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FLORISTIC COMPOSITION AND DIVERSITY OF WOODY SPECIES IN PARKLAND AGROFORESTRY PRACTICE IN TIGRAI, NORTHERN ETHIOPIA

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ABSTRACT

Multipurpose tree species grown in scattered form over a crop field (parkland agroforestry practice) supports to smallholder farmers' livelihoods and play a critical role in biodiversity conservation. However, there is still gap of knowledge on the biological legacies of farm land trees in terms of biodiversity conservation. Therefore, this study aimed to investigate the floristic composition and diversity of parkland agroforestry in lower (1700-1900 m a.s.l.) and upper (1901-2333 m a.s.l.) midland of Tahtay Maichew district. A total of 20 plots with 100 m X 100 m quadrat were used to collect vegetation data along two parallel transect lines per each midland category. Independent sample t-test was employed to analysis the diversity indices. The result show that, except Simpson's index, the Shannon, Richness and evenness indices were not significantly varied between the lower and upper midland categories. A total of 21 woody species composition under 11 families in the lower and 21 woody species belongs to 17 families in the upper midland category were documented. The overall DBH and height class distribution of each midland category ratifies irregular inverted J-shape population pattern. Promoting farmer managed natural regeneration through appropriate system such as zero grazing system is highly required.

KEYWORDS: District, Midland, Smallholder farmers, Species composition.

1. INTRODUCTION

Parkland agroforestry is generally understood as landscapes in which mature multipurpose woody trees occur scattered in cultivated or recently fallowed fields (Bishaw and Abdelkadir, 2013). Multipurpose tree species in agricultural land scape supports farmers' livelihoods and play a critical role in the biodiversity conservation (Kuyah *et al.*, 2014). Some studies have been conducted in Ethiopia, on farm land trees/shrubs diversity and their roles on the resilience of small holder livelihoods (Endale *et al.*, 2017; Samuel *et al.*, 2018).

Now days, one of the most serious problem in ecosystem management is loss of farmland biodiversity (Benton, 2007). Despite the potential ecological importance of farmlands trees/shrubs reported by different scholar's. However, it is deteriorating from time to time and its density being reduced so, the long-term prospect for a sustained supply of the goods and services from these trees are vanishing (Kassa *et al.*, 2010). This is due to the significance in contributing biodiversity conservation have been largely ignored (Dayamba *et al.*, 2016).

However, promoting parkland agroforestry practice can have potential to reduce pressure on remnant natural forests from deforestation and enhances species diversification (Nair *et al.*, 2009). Agroforestry is incorporating trees in which woody perennials trees are deliberately integrated in spatial mixtures or temporal sequences with crops and/or animals on the same land unit (Powell *et al.*, 2015). In many sub-Saharan African country sides, trees where they are dominantly grown in farm land system are not only reflecting local, ecological and climatic conditions but they are protected for their desired characteristics or spiritual value (Elias, 2013).

In the dry lands of Ethiopia, there has also been practicing a number of indigenous agroforestry system mixed with cereal-livestock, agri silvo- pasture and silvo-pastoral system (Gebrehiwot, 2004). For instance, multipurpose trees grown across diverse land use types like home gardens, windbreak and scattered trees on farmland are part of an agroforestry system (Zomer *et al.*, 2009).

These trees planted or retained by farmers in agricultural landscapes where wild stands are found for a reservoirs of biodiversity and guarantee for sustainable land management (Endale *et al.*, 2017). And the values of these species are a potential for seed sources and field gene banks' that support ex-situ conservation (Merritt & Dixon, 2011).

Another crucial role of agroforestry systems is to maintain soil productivity through the integration of selected trees with agricultural field crops (Kassa *et al.*, 2010). Farmers maintained many tree/shrub species for environmental services like soil and water conservation in the drier regions (Faye *et al.*, 2011). A tree growing on farmland trees/shrubs provides fodder for livestock on top of crop residues that the leaves and pods of tree species are deposit as manure in the fields, thus serving nutrient recycling (Bayala *et al.*, 2014).

