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Woody fodder species in three agro-ecological Parklands of Arba Minch Zuria Woreda, Gamo Gofa Zone, Southern Ethiopia

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This study was conducted in Arba Minch Zuria Woreda of SNNPR, Ethiopia on Parkland agroforestry practices in three agro-ecological zones. The objective of the study was to investigate the fodder tree and shrub species composition, richness, diversity and structure. Key Informant Interviews and Focus Group Discussions were held. In total, ninety 50 m × 20 m plots were laid and standard procedures were followed. Forty nine woody species belonging to 43 genera and 31 families were identified as fodder species. Fabaceae represented by 7 species and Combertaceae and Moraceae (3 species each) were the most diverse families. Mid altitude (H'=2.98) is more diverse followed by High altitude (H'=2.23) and Low altitude agro-ecology (H'=1.94). Species in the low altitude were densely populated and have large basal area followed by mid altitude and high altitude. The top most important species with highest Importance Value Index (IVI) were *Ficus sur* (51.90), *Ficus sycomorus* (46.484) and *Mangifera indica* (60.161) High altitude, middle altitude and lower altitude, respectively. Generally, in the study area, there were diverse fodder trees and shrubs, all likely sources for farmers to feed livestock. So, there should be strong management and conservation practices to ensure future availability, continuous awareness raising efforts, and further study should be conducted for nutritional evaluation.

Key words: Fodder, diversity, Parkland, Arbaminch Zuria Woreda, agroforestry practices.

INTRODUCTION

It has been reported that status of animal protein deficiency in developing world is caused by shortage of forage (Azim et al., 2011; Gaikwad et al., 2017). This constraint mainly limits the realization for exploitation of the full potential of the livestock resources. If animals are not properly fed, they cannot express their genetic potential for production and reproduction (Adugna et al., 2012).

Fodder tree and shrub are increasingly recognized as an important component of animal feeding; especially as available supplies of protein in many parts of world. Different scholars (Chakeredza et al., 2007; Abebe et al.,

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2008; Aynalem and Taye, 2008) studied and published reviews about the importance of these fodder trees and shrubs in different areas at different times.

Livestock production provides smallholders with a number of benefits, but it also possesses real threats to the environment, which can be mitigated through agroforestry interventions (Dawson et al., 2014). The production of livestock in East Africa has to date mostly focused on these interventions (Cecchi et al., 2010; Dawson et al., 2014; Baudron et al., 2015).

The fodder obtained from trees or shrubs, containing high levels of crude protein, mineral matter and digestibility, are acceptable by the livestock, because of their deep root system; they continue to produce well into the dry season (Dicko and Sikena, 1992; Paterson et al., 1998). They are also considered to be an important contributor to grazing livestock nutrition in rainy areas (Lefroy et al., 1992; Devendra, 1997; Abebe et al., 2008). During the prolonged dry and crop fallow season, farmers traditionally use leaves of indigenous fodder tree species to meet nutritional requirement of grazing or browsing livestock (Lefroy et al., 1992; Otsyina et al., 1999; Gaikwad et al., 2017).

Traditional agroforestry practices are common in various parts of Ethiopia like coffee shade tree systems, scattered trees on the farmland (Parkland agroforestry), homegarden, woodlots, farm boundary practices, and trees on grazing land (Endale, 2019).

The southern region of Ethiopia is endowed with indigenous agroforestry practices that have evolved over years, and which have enabled maintenance of the region's greenery, with its magnificent ecological and socio-economic benefits (Tesfaye, 2005; Molla, 2016). The region is known for its diverse and immense biodiversity of resources in different natural and agroforestry settings (Tesfaye, 2005; Mengistu and Asfaw, 2016; Aklilu and Melaku, 2016; Molla, 2016).

