2018) 456–462.

- [17] G. Yakob, Z. Asfaw, S. Zewdie, 2014. Wood production and management of woody species in homegardens agroforestry: the case of smallholder farmers in Gimbo District, South West Ethiopia, *Int. J. Nat. Sci. Res.* 2 (2014) 165–175.
- [18] Sileshi, G. W., 2016. The magnitude and spatial extent of influence of *Faidherbia albida* trees on soil properties and primary productivity in drylands. *J. Arid Environ.* 132, 1–14. <https://doi.org/10.1016/j.jaridenv.2016.03.002>
- [19] A. Agidie, B. Ayele, A. Wassie, K. M. Hadgu, E. Aynekulu, J. Mowo, 2013. Agroforestry practices and farmers' perception in Koga Watershed, upper blue Nile basin, Ethiopia, *J. Agric.* 59 (2013) 75–89.
- [20] A. Kuria, G. Lamond, T. Pagella, A. Gebrekirstos, K. Hadgu, F. L. Sinclair, 2014. Local Knowledge of Farmers on Opportunities and Constraints to Sustainable Intensification of Crop-Livestock-Trees Mixed Systems in Lemo Woreda, SNNPR Region, Ethiopian highlands, 2014.
- [21] D. Amare, M. Wondie, W. Mekuria, D. Darr, 2019. Agroforestry of smallholder farmers in Ethiopia: practices and benefits, *Small-scale For.* 18 (1) (2019) 39–56.
- [22] A. Abiyu, D. Teketay, G. Gratzner, M. Shete, 2014. Tree planting by smallholder farmers in the upper catchment of Lake Tana Watershed, Northwest Ethiopia, *Small-scale For.* 15 (2) (2016) 199–212.
- [23] T. Seta, S. Demissew, Z. Asfaw, 2013. Home gardens of Wolayta, Southern Ethiopia: an ethnobotanical profile, *Acad. J. Med. Plants* 1 (2013), 14–13.