In Tigrai, though farm land trees/shrubs are widely using in different agro-ecological zones, there is limitation of scientific data on the floristic composition and diversity of parkland agroforestry in Tigrai, northern Ethiopia specifically in the upper and lower midland of Tahatay Maichew district. Hence, the objective of this study was to investigate floristic composition and diversity of parkland agroforestry.

2. MATERIALS AND METHODS

2. 1. Study area

The study was conducted at the upper and lower midland categories of Tahtay maichew district central zone of Tigray, which is located approximately between 13° 58' to 14° 19' N and 38° 29' to 38° 42' (Figure 1). The total area of the woreda is 18,618 km^2 (Atsbeha, 2012). Its altitude found between 1700-2333 m a.s.l. The name of the specific study sites were *Hadush Adi* and *Wuhdet*. *Hadush Adi* is found at the upper midland category which is located 14° 3' to 14° 7' N and 38° 34' to 38° 35' E. *Wuhdet* is located at the lower midland category and its location is 14° 10' to 14° 15' N and 38° 39' to 38° 36' E(Figure 1).

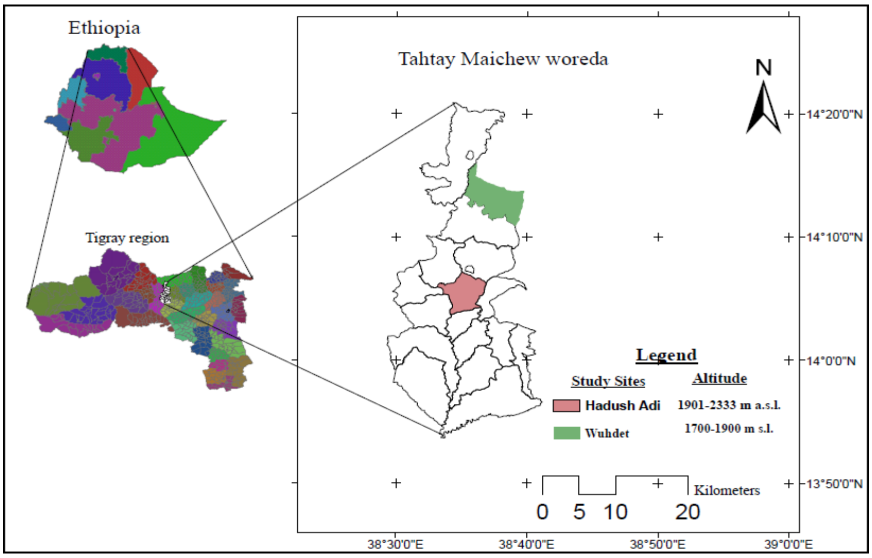

Figure 1: Map of the study area.

2.2 Sampling design

2.2.1 Vegetation sampling design

According to the Ethiopia agro-ecological classification, the altitudinal range of midland agro-ecological zone is found between 1500-2300 m a.s.l (Bekele, 2007). Based on that, the current study is also found in this agro-ecological zone (1700-2333 m a.s.l). However, this agro-ecology is locally classified in to two agro-ecological zones with the elevation ranges between 1700-1900 m a.s.l. is classified as lower midland category and the altitudinal range between 1901-2333 m a.s.l. is also classified as upper midland category. Therefore, the study area was stratified in to upper and lower midland categories of farmland trees/shrubs.

To establish transect lines, the first transect line was randomly selected and then center plots were taken through GPS reading. Along the transect lines, 100 m X 100 m quadrats with 250 m distance between the plots were systematically laid down for vegetation data. Similar method was used by Takimoto (2007), Larwanou *et al.*(2010) for farm land tree/shrub species inventory. Two transect lines with 3.25 km length and 1 km distance between them was used in each upper and lower midland category of farmland trees/shrubs. Equal numbers of plots or quadrats (i.e. 20 quadrats) were established in small holder farmland at both midland categories. And all the plots were laid at least 100 meter (m) away from nearest roads to avoid the boarder effect of the road side.