Tree and shrub resources from natural forests are lost due to agricultural expansion and high human and livestock pressure associated with land degradation and feed shortage (Geist and Lambin, 2002; Feddema et al., 2005; FAO, 2010; DeFries et al., 2010, Chakravarty et al., 2012; Kissinger et al., 2012; Hosonuma et al., 2012; Tadesse and Solomon, 2014). This holds true also for fodder tree and shrub species despite high demand of these species for feeding livestock in the community to get increased products.

To cope with such problems, agroforestry is considered as the best solution (Nair, 1993; Bhagwat et al., 2008; Alao and Shuaibu, 2013; Atangana et al., 2013; Atangana et al., 2014).

Livestock in the Ethiopian rift valley mainly depend on grazing of natural grasses and crop residues (Belete et al., 2012; Yisehak et al., 2014). As a result, there are issues of sustainability of natural forests and other reservoirs. The Gamo Gofa zone, generally, and Arba Minch Zuria Woreda, particularly, is not exceptional. Traditionally, there are fodder trees and shrubs grown in and around farm lands that the livestock can utilize as fodder in the agroforestry practices.

The land use systems where there is scattered tree and shrubs in a farmer's crop field are commonly called Parklands; and agroforestry practice is most traditional in these areas. Despite these convenient tree- and shrub-based agricultural systems, there are no previous reports on fodder tree and shrub species in the Arba Minch Zuria Woreda of the Gamo Gofa zone. So the current study investigated the composition, richness, diversity and structure of woody species, which serve as animal feed, in the three main agro-ecological zones of Ethiopia: highland (2300-3200masl), midland (1500-2300masl) and lowland (500-1500masl).

MATERIALS AND METHODS

Description of study area

Location and topography

The study was conducted in three kebeles namely Chano Mile representing lowland, Dega Ocholo representing midland and Zigiti Merche representing highland of Arba Minch zuria woreda of Gamo, Southern Ethiopia (Figure 1).

Arba Minch Zuria is one of the woredas in the Southern Nations, Nationalities, and Peoples' Region of Ethiopia. A part from the Gamo Gofa Zone located in the Great Rift Valley, Arba Minch Zuria is located roughly between 5°70" -6°21" N latitude and 37° 31"- 37° 67" E longitude. The woreda is found at about 500 km south of Addis Ababa, capital city of Ethiopia.

Topography of the *woreda* is characterized by escarpment and narrow valleys. The slope ranges between 20 and 70% which has resulted in massive soil erosion. The altitude of the woreda lies between 1150 and 3300 masl.

The drainage patterns follow the general topographic orientation, so that small rivers rising from Gamo highlands drain to Lake Abaya and Lake Chamo. Among these, Hare and Baso drain to Lake Abaya; whereas Kulfo, Sile and Sego Rivers drain to Lake Chamo (AZWANaRDO, 2016/2017).

Climate and soil

Out of 29 kebeles in Arba Minch Zuria Woreda, 10 kebeles (33%) are in lowland, 15 kebeles (53%) are in midland and the remaining 4 kebeles (14%) are in highland agro-ecology (AZWANaRDO, 2017).

The average annual temperature of the woreda ranges from 16 to 37°C, varying between July and March. Rainfall distribution in the woreda is bimodal with a long rainy season from the beginning of March to the end of May with maximum rainfall around the month of April (228 mm), and a short rainy season from mid-August to mid-October. The minimum rainfall is recorded in January (18 mm) (AZWANaRDO, 2017).

As Mateos (2003) stated, the soils under the forest and the state farm are composed of three main types: Fluvisols, Gleysols and Vertisols. Fluvisols consist of soil materials developed in alluvial deposits and flood plains. Accordingly, it is mainly quaternary volcanic alluvial deposits and lacustrine clay.

