

INNOVATIONS

Content available on Google Scholar

Home Page: www.journal-innovations.com

Contribution of Traditional Agroforestry Practices for Woody Species Diversity in Libo Kemkem District, South Gondar Zone, Amhara Region, Ethiopia

Melkie Achenef

Debre Tabor Univesity, Faculty of Agriculture and Environmnetal Sciences, Department of Forestry ,Ethiopia

Abstract: Understanding the role of traditional agroforestry practices for woody species composition and diversity is crucial to enhance agricultural productivity and ensure sustainable development. The aim of this paper was to assess woody species composition and diversity of traditional agroforestry practices in Libo Kemkem district, South Gondar zone, Amhara region, Ethiopia. For this study, three sample kebeles namely Mander Maraym and Asta Maryam from high land, Derta from mid land, and Shehoch Tara from low land kebeles were selected based on existing agroforestry practices and agro-ecological zone. Reconnaissance survey, field observation, and field inventory were carried out from on-site farm woody species. For socio-economic data collection, household survey was randomly administered on 112 respondents by using semi-structured questionnaires. Vegetable data were analyzed by using Shannon diversity index. The result revealed that farmers were planted and intentionally maintained diverse types of tree and shrub species on their farmland as farmland tree/shrub resources. The diverse traditional agroforestry practices across different agro-ecological zones of the inventoried sites have hosted a large number of indigenous (63) and exotic (11) woody species. A total of 74 woody species representing 35 families were recorded in the various traditional agroforestry practices across the three assessed agro-ecological zones. Among the 74 woody species recorded, 35 species were from the highland, 65 were from the mid-altitude and 27 from the lowland zone. Hence, traditional agroforestry practices provide a significant contribution for maintaining biodiversity in agro-ecosystems through preserving native and non-native woody species. The species diversity of agroforestry practices must be further augmented with both indigenous and useful non-invasive exotic woody species so as to improve its biodiversity conservation role in the agro-ecosystems.

Keywords: 1 . Agroforestry practice 2. Biodiversity 3. Conservation 4. Woody species

Introduction

Back ground and Justification

Ethiopia is a large country in the horn of Africa and located between 3⁰ and 15⁰ N latitude, 33⁰ and 48⁰ E longitude [1] and covers approximately 1.12 million km² (472,000 square miles) land surface area. It has a variety of climate, soil, topography and vegetation which supports high endemic flora and fauna that enables to attracts regional and global tourists [2]. In land area it is the ninth largest country in Africa. Ethiopia is a country with different landscapes and one of the countries with the widest cultural diversities in eastern Africa [3]. Agriculture provides approximately 70 percent of raw materials for the industrial sector; generates more than 90 percent of export earnings and 85 percent of employment. Even though the sector is imperative for the livelihood of the people and it is characterized by low productivity and outputs [4]. In Ethiopia, it is estimated that 40 percent of the land area was covered with forests at the beginning of the 19th century [5]. Peoples in mountainous areas heavily depend on forest resources for their livelihood and welfare [6]. With more than 90 million inhabitants [7] living in rural areas, Ethiopia is primarily an agrarian country. In Ethiopia, many rural communities have for centuries lived in and around vegetation areas and they make use of timber and non-timber forest products for their livelihoods [8]. Forest provides people with food, shelter, oxygen, recreation and timber and non-timber forest products. They are the source for more than 5,000 commercially-traded products [9]. However, this important resource is severely degraded from time to time. Despite the rich biodiversity resources and its potential benefits including forests, today's threats to species and ecosystems are the greatest recorded [10].

Ethiopia currently faces a number of environmental challenges. The forest resources in Ethiopia are depleting due to deforestation and forest degradation [11]. One of the major challenges facing Ethiopia in its struggle for agricultural development is environmental degradation, which is the process of progressive deterioration of biological (flora and fauna) and physical (soil, water, micro-climate, etc.) resources of the land, as well as loss of biodiversity [12]. Population pressure, environmental degradation, particularly loss of biodiversity, calls urgently for conservation, or planting of the right tree species at the right place for the appropriate purpose [13], along with management of remnant tree resources in the form of on-farm trees, other forms of agroforestry trees in rangelands and the like [14]. Agroforestry practices have evolved overtime in the world, capturing a lot of international attention as a viable alternative to many traditional land use systems [15]. In these traditional land-management practices, trees are deliberately retained on or around farm land, to support agriculture and other livelihood systems [13]. Agroforestry practices via the integration of trees, shrubs, crops, or animals in the same system has the capacity to resolve the needs of the people for food production and biodiversity conservation [16] by the provision of habitats for edge species [17], conservation of remnant native species and their gene pools [18], provision of corridors and stepping stones for persistence and movement of flora and fauna species by linking fragmented habitats [17], erosion control and water recharge, and buffering the logging pressure on the surrounding natural forest. Despite the large coverage and agroforestry practices in tropical countries like Ethiopia inventory and documentation of species composition and diversity studies are scanty and mainly focused in south and south western part of the country [19]. Therefore, this paper assesses and