To understand the farm land trees/shrubs diversity, composition and vegetation structure, the following activities were performed. All trees/shrubs in each plot at both midland categories were identified and recorded. All woody plant species having ≥2.5 cm in DBH and having >2 m height mature trees/shrubs were also measured in each plot using four (4) meter length graduated stick for individuals having ≤4 m height and clinometer for individuals having > 4 m height (Kindu *et* *al.*, 2006). The DBH and canopy cover of trees/shrubs were measured using caliper and diameter tape respectively. The diameters of the canopy trees/shrubs species was measured in two perpendicular directions (east-west and north-south) and each tree/shrub species was recorded with its name in the field. Trees/shrubs with multiple stems diameter (at 1.3 meter height) were measured separately and the average of these multiple stems of DBH was treated as individual (Kent & Coker, 1992). In order to know the regeneration or planted individual in the farm land trees/shrubs, seedlings and sapling were recorded in each plot. Consequently, all seedlings with height <1 meter and saplings with a height of 1 to 2 meters and for both <2.5 cm DBH size were counted in all plots (Endale *et al*., 2017). Nomenclature of species were followed the publications of the Flora of Ethiopia and Eritrea and Useful trees and shrubs for Ethiopia (Bekele, 2007).

3. Data analysis

All farm land trees/shrubs encountered in the sample plots of both lower and upper midland categories were analyzed by using Shannon diversity index (*H'*), Shannon equitability/evenness index (E), Margalef's richness index (S), Simpson's diversity index (D) (Shannon 1948). Independent sample t-test was employed to test the significant differences between the upper and lower midland categories of farmland trees/shrubs indices using SPSS version 20. Similarity of native woody species between the two study sites was analyzed using Sorensen's similarity coefficient (Sorensen's, 1948). Important value index (IVI) was used to determine the ecological significance of the native species from the summation of the relative values of density, frequency and dominance of each woody species (Kent & Coker 1992).

All trees/shrubs recorded in all plots were used in the analysis of the vegetation structure. Histograms (Figures) and tables were drawn to display the population structure of the farm land trees/shrubs based on the DBH and height class. Thus, tree density, diameter at breast height, basal area, height, frequency, important value index were used for description of vegetation structure.

4. RESULTS AND DISCUSSIONS

4.1. Diversity and composition of species in parkland agroforestry

4.1.1. Woody species diversity

The results of diversity indices for richness, Shannon diversity and Evenness were observed non-significant differences between the two midland categories of farmland trees/shrubs species (Table 1). However, Simpson's diversity indices were significantly higher in lower midland than upper midland.

Table 1: Species diversity in parkland agroforestry practice (mean ± SE).

	Midland categories		
Variables	**Lower midland**	**Upper midland**	**P-value**
Shannon(*H'*)	1.32±0.06[a]	1.11±0.09[a]	0.06
Simpson	0.65±1.03[a]	0.53±0.03[b]	0.045
Evenness	0.62±0.03[a]	0.7±0.04[a]	0.06
Richness	0.91±0.08[a]	1.06±0.07[a]	0.155

*Different letters in the same row are significantly varied (P<0.05). SE=standard error

The Simpson's diversity index was significantly higher in the lower midland than the upper midland category (P<0.05). This indicated that, the highest homogeneity and abundant of woody species were found in the lower midland category. The most abundant woody species in the lower midland have positive impact on soil fertility improvement so that farmers are tending them so as to enhance crop productivity. Accordingly, Simpson's diversity measures the relative abundance of each species and more relative abundant of species were recorded in the lower midland. This is in line with the finding of Molla and Kewessa (2015); Mengistu and Asfaw (2016), Simpson's diversity gives more weight to the most abundant species than rare species occurred. A species overlap was explored between the lower and upper midland categories of farm land trees/shrubs. Subsequently, the Sorensen's coefficient of similarity index was confirmed low species overlap (33.3%) between the two midland categories. This implied that, each farmland category has its own species characteristic. This low similarity coefficient could be due to altitudinal variation, species adaptability and the extent of disturbance could be made difference between the two midland categories.