According to AZWANaRDO (2017), the total land area of the woreda is about 168,172 ha from which 60,605 ha are occupied by settlements, roads, and others, 45,916 ha are arable land, 34,137 ha are cropland, 15,163 ha are forest land, 8,450 ha are water

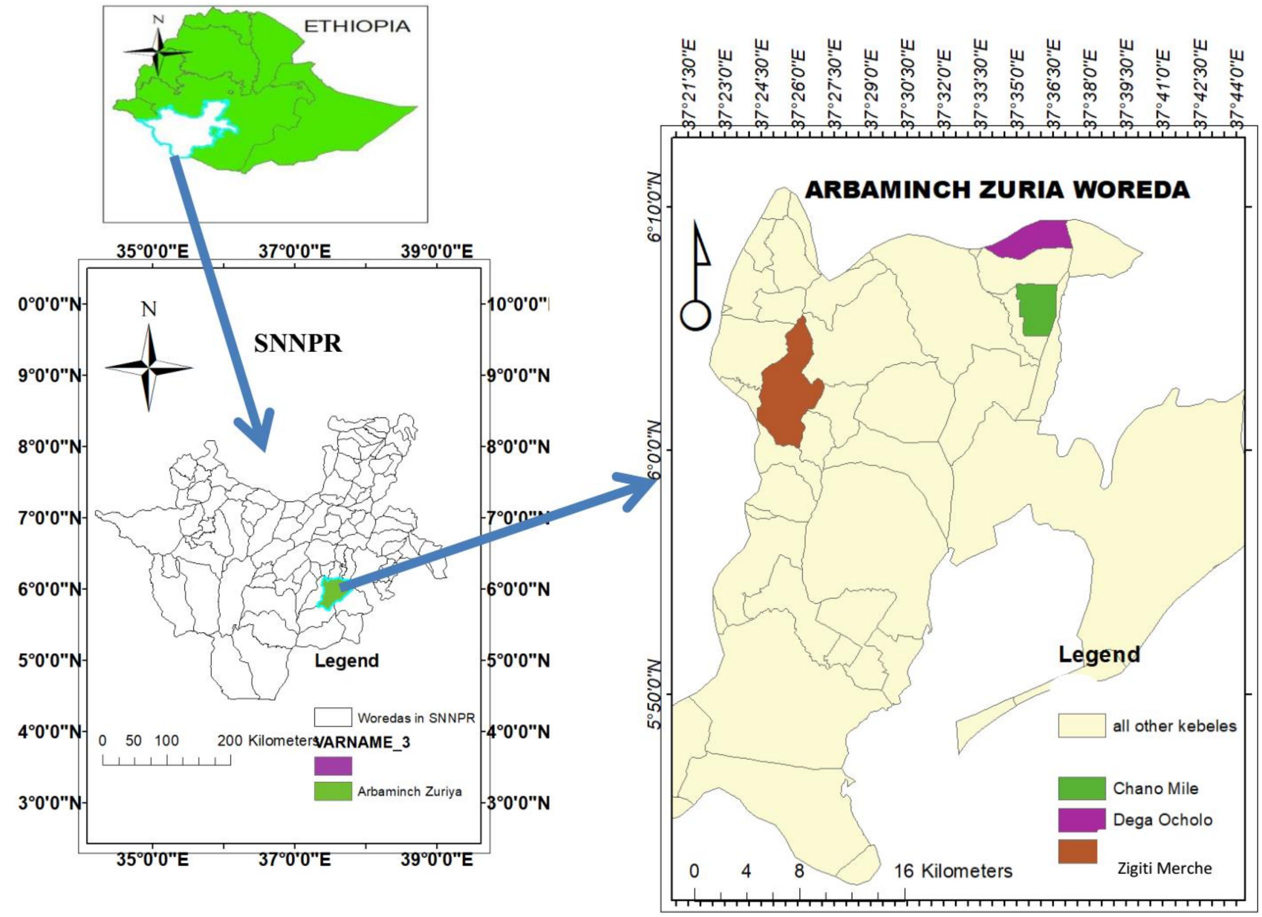

Figure 1. Map of the study area.

bodies, 3,563 ha are grazing land, and 338 ha are non-arable land.