quantifies the contribution of traditional agroforestry practices for woody species composition and diversity in Libo Kemkem district, Amhara region, Ethiopia.

Materials and Methods

Description of the Study Area

The study was conducted in Libo Kemkem district, South Gondar Zone, Amhara Region, Ethiopia (Fig 1). This district is situated between 12° 39' 66" and 12° 42' 45" N latitudes and 37° 26' 99" and 37° 28' 42" E longitudes. The district is located 645 and 70 kilometers away from Addis Abeba and the regional city of Bahar Dar respectively. It covers an area of 1,560 km² and comprises 33 rural and 2 urban Kebeles. The total population of the district is 198,951, of which 100,951 are males and 97,423 are females. The altitude of the district ranges from 1,800 to 3,000 meters above sea level and the temperature ranges from 18 °C to 25 °C. The area receives an average annual rain fall ranging from 900 to 1400 mm. From the total area of land, 51% is cultivable, 8.3% pasture, 5.9% forest or shrub land, 17.98% is considered degraded or other. The livestock populations of the district are estimated to be 115,453 cattle, 36,448 goats, 17,939 sheep, 371 horses, 461 mules; 1,220 donkeys; 75,972 hens and 10,337 bee hives [20].

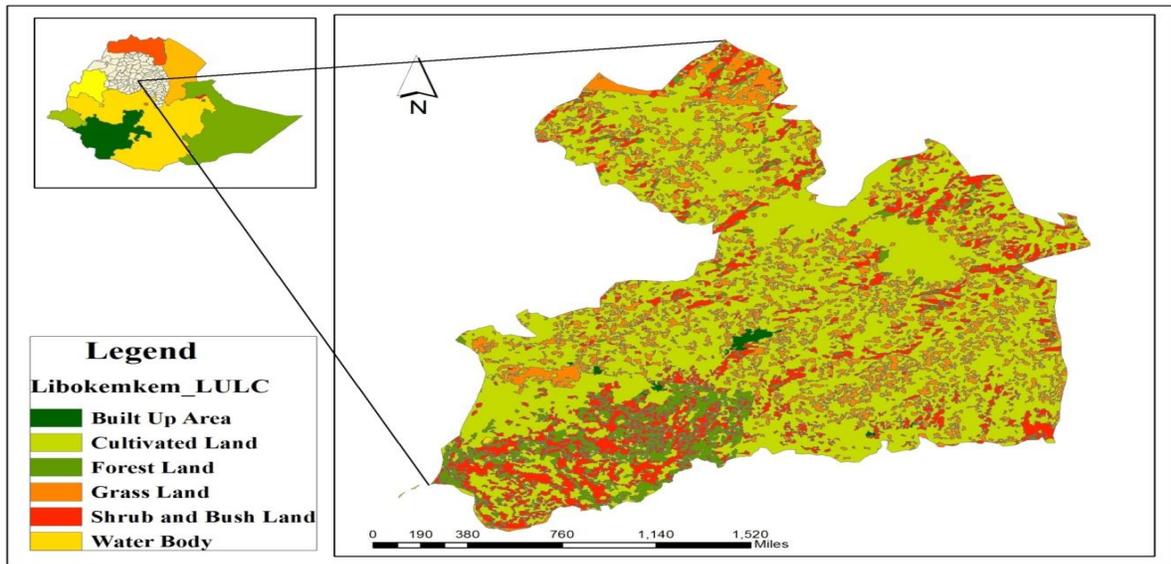


Figure 1. Map of the study area

The people of Libo Kemkem district are practicing diverse agricultural system which includes crop production and rearing of livestock as well as traditional agroforestry practices. Crop production is more dominant agricultural practices. In some areas where there are rivers, irrigation practice is common. The major types of crops grown in the area consist of cereals (wheat, teff, maize, barley, rice, and sorghum); pulses (beans, chickpeas, peas); oil seeds such as linseed, Niger seed. Moreover, *Chat* (*Catha edulis*), banana (*Musa spp.*), papaya (*Carica papaya*), lemon (*Citrus aurantifolia*), and gesho (*Rhamnus prinides*) are widely cultivated in the areas [21].