4.1.2. Trees/shrubs species composition

A total of 21 species under 11 families from the lower and 21 species belongs to 17 families from the upper midland category of farmland trees/shrubs were recorded and out of which seven woody plant species were recorded common to both midland categories. The dominant family of species for both lower and upper midland of farmland trees/shrubs was fabaceae which embraces 5 species (23.81 %) and 4 species (19.05%) respectively. This indicated that such type of local environmental condition is suitable for this family or might be able to resist the anthropogenic factor. This family was also dominant in Southern Tigray (Woldemichael *et al.*, 2010). And it is also dominantly recorded in the south-eastern rift valley escarpment of Ethiopia (Negash *et al.*, 2012).

In the lower midland of farmland trees/shrubs, the highest portion growth form was covered by tree 17(81%) and the rest trees/shrubs and shrubs species habit each represented by 2 species (9.5 %).The growth form of upper midland category was characterized by trees, trees/shrubs and shrubs 11(52.38%), 4 (19.05%) and 6 (28.57%) respectively. This finding is in line with Yakob and Fekadu (2016), in lower elevation has higher tree growth form than upper elevation. The variation of structure and composition of woody species along elevation is related to environmental variability such as elevation/topographic effect, soil type/depth, species adaptability and management variation (Moges, 2009).

4.1.3 Vegetation structure of woody species in parkland agroforestry

The diameter and height class distribution of the entire quadrants (plots) of the current study were conventionally grouped in to eight (8) classes. The general trend of total number of individuals' in each successive DBH and height classes were decreased with an increasing tree diameter and height class in each category of farmland trees/shrubs (Figure 2 and 3). This implied that, the number of population at young stage were higher than the middle and mature population stage. So, the distribution of DBH class and height class displayed an inverted J-shaped pattern due to the fall of individuals' trees/shrubs as DBH and height class increasing. This fluctuation of DBH and height classes were indicated that, removal of trees for increasing land use efficiency, farm equipment, fuel wood and fencing (personal communication). This statement was in line with the finding of Endale *et al*. (2017) conducted on farm land tree species. Therefore, the investigating pattern of DBH and height class distribution could play a central role to forecast the general trends of population dynamics and conscription (Kanzler, 2002; Dibaba *et al.*, 2014).

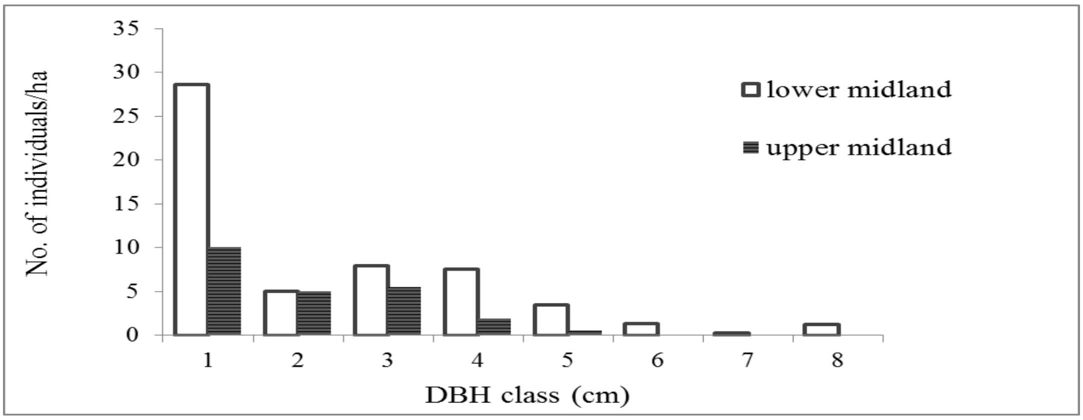

Figure 2: DBH class distribution (structure) at both midland categories.