Sampling and data collection

Site selection and sampling techniques

The study was conducted in three selected kebeles of Arba Minch Zuria Woreda, that is, Chano Mille (1,178-1,233 masl), Dega Ocholo (1,600-2,200 masl) and Zigit Merche (2,220-2,682 masl), each from lowland, midland and highland agro-ecology, respectively. The study kebeles were selected purposively based on their suitability and accessibility for the researcher. Reconnaissance was carried out to get firsthand information about the landuse/land cover types of the area so that sampling plots could be established in appropriate way.

To ascertain the Parkland agroforestry practice of each *kebele*, an inventory was conducted using a transect walk. Thus, along each transect line, the available identified fodder tree and shrub species were inventoried in each of the 50 m × 20 m (1000 m^2) sample plots. In total ninety, sample plots (that is**,** 30 from each *kebele)* were laid. The distance between each of the transects and plots was 500 and 400 m, respectively. But, areas like roads, stone gorges, and natural forests were not considered. The first plot was selected randomly and subsequent plots were systematically selected. In addition to these, an agricultural development expert (DA), focus group discussant (FGD), and key informants (KII) were selected. As a result, one agricultural development expert and four key informants were purposively selected from each kebele. The key informants were the model farmers who were knowledgeable about animal production and fodder tree feeding/farming as an agroforestry practice by adapting techniques used by den Biggelaar (1996). The participants of group discussion were selected by the help of experts (DAs). Specifically, they were drawn from elder farmers and village leaders in each kebele.

Data collection method

Key informants (knowledgeable model cattle breeders), personal experiences and observation were deployed to identify fodder tree/shrub species in the study area. For the identified fodder trees/shrub species, the local name, part edible by the animals and the type of animals that mostly prefer the species were identified and further confirmed by the FGDs as well. Species identification for common species was done in the field using different plant identification keys as references (Azene, 2007). But for others species, identification was done by an expert botanist in the discipline.

All identified fodder tree and shrub species in each plot of the Parkland agroforetsry were counted and recorded. For those tree and shrub species with DBH ≥ 2.5 cm, DBH and height measurements were taken using tree caliper and clinometer, respectively. Where topography made the height measurement difficult, height was estimated using a graded 5-m tree pole. The altitude of each plot and garden was recorded using GPS. Particular events like experience of planting the fodder species, and fodder foliages collected by farmers were also photographed to complement observations on the ground.

Data analysis

Diversity, richness and structure

Fodder tree and shrub species diversity of parkland agroforestry practices was calculated using Shannon diversity index (H') (Kent and Coker, 1992). Each of the Shannon diversity index was converted to effective number of species (True diversity) for comparison. The Shannon diversity index is calculated as follows:

$$H' = -\sum_{i=1}^{S} (Pi * ln\ Pi) \quad (1)$$

where H′ is the Shannon-Wiener index of species diversity, *s* is the number of species in community, P_i is the proportion of total abundance represented by the i^{th} species, and *ln* is natural log. True diversity was calculated and expressed in terms of number.

$$\text{True diversity} = e^{H'} \quad (2)$$

where *e* is the base of the natural logarithm and *H' is* Shannon-Wiener index.

Structure

The structure of fodder trees and shrubs were characterized in terms of Density, Basal Area, Frequency and Importance Value Index (IVI) as recommended by Newton (2007) and Leul et al. (2010). The structural parameters for fodder trees and shrub species, including Density, Basal Area, Dominance, Frequency and Importance Value Index were analyzed and calculated using the relative standard equation as the following.

Density

This is the most important structural parameters to be considered during vegetation data analysis calculated as:

$$\text{Density} = \frac{total\ No\ of\ individual\ species}{sample\ area\ in\ hectare} \quad (3)$$

$$\text{Relative density} = \frac{total\ number\ of\ individuals\ of\ aspecies}{total\ number\ of\ all\ species} x\ 100 \quad (4)$$

Basal area

It is the cross-sectional area of woody stems at breast height or at 1.37 m. It is calculated as:

$$BA = \frac{\pi (DBH)^2}{4} \quad (5)$$

where π = 3.1416, BA = basal area (m^2), DBH = diameter at breast height (cm).