Research Methodology

This research was carried out in Libo kemkem District, which has diverse agroforestry practices that provide tangible and non-tangible output to the livelihood of the farmer. For the household survey, structured questionnaires with open and closed-ended questions were developed to collect the required socio-economic information and types of agroforestry practices. Moreover, On-farm woody species diversity assessment was carried out to estimate woody species composition and diversity. Household survey data were analyzed by descriptive statistics and on-farm woody species diversity was analysed by Shannon Diversity Index.

Reconnaissance survey

A reconnaissance survey was conducted to have a general overview of the research sites, the livelihoods of the community, and the conditions of the agroforestry practices in the study area. With the consultation of the district agricultural office three kebeles namely Mender Maryam and Asta Maryam, Derta and Shoch Tara were purposefully selected based on agro-ecological zones and traditional agroforestry practice. To assess the diversity of trees and shrubs within the traditional agroforestry systems, sample households were selected. These households (HHs) were asked to show the different agroforestry land use practices and tree/shrub species diversity in each production system. Data collected from each production system included woody species composition and diversity. All trees and shrubs in different farms (homegarden, silvopastoral system and parkland agroforestry farms) of each HH were completely enumerated. Although the contribution of smaller plants, such as herbaceous species, grasses, vegetables and field crops to the floristic diversity of farms is significant, the study was restricted to trees and shrubs, which are integrated into agricultural fields.

Data analysis

Woody Species Diversity

The species diversities in the traditional agroforestry farms were calculated using Shannon-Wiener Diversity Index (H') [22]. Diversity, comprised species richness and evenness. Indices that combine both richness and evenness in to a single value are diversity indices. Diversity has emerged as the most widely used criterion to assess the conservation potential and ecological value of a forest site [22].

Species Richness

Species richness is expressed as the total number of species in a community or per unit area.

Species Evenness

Species Evenness (measure of species balance) is a measure of the relative abundance of the different species making up the richness of an area. In other words, species evenness or equitability explains as to how species abundance is distributed among species. Equitability or evenness (J) is given by:

$$J = \frac{H'}{H'_{max}} = \sum_{i=1}^S p_i \ln \left(\frac{p_i}{\ln(S)} \right) = \frac{H'}{\ln S} \dots\dots\dots(3)$$

Where:

- H' is Shannon-Wiener Diversity Index
- S is the number of species found when all sample plots are pooled
- Pi is the proportion of total individuals in the ith species.

$$\text{Diversity Shannon diversity index (H')} = - \sum_{i=1}^S P_i \ln P_i \dots\dots\dots(4)$$

Where:

- H' is the Index of Species Diversity
- S is the number of species
- Pi=n/N is the proportion of individuals found in the ith species (ranges 0 to 1)
- n=number of individuals of a given species
- N = total number of individuals found [23].

Shannon diversity index (H') is taking in to account the number of individuals as well as the number of species. Shannon diversity varies from 0 for a community with only a single species to a high value for a community with many species, each with few individuals. Shannon diversity index (H') increases with number of species in a community and in theory can reach very large values. But in practice for biological communities H' does not exceed 5.0 [24]. The results are summed across the species and multiply by -1. Shannon diversity index is high when it is above 3.0, medium when it is between 2.0 and 3.0, low between 1.0 and 2.0, and very low when it is smaller than 1.0 [25].

Result and Discussion

Woody Species composition and Diversity of Traditional Agroforestry Practices

Farmers in the study area were planted and retained various type of trees and shrubs species. The diverse traditional agroforestry practices across different agro-ecological zones of the inventoried sites have hosted a large number of indigenous (63) and exotic (11) woody species. A total of 74 woody species representing 35 families were recorded in the various traditional agroforestry practices across the three assessed agro-ecological zones. Among the 74 woody species recorded, 35 species were from the highland, 65 were from the mid-altitude and 27 from the lowland zone (Table 1). Generally, higher number of woody species (65) was observed in the mid altitude as compared to high land (35) and low land (27) (Table 1). Even

the drier lowland site has a considerable number of woody species, which in some cases are more diverse than the apparently natural woodlands or natural forests. Similarly higher number of families was also recorded in the mid lands (35) than high land (24) and low land (17) as summarized below (Table 1, Figure 1). Agroforestry practices hosts a considerable number of tree species, which in some cases are more diverse than natural forests. According to a study report made by [26] only 54 species were existed in natural forest land at Gondar Zuria district as compared to (55) species in home garden and (58) species in parkland agroforestry practices. Moreover, a study carried out by [27] in Arsi Negelle area revealed that only 31 woody species were recorded in a natural forest as compared to 77 tree/shrub species in agroforestry practices.