Where (1 =<2.5 cm, 2. = 2.5-10 cm, 3. = 10.1-20 cm 4. = 20.1-30 cm, 5. = 30.1-40 cm, 6. = 40.1-50 cm, 7. = 50.1-60 cm, 8. = >60)

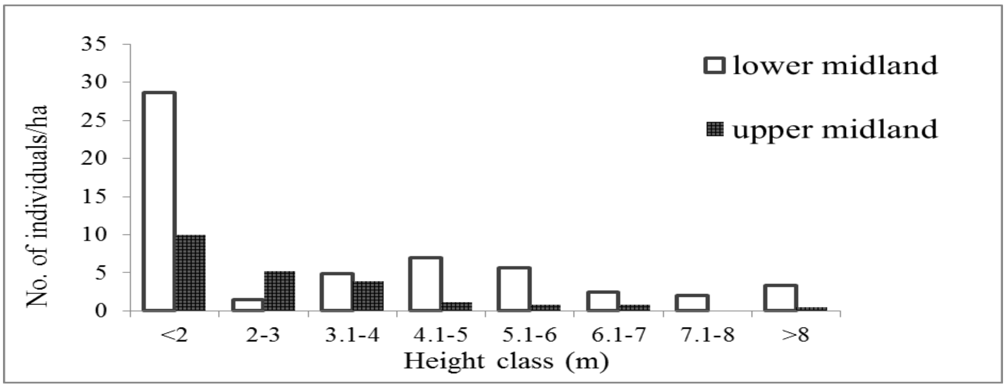

Figure 3: Height class distribution (structure) at both midland categories.

Hence, analyzing of frequency distribution of DBH class on top 3 selected woody species from lower midland categories were revealed different patterns (Figure 4). Evaluation of DBH pattern of the top selected important species could be varied in population structures indicating different population dynamics among each species (Dibaba *et al.*, 2014; Tilahun *et al.*, 2015). In the lower midland category, the DBH pattern of *Ziziphus spina-christi* tree decreasing rapidly from class 1 towards class 2 and followed by increasing rapidly towards class 3 and followed by gradually decreasing towards class 4,5,6,7 and 8 (Figure 4). Whereas, *Faidherbia albida* tree (Figure 4) decreasing rapidly from class 1 towards class 2 and followed by gradually decreasing towards class 3 and followed by slightly increasing towards class 4 and followed by decreasing towards class 5 and 6 but absent class 7 and increasing towards class 8 and this is also indicated irregular population structure. The DBH pattern of *Balanites aegyptiaca* tree (Figure 4) class 1 was revealed a lower frequency as compare with class 5 and this was decreasing rapidly towards class 6, 7 and 8.

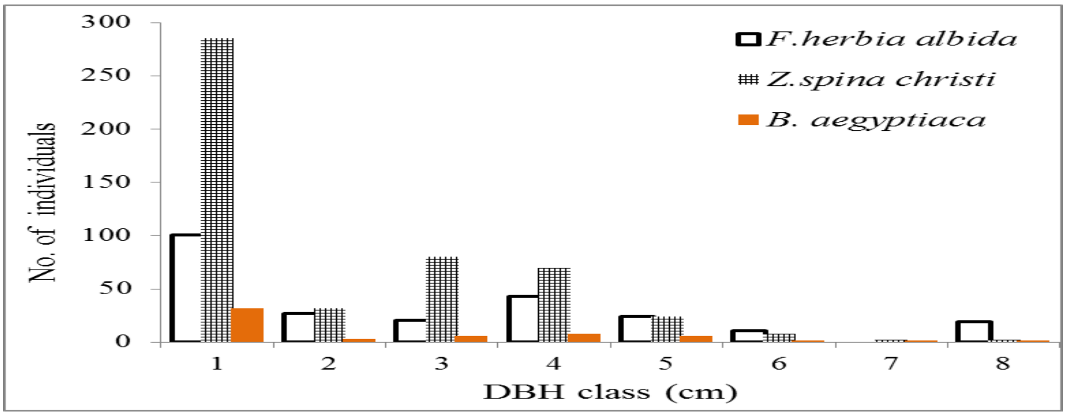

Figure 4: DBH class distribution of the top 3 woody plant species in the lower midland of farmland trees/shrubs.