Dominance of species

This is calculated as follows:

$$Dominance = \frac{\text{area covered by species}}{\text{sum of all plot areas in Ha}} \quad (6)$$

$$Relative\ dominance = \frac{\text{basal area of single species}}{\text{total basal area of all species}} x100 \quad (7)$$

Frequency

It is defined as the probability of finding a species in a given sample area or quadrat (Mata et al., 2011). Two frequency values were computed for each woody species encountered within the study plots:

$$F = \frac{\text{Number Of Plots In Which Species Occured}}{total\ number\ of\ sample\ plots} \text{X100} \quad (8)$$

$$RF = \frac{\text{Frequency of a species}}{Frequency\ of\ all\ species} x100 \quad (9)$$

where F is frequency and RF is relative frequency.

Important value index (IVI)

This is used to express the relative ecological significance of the species in the ecosystem. It was calculated by summing up the relative dominance, relative density and relative frequency of the species (Kent and Coker, 1992) calculated as follows:

$$IVI = RF + Rd + RD \quad (10)$$

where IVI stands for importance value index, RF for relative frequency and Rd for relative density and RD for relative dominance. The species floristic and structural data were analyzed using Microsoft excels version 10 software.

RESULTS AND DISCUSSION

Species composition

A total of 49 species belonging to 43 genera and 31 families were identified as fodder trees and shrubs from the three agro-ecologies. The species were also distributed among different families in different proportions. Accordingly, Fabaceae was represented by 7 species; both Combretaceae and Moraceae were represented by 3 species; Anacardiaceae, Boraginaceae, Buddlejaceae, Meliaceae, Myrtaceae, Rubiaceae, Verbenaceae, and Oleaceae were represented by 2 species each; and the rest of the families were represented by one species each. The species reported in this study were in agreement with the previous literature in other areas. For instance, species such as *Acanthus pubescens*, *Buddleja polystachya*, *Celtis africana*, *Combretum molle*, *Millettia ferruginea*, and *Terminalia schimperiana* were reported as fodder species from Wolaita zone by Takele et al. (2014). *Annona senegalensis, Acacia albida, Kigelia africana* and *Terminalia brownii* were also reported as important browse species in improvement of livestock feeds in western Bahr El Ghazal State of Sudan by Gaiballa and Lee (2012). *Cordia africana, Ehretia cymosa* and *Vernonia amygdalina* were reported as multipurpose fodder trees in Ethiopia by Abebe et al. (2008). *Leucaena leucocephala, Azadirachta indica* and *Psidium guajava* were reported as fodder species from the scarcity zone of Maharashtra in India (Gaikwad et al., 2017). *Grevillea robusta, Persea americana, Mangifera indica* and *Carica papaya* were reported from Kenya as fodder species by Gachuiri et al. (2017). Most of the species identified in this study were also reported as fodder in different parts of Ethiopia by Azene (2007).

Richness

The species richness of the fodder tree and shrub were 19, 32 and 19 in lowland, midland and highland, respectively. This shows species richness is higher at midland with an irregular pattern at increasing altitudes. This could be because of suitability of the mid agro-ecology for different species. Besides, this can be explained in terms of fewer disturbances in midland.

Diversity

In terms of fodder tree and shrub species, Parkland agroforestry of midland (H' = 2.98, 20 species) is more diverse followed by highland (H' = 2.23, 9 species) and lowland agro-ecology (H'= 1.94, 7 species). This report is in disagreement with the report by Tesfaye (2005) and Shimono et al. (2010), who reported that species diversity and richness decrease with increasing altitude in a regular trend. However, species richness and diversity were higher in midland followed by Highland and Kola. This could be because species in lowland were dominated by uniform fruit plantations (homogenization) and other fodder species (e.g., *M. indica* and *Cordia africana*) unlike that of different remnant and natural regenerating species in addition to suitability of agro-ecology of midland and highland.