Table 1. Number of species and families found in the three agro-ecological zones

Agro-ecological zones	Woody Species	Family
High land (Mender Maryam and Asta Maryam)	35	24
Mid land (Derta)	65	35
Lowland (Shoch Tara)	27	17

This study revealed that both the number of species and families of woody species were found to be variable across agro-ecological zones (Table 1). This could be due to altitude variation since it presents changes in the availability of resources, such as heat and water [28]. Moreover, among the 74 woody species recorded, 63 were naturally regenerated indigenous. The total number of exotic tree species recorded from all the surveyed farms was 11, and were found to represent 8 families. Among the 35 families identified in the study areas, the families with the highest number of woody species were Fabaceae (9), poaceae (9) and Myrtaceae (7) (Figure 1).

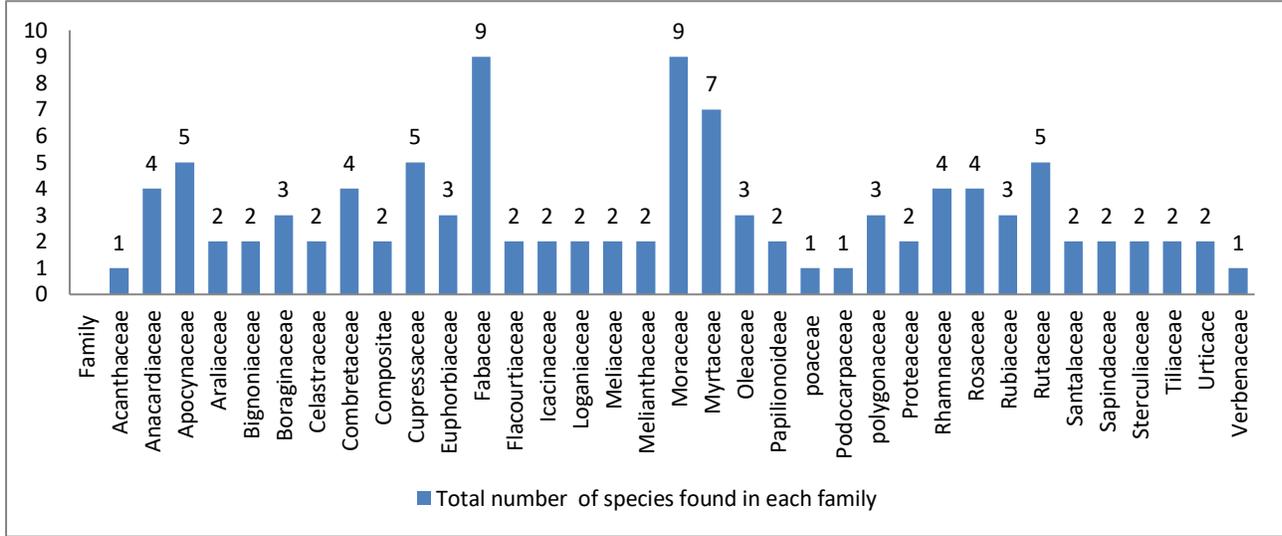


Figure 1. Total number of species recorded in each family in the three agro-ecological zones

Woody species comprises trees and shrubs. In terms of life form, trees outnumbered than shrubs in both sites (Figure 2). Among the 74 recorded woody species, trees and shrubs constituted 51 (69%) and 23 (31%) respectively (Figure 2).

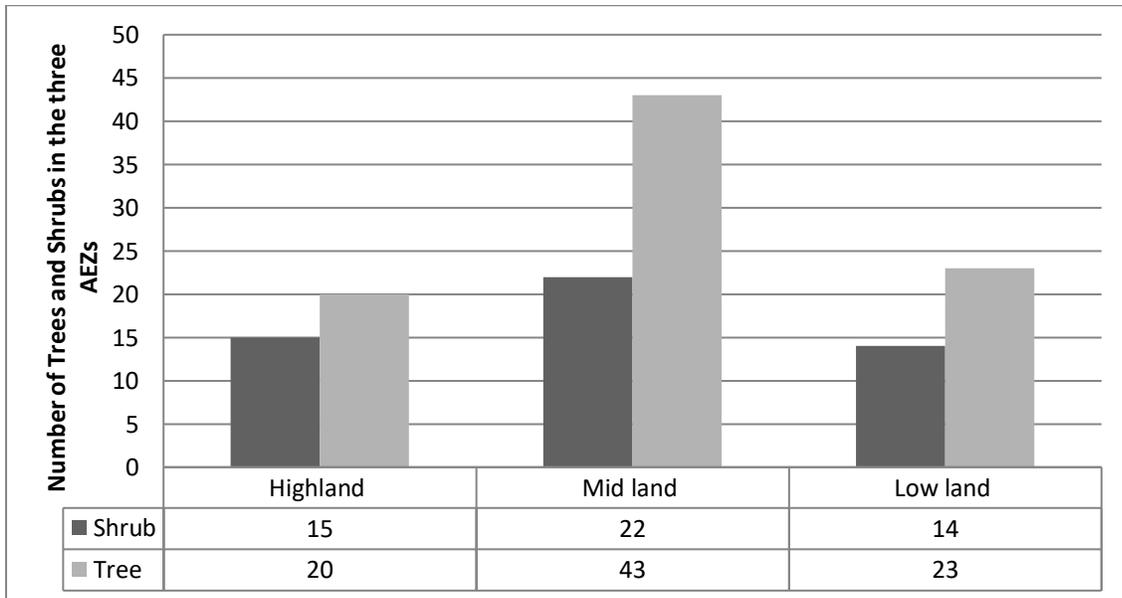


Figure 2. Proportions of trees and shrub species in each agro-ecological zone

The Shannon diversity index value for all the woody species encountered ranged from 1.69 to 2.61 for Low land and Mid land agro-ecological zones respectively (Table 2). The higher diversity of species found in the midland AEZs compared to high land and low land AEZs. The relatively high diversity values in turn indicates the importance of agroforestry practices for the conservation of genetic resources of the woody species, particularly for rare and unique

species that are under heavy threat of extinction. Shannon evenness indices were low in the low land agro-ecological zone (0.51) (Table 2). Relatively the higher evenness was encountered in the mid land AEZ (0.62) as compared to other AEZs. Generally, Shannon evenness indices were low in all AEZs indicating lack of uniform distribution of species over the sites (Table 2). However, higher evenness was encountered in the midland AEZ (0.62), which indicated the occurrence of few but evenly distributed species as compared to other AEZs. In all the three agro-ecological zones species richness was relatively higher (Table 1, 2) but due to the dominance by few species evenness was low (Table 2).

Table 2. Comparisons of various diversity indices of woody species in the three study sites.

Diversity indices	High land	Mid land	Lowland
Species richness	35	65	27
Species evenness			
Shannon's Equitability (J)	0.54	0.62	0.51
Heterogeneity			
Shannon-Wiener Diversity (H')	1.94	2.6	1.69

There is enough evidence to indicate that trees and shrubs, if managed properly, can make significant contributions for maintaining biodiversity, improving fertility and overall productivity of soils in agro-ecosystems [13]. Despite the overall diminish in the extents of biodiversity of the natural forests in the highlands of Ethiopia; traditional tree managements in the form of agroforestry have given refuges for a considerable number of native woody species. It could be possible that these native tree/shrub species are still preserved as farmland tree resources and serve as major sources of biodiversity rehabilitation in the future. Generally, in this study the diverse traditional agroforestry practices across different agro-ecological zones of the inventoried sites have hosted a large number of indigenous (63) and exotic (11) woody species. A total of 74 woody species representing 35 families were recorded in the various traditional agroforestry practices across the three assessed agro-ecological zones. This implies that traditional agroforestry practices can play a significant role in the conservation of woody species. This is in agreement with other study conducted by [29] on the diverse traditional agroforestry practices across different agro-ecological zones of southern eastern Ethiopia, which indicated that traditional agroforestry practices have hosted a large number of indigenous (72 tree/shrub species) and exotic (16 trees/shrubs species). Other studies carried out on Parkland agroforestry (scattered trees on-farm system) by [19] also indicated that park land agroforestry is one of the most noticeable traditional practices across most agro-ecosystems in the highlands of Ethiopia. In these systems, farmers deliberately preserve several native tree/shrub species for a variety of purposes such as protection of crops and workers from the sun heat, for the supply of fodder, fuel wood or fruits and to improve soil fertility. For instance, floristic study made in the Sidama traditional agroforestry system showed the existence of more than 80 native woody species on and/or near farmlands.