Structure

The structure of Fodder tree and shrub species was analyzed (Appendix 1). Accordingly, fodder tree and shrub species in the Parklands of Lowland (140 individuals ha^{-1}) were densely populated followed by Midland (114.3 individuals ha^{-1}) and Highland (88.7 individuals ha^{-1}). This result is in agreement with Yirefu et al. (2016). The authors reported that woody species density and richness decreases from lowland to highland. This could be due to the fact that to get maximum benefit of desired product (e.g., fruit) farmers might have accommodated a higher number of tree and shrubs species in Lowland.

The species such as *V. amygdalina* (25.0 individuals ha^{-1}, 28.2%), *B. polystachya* (20.67 individuals ha^{-1}, 23.3%) and *Erythrina brucei* (13 individuals ha^{-1}, 14.7%) were abundant fodder tree and shrub species in *Highland* (Zigit Merche). In Midland (Dega Ocholo) species such as *C. africana* (16 individuals ha^{-1}, 14%), *T. brownii* (15.3 individuals ha^{-1}, 13.4%), *Rhus vulgaris* (12.7 individuals ha^{-1}, 11.08%), and *Ficus sur* (11.3 individuals ha^{-1}, 9.9%) contributed for more of the total density of the fodder trees and shrub species. Whereas, *M. indica* (individuals ha^{-1}, 36.43%), *C. africana* (26. individuals ha^{-1}, 19.05%), and *Trichilia emetica* (11.7 individuals ha^{-1}, 8.33%) were the most abundant species in Lowland (Chano Mile).

The basal areas of the species in Parkland of the respective agro-ecology regions varies from 0.320 m^2 ha^{-1} in Highland, 0.893 m^2 ha^{-1} in Midland to 1.005 m^2 ha^{-1} in Lowland, respectively. The fodder tree and shrub species with the highest basal area in Parkland agroforestry practice of Highland were *Ficus sur* (0.110 m^2 ha^{-1}, 34.45%), *C. africana* (0.09 m^2 ha^{-1}, 28.09%), *E. brucei* (0.031 m^2 ha^{-1}, 9.55%) and *Dombeya torrida* (0.018 m^2 ha^{-1}, 5.68%). *Ficus sycomorus* (0.385 m^2 ha^{-1}, 43.06%), *Ficus vasta* (0.145 m^2 ha^{-1}, 16.25%), *P. americana* (0.077 m^2 ha^{-1}, 8.93%) and *F. sur* (0.053 m^2 ha^{-1}, 5.96%) were the species that contribute highest percent of the total basal area of the species in the Parkland agroforestry of Midland. While *F. sycomorus* (0.502 m^2 ha^{-1}, 50%), *K. africana* (0.161 m^2 ha^{-1}, 16%), *A. albida* (0.093 m^2 ha^{-1}, 9.3%) and *Moringa stenopetela* (0.047 m^2 ha^{-1}, 6.68%) were species that accounted for largest share of total basal area of species in Lowland.

The most frequent species in Parkland agroforestry of *Highland* were *V. amygdalina* (67%), *B. polystachya*, *E. brucei* (50%), *F. sur* (37%), *Galiniera saxifraga* and *Hibiscus calyphyllus* (20%).

In Midland, frequent species in Parkland agroforestry were *F. sur* (56.7%), *C. africana* (50%), *R. vulgaris* (40%), *T. brownii* (30%), *Acacia tortilis* and *H. calyphyllus* (23%).

The species such as *M. indica* (90%), *C. africana* (73%) *A. indica* (53%), *T. emetica* (47%), and *Moringa stenopetala* (40%) were most frequent species in Parkland of lowland.