Conclusion

Farmers were planted and intentionally maintained diverse types of tree and shrub species on their farmland as farmland tree/shrub resources. Thus, traditional agroforestry practices across the different agro-ecological zones of the study area have hosted a large number of indigenous (63) and exotic (11) woody species. Totally, 74 woody species were recorded in this study area. Hence, traditional agroforestry practices provide a significant contribution for maintaining biodiversity in agro-ecosystems through preserving native and non-native woody species. The species diversity of agroforestry practices must be further augmented with both indigenous and useful non-invasive exotic woody species so as to improve its biodiversity conservation role in the agro-ecosystems.

Acknowledgement

The authors are grateful to the Debre Tabor University, Faculty of Agriculture and environmental Science, Department of Forestry for their financial support and provision of soft ware training.

References

1. Balcha G. (1999). *The status of forest genetic resources in Ethiopia. A paper presented at the regional training workshop on the conservation and sustainable use of forest genetic resources in Eastern and Southern Africa. 6-11 December 1999, Nairobi, Kenya.*
2. Young J. (2012). *Ethiopian Protected Areas a 'Snapshot'. A reference guide for future strategic planning and project funding by Ethiopian Wild Life Authority. Word Press, Addis Ababa, 23.*
3. Alemnew Alelign, Demel Teketay, Yonas Yemshaw, Sue Edwards (2007). *Diversity and status of regeneration of woody plants on the peninsula of Zegie, northwestern Ethiopia. Tropical Ecology 48(1): 37-49, 2007 ISSN 0564-3295.*
4. Adhikari, B., Williams, F., and Lovett, J.C. (2007). *Local benefits from community forests in the middle hills of Nepal. Forest policy and economics, 9(5), 464-478.*
5. Dudgeon, D. (2000). *The Ecology of Tropical Asian Rivers and Streams In Relation To Biodiversity Conservation. Annual Reviews Environ. Resource 31: 239-263.*
6. Liu, D., (2003). *Rehabilitation of Degraded forests to improve Livelihoods of poor farmers in south China. Center for International Forestry Research, Bogor, Indonesia. 97p.*

7. *UNEP (2016). The contribution of forests to national income in Ethiopia and linkages with REDD+. United Nations Environment Programme: Nairobi.*
8. *UNDP (2017). Socio-economic value of forest products for rural communities in Ethiopia Assessment Summary UNDP Ethiopia/2017World Bank (2004). International bank for reconstruction and development, the World Bank responsible for the new millennium, Washington, D.C.*
9. *Anonymous (2009). Convention on Biological Diversity (CBD) Ethiopians 4th Country Report, Addis Ababa.*
10. *Solomon Gebreyowhans (2015). Community perception on rangeland degradation: a case study in two differently settled areas of northern Ethiopia J. Agricult. Res. Dev., 5 (1)*
11. *Demel Teketay, Mulugeta Limenih, Tesfaye Bekele, Yonas Yeshaw, Sisay Fekete, Wubalem Taddese, Yitebitu Moges, Tesfaye Hunde and Demek Nigussie (2010). Forest Resources and Challenges of Sustainable Forest Management and Conservation in Ethiopia.*
12. *Nair, P.k.R. (1990). The prospects for agroforestry in the tropics. World Bank technical paper No 131. World Bank, Washington DC.*
13. *Food and Agriculture Organization (1986). Tree growing by rural people. FAO Forestry paper no. 64. FAO, Rome, Italy.*
14. *Harvey, C.A.; González Villalobos, J.A. (2007). Agroforestry systems conserve species-rich but modified assemblages of tropical birds and bats. Biodivers. Conserv. 2007, 16, 2257–2292.*
15. *Jose, S. (2009). Agroforestry for ecosystem services and environmental benefits: An overview. Agrofor. Syst. 2009, 76, 1–10.*
16. *Dawson, I.K.; Guariguata, M.R.; Loo, J.; Weber, J.C.; Lengkeek, A.; Bush, D.; Cornelius, J.; Guarino, L.; Kindt, R.; Orwa, C.; (2013). What is the relevance of smallholders' agroforestry systems for conserving tropical tree species and genetic diversity in circa situm, in situ and ex situ settings? A review. Biodivers. Conserv. 2013, 22, 301–324.*
17. *Zebene Asfaw (2003). Tree Species Diversity, Topsoil Conditions and Arbuscular Mycorrhizal Association in the Sidama Traditional Agroforestry Landuse, Southern Ethiopia. Doctoral thesis, Swedish University of Agricultural Science, Department of Forest Management and Product. Uppsala, Sweden*

18. *Workye Melese, Aschalew Assefa and Kirkim Dehnine (2018). Improved forage production practice and challenges in Libokemkem District, Ethiopia. Agric. Sci. Digest, 38(4) 2018: 280-284 Print ISSN:0253-150X / Online ISSN:0976-0547.*
19. *Magurran, A. E. (1988). Ecological Diversity and Its Measurement. Chapman & Hall, London*
20. *Shannon, C. I. and Wiener, W. (1949). The Mathematical theory of communication. University of Illinois Press, Urbana, Illinois.*
21. *Kerbs, C.J. (1999). Ecological Methodology. Second edition. Addison Wesley Longman, Inc.*
22. *Cavalcanti, E. A. H., Larrazábal, M. E. L. (2004). De.Macrozooplâncton da zonae conômica exclusiva do nordeste do brasil (segunda expedição oceanográfica – REVIZEE/NE II) com ênfase em Copepoda (Crustacea). Revista Brasileira de Zoologia. 21 (3): 467-475.*
23. *Behonegn Akalu (2010). Diversity, Structure and Socioeconomic Importance of Woody Vegetation in North Gondar, Ethiopia: The Case of Gondar Zuria Woreda, MSC Thesis, university of BOKU, Austria*
24. *Motuma Tolera (2006). Woody species diversity of agricultural landscapes in ArsiNegelle district, Ethiopia: implications for biodiversity conservation, M.Sc. thesis, University of Hawassa, Wondo Genet College of Forestry, Ethiopia.*
25. *Shimono A, Zhou H, Shen H, Hirota M, Ohtsuka T, Tang Y.(2010). Patterns of plant diversity at high altitudes on the Qinghai-Tibetan Plateau. Journal of Plant Ecology. 2010; 3(1):1-7.*
26. *Biruk Asfaw (2006). Woody species composition and socio-economic roles of traditional agroforestry practices across different agro-ecological zones in south eastern Langano, Oromiya, MSC Thesis, Hawassa University, Wondo Genet College of Forestry.*

Appendix

Appendix-1: The botanical name of woody species in the three agro-ecological zones of Libo Kemkem district, Ethiopia

No.	Species	Family	Life form	Abundance in study sites			Origin
				High land	Mid land	Low land	
1	<i>Acacia abyssinica</i> (Hochst. ex Benth)	Fabaceae	tree	7891	156	-	I
2	<i>Acacia decurrens</i>	Fabaceae	tree	312	-	-	E
3	<i>Acacia polyacantha</i> Willd.	Fabaceae	tree	-	-	105	I
4	<i>Acanthus arboreus</i>	Acanthaceae	shrub	-	48	-	I
5	<i>Albizia gummifera</i> (J.F. Gmel.)	Fabaceae	tree	144	106	-	I
6	<i>Anogeissus leiocarpus</i>	Combretaceae	tree	-	76	11	I