The top most important fodder woody species with highest IVI were *F. sur* (51.90), *F. sycomorus* (46.484) and *M. indica* (60.161) in highland, midland and lowland agroecologies, respectively and species with least value of IVI were *L. leucocephala, Caesalpinia decapetala* nd

A. senegalensis, respectively in Highland, Midland and Lowland. As Whittaker and Niering, (1975) puts forward, the IVI is an important index for summarizing vegetation characteristics and ranking species for management. Accordingly, species with lower IVI value (more sparse or among least dense) need high conservation effort, while those with higher IVI value require less management attention.

Conclusion

The results of the present study showed that, the Parkland agroforestry practices in Arba Minch Zuria Woreda is rich in woody species, which animals prefer for food (so-called fodder tree and shrubs). About 49 fodder tree and shrub species that belong to 43 genera and 31 families were identified from the aforementioned practice. The midland (Woina dega) had higher species richness and diversity than other agro-ecologies. Density, basal area and abundance of individuals of species decreased lowland (Kola) to highland (Dega) agroecology. This could be due to human interferences and management practices, suitability of agro-ecology and nature of the species. The species with highest values of IVI (e.g., *F. sur*, *F. sycomorus* and *M. indica*) require less conservation effort than species with lower value of IVI (e.g., *L. leucocephala, C. decapetala* and *A. senegalensis).* Generally, in the study area, there were diverse fodder trees and shrubs that may be promising for farmers to feed to livestock, while obtaining ecological and socioeconomic merits. Thus, further actions and topics for research are recommended as following. The awareness of the farmers on the utilization and management of this potential species should be continuously advocated, open traditional systems particularly open grazing could significantly result in severe land degradation. Farmers should adopt and feed cut carry feeding system of available species from their crop field. The woreda agriculture and livestock sector should integrate agroforestry in their annual extension plan in general and silvopastoral system, in particular. The role of agroforestry systems and practices for livestock farmers should be acknowledged at the national, regional and even at woreda levels. Further research on nutritional value, propagation, management and interaction of fodder species with annual crops and economic analysis of the species is highly recommended for the study area.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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Appendix 1. The structure of fodder trees and shrub species in Parkland agroforestry in three agro-ecologies of Arba Minch zuria woreda.

Scientific name	Density (individuals ha^{-1})	Basal area (m^2 ha^{-1})	Frequency (%)	IVI	AE
Buddleja polystachya Fresen.	20.667	0.004	50.00	39.011	High altitude
Erythrina brucei Schweinf.	13.000	0.031	50.00	38.772	
Galiniera saxifraga Hochst.	4.667	0.003	20.00	12.130	
Psydrax schimperiana (A.Rich.)	0.667	0.001	3.33	2.086	
Ficus sur Forsik.	6.000	0.110	36.67	51.901	
Nuxia congesta	0.333	0.017	3.33	6.506	
Vernonia amygdalina	25.000	0.005	66.67	49.327	
Grevillea robusta	1.333	0.009	6.67	6.281	
Acanthus pubescens	1.333	0.001	16.67	6.526	
Hibiscus calyphyllus	1.333	0.001	20.00	7.508	
Dombeya torrida	2.333	0.018	6.67	10.253	
Leucaena leucocephala	0.333	0.001	3.33	1.568	
Cordia africana	1.000	0.090	6.67	31.157	
Syzygium guineense	6.333	0.007	13.33	13.236	
Schrebera alata	1.000	0.013	3.33	6.036	
Caesalpinia decapetala	0.333	0.001	6.67	2.539	
Lippia adoensis	1.000	0.001	10.00	4.206	
Pittosporum viridiflorum	1.000	0.009	3.33	4.787	
Rubus sanctus	1.000	0.001	16.67	6.170	
Total in High altitude	88.667	0.320	343.33	300	
Terminalia schimperiana Hohst	*0.667*	*0.013*	*6.67*	*3.572*	*Mid altitude*
Persea americana Mill.	*1.000*	*0.077*	*3.33*	*10.254*	
Ficus vasta Forsik	*1.667*	*0.145*	*10.00*	*19.963*	
Acacia seyal Delile var.	*2.000*	*0.001*	*6.67*	*3.413*	
Millettia ferruginea(Hochst.)	*3.667*	*0.014*	*20.00*	*9.288*	
Erythrina brucei Schweinf.	*3.000*	*0.049*	*16.67*	*11.925*	
Solanum incanum L.	*3.333*	*0.001*	*20.00*	*7.506*	
Acacia tortilis Forsk.	*5.000*	*0.024*	*23.33*	*12.328*	
Psydrax schimperiana(A.Rich.)	*1.000*	*0.002*	*3.33*	*1.876*	
Ficus sur Forsik	*11.333*	*0.053*	*56.67*	*28.653*	
Terminalia brownii	15.333	0.010	30.00	21.340	
Vernonia amygdalina	3.333	0.008	16.67	7.625	
Grevillea robusta	1.000	0.005	3.33	2.237	
Dovyilas abyssinica	2.333	0.004	13.33	5.488	
Moringa stenopetala	0.667	0.012	3.33	2.708	