Innovations, Number 65 June 2021

7	Apodytes dimidiata	Icacinaceae	tree	142	60	-	I
8	Arundo donax L.	Poaceae	tree	-	410	-	I
9	Azadirachta indica	Meliaceae	tree	-	78	102	E
10	Bersama abyssinica Fresen.	Meliantaceae	tree	78	138	-	I
11	Buddleia polystachya	Loganiaceae	shrub	492	49	-	I
12	Carissa edulis Vahl	Apocynaceae	tree	497	209	-	I
13	Carissa spinarum	Apocynaceae	tree	21478	100	39	I
14	Citrus aurantifolia (Christm.)	Rutaceae	shrub	-	312	40	E
15	Citrus reticulata	Rutaceae	shrub	-	98	-	E
16	Citrus sinensis (Osbeck)	Rutaceae	shrub	-	212	22	E
17	Coffee arabica (L.)	Rubiaceae	shrub	-	513	22	I
18	Cordia Africana (Lam)	Boraginaceae	tree	2547	298	96	I
19	Croton macrostachyus (Del)	Euphorbiaceae	tree	8108	431	30	I
20	Cupressus lusitanica (Mill.)	Cupressaceae	Tree	159	55	-	E
21	Dalbergia melanoxylon	Fabaceae	tree	-	-	10	I
22	Debregeasia bicolor	Urticaceae	tree	62	2	-	I
23	Dodona eaviscosa (L.F)	Sapindaceae	shrub	114	179	-	I
24	Dombiatorrida (J. F. Gmel.)	Sterculiaceae	shrub	78	10	-	I
25	Dovyalis abyssinica (A.Rich.) Warb.	Flacourtiaceae	shrub	89	48	-	I
26	Ekebergia capensis (Sparrm.)	Meliaceae	Tree	-	23	-	I
27	Entada abyssinica	Fabaceae	climber	-	111	-	I
28	Eucalyptus spp	Myrtaceae	tree	77608	8113	2000	E
29	Ficus sur (Forssk.)	Moraceae	tree	2312	57	33	I
30	Ficus thonnigii (Blume)	Moraceae	tree	2309	247	15	I
31	Ficus vallis (Choudae)	Moraceae	tree	-	45	-	I
32	Ficus vasta (Forssk)	Moraceae	tree	-	71	24	I
33	Gardenia volkensii	Rubiaceae	tree	-	-	6	I
34	Grevillea robusta (A. Cunn. Ex. R. Br.)	Proteaceae	tree	428	78	-	E
35	Grewia ferruginea Hochst. ex. A. Rich.	Tiliaceae	shrub	321	36	-	I
36	Juniperus procera (Hochst. Ex Endl.)	Cupressaceae	tree	97	91	27	I
37	Mangifera indica (L.)	Anacardiaceae	tree	-	46	247	E
38	Malus domestica	Rosaceae	tree	4587	-	-	I
39	Maytenus arbutifolia (A. Ric) Wiczeck	Celastraceae	Shrub	348	638	-	I
40	Myrica salicifolia	Myricaceae	tree	28	-	-	I
41	Millettia ferruginea (Hochst.) Baker	Fabaceae	tree	-	61	-	I
42	Olea europaea L.	Oleaceae	tree	1251	54	-	I
43	Osyris compressa	Santalaceae	shrub	441	2	-	I
44	Podocarpus falcatus (Thunb.) Mirb.	Podocarpaceae	tree	-	49	-	I
45	Premna schimperi (Endle)	Verbenaceae	shrub	-	78	-	I
46	Prunus persica (L. Batsch)	Rosaceae	tree	48	612	2	I
47	Psidium guajava (L.)	Myrtaceae	tree	-	-	210	E
48	Rhamnus prinoides (L'Herit.)	Rhamnaceae	shrub	398	526	40	I
49	Rhus glutinosa (A. Rich)	Anacardiaceae	tree	-	21	-	I
50	Rhus vulgaris Meikle	Anacardiaceae	shrub	-	10	-	I
51	Rosa abyssinica Lindley	Rosaceae	Climber	148	30	-	I
52	Rumex nervosus Vahl.	polygonaceae	shrub	57	21	8	I
53	Schefflera abyssinica (Hochst. ex. A. Rich.)	Araliaceae	tree	98	25	-	I
54	Sesbania sesban (L.) Merr.	Papilionoideae	shrub	50	171	-	E
55	Stereospermum kunthianum	Bignoniaceae	tree	-	22	14	I
56	Syzygium guineense (Wild.) DC	Myrtaceae	tree	147	247	-	I
57	Terminalia liabrownii	Combretaceae	tree	-	5	9	I
58	Vernonia amygdalina (Del.)	Compositae	tree	152	63	-	I
59	Ximena Americana L.	Olacaceae	tree	-	135	-	I
60	Ziziphus spina-christi	Rhamnaceae	tree	-	-	3	I
61	Unidentified (Wachla)		tree	-	4	-	I
62	Unidentified (Wajnse)		shrub	108	10	-	I
63	Unidentified (Termi)		tree	-	5	1	I
64	Unidentified (Serkine)		tree	-	2	-	I
65	Unidentified (Qlabo)		shrub	152	2	-	I
66	Unidentified (Qorba)		tree	-	2	-	I
67	Unidentified (Meflo)		tree	-	24	-	I
68	Unidentified (Aberkha)		tree	-	-	4	I
69	Unidentified (Ahomza)		shrub	-	22	-	I
70	Unidentified (Arggfo)		tree	-	2	-	I
71	Unidentified (Bertlom)		tree	-	3	1	I

Innovations, Number 65 June 2021

72	Unidentified (Marleva)		shrub	-	5	-	I
73	Unidentified (Lemcha)		tree	-	10	-	I
74	Unidentified (Galzba)		tree	-	11	-	I
Total number of species in each AEZ					35	65	27
Total number of species in the three AEZ					74		

“+” denotes presence of species and “I” denotes indigenous species.

“-” denotes absence of species and “E” denotes planted exotic species.