Appendix 1. Contd.

Acanthus pubescens	1.333	0.001	3.33	1.979	
Lippia javanica	3.000	0.001	10.00	4.959	
Ficus sycomorus	1.333	0.385	10.00	46.484	
Dombeya torrida	1.667	0.003	6.67	3.344	
Hibiscus calyphyllus	5.667	0.000	23.33	10.275	
Mangifera indica	1.667	0.005	6.67	3.524	
Rhus vulgaris	12.667	0.002	40.00	20.337	
Cordia africana	16.000	0.022	50.00	27.692	
Syzygium guineense	0.667	0.004	3.33	1.829	
Schrebera alata	0.333	0.031	10.00	6.062	
Hypericum quartinianum	3.667	0.001	3.33	4.037	
Caesalpinia decapetala	0.333	0.000	3.33	1.098	
Dodonaea viscosa	1.000	0.001	3.33	1.767	
Nuxia congesta	2.667	0.003	6.67	4.166	
Combretum molle	1.000	0.011	6.67	3.575	
Lippia adoensis	4.000	0.001	13.33	6.563	
Maytenus sp.	2.000	0.001	10.00	4.134	
Total in Mid Altitude	114.333	0.893	443.33	300	
Persea americana	1.333	0.009	10.00	4.010	
Annona senegalensis	0.667	0.006	6.67	2.517	
Trichilia emetic	11.667	0.022	46.67	20.349	
Kigelia africana	3.667	0.161	26.67	24.267	
Terminalia brownii	6.333	0.011	13.33	8.398	
Acacia albida	3.333	0.093	16.67	15.202	
Grevillea robusta	2.667	0.021	13.33	6.785	
Moringa stenopetala	10.000	0.067	40.00	22.271	
Ehretia cymosa	2.000	0.004	13.33	4.628	Low altitude
Citrus aurantifolia	3.333	0.004	10.00	4.866	
Leucaena leucocephala	1.000	0.003	10.00	3.093	
Mangifera indica	51.000	0.047	90.00	60.161	
Cordia Africana	26.667	0.029	73.33	37.413	
Azadirachta indica	7.667	0.002	53.33	16.949	
Carica papaya L	4.667	0.008	20.00	8.351	
Acacia seyal	0.333	0.008	6.67	2.428	
Caesalpinia decapetala	1.667	0.001	10.00	3.358	
Ficus sycomorus	0.333	0.502	6.67	51.650	

Appendix 1. Contd.

Psidium guajava	1.667	0.007	6.67	3.304
Total in Low altitude	140.000	1.005	473.33	300
Total in all agro-ecology categories	343.000	2.218	1260.00	900

Note : AE for agroecology and IVI for important value index