Where (1 =<2.5 cm, 2. = 2.5-10 cm, 3. = 10.1-20 cm 4. = 20.1-30 cm, 5. = 30.1-40 cm, 6. = 40.1-50 cm, 7. = 50.1-60 cm, 8. = >60).

The DBH distribution pattern of top three selected woody species (*Acacia lahai, Croton macrostachyus* and *Cordia Africana*) in the upper midland category of farmland trees/shrubs was showed that irregular population structure (Figure 5). This result indicates that, those species are highly viable for farm equipment and highly interested for furniture production (personal observation and communication). Therefore, in the upper midland, there is a trend of decreasing and absent of DBH frequency towards the highest DBH class. This implied, selective cutting of the middle and larger DBH class size of the species for increasing land use efficiency, construction purpose, fuel wood and farm round fencing (personal observation This is similar to the finding by Tilahun *et al.* (2015) species with disturbance of DBH pattern might result in the future decline of the species population and reflects a bad staffing with relatively good reproduction.

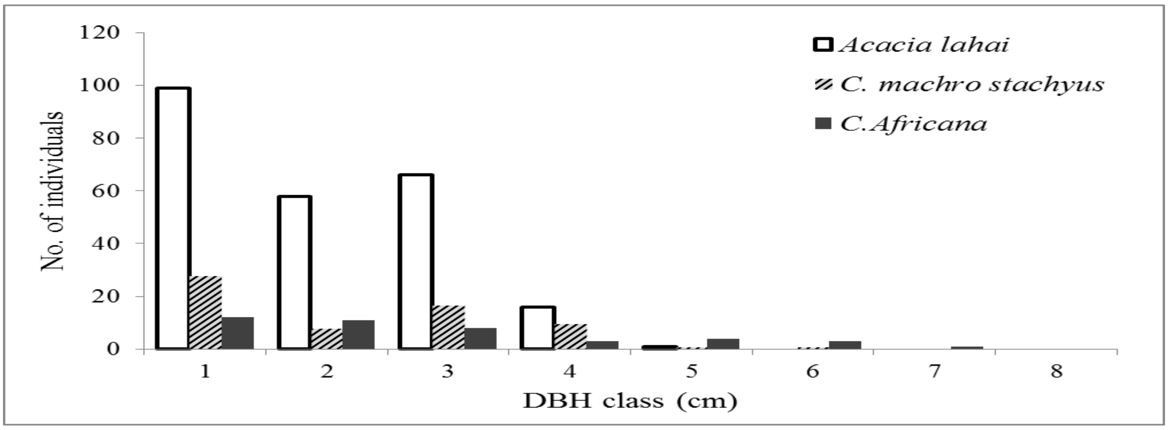

Figure 6: DBH class distribution of the top 3 woody plant species in the upper midland of farmland trees/shrubs.

Where (1 =<2.5 cm, 2 = 2.5-10 cm, 3 = 10.1-20 cm 4 = 20.1-30 cm, 5 = 30.1-40 cm, 6 = 40.1-50 cm, 7 = 50.1-60 cm, 8 = >60).

Unlike the forest, the regeneration capability of farm land trees/shrubs beside to farmers' preferences could affect by different factors. In the lower midland of small holder farmland trees/shrubs was exhibited relatively higher regeneration capacity than upper midland of small holder farmland trees/shrubs (Figure 6). Likewise, a total of 277 (13.85 ha^{-1}) seedlings, 297 (14.85 ha^{-1}) sapling and 535 (26.75 ha^{-1}) mature trees/shrubs were recorded from 20 hectare of the lower midland category. And 85 (4.25 ha^{-1}) seedlings, 116 (5.8 ha^{-1}) saplings and 266 (13.3 ha^{-1}) mature trees/shrubs were recorded also from 20 hectare of the upper midland of farmland trees/shrubs. Abundance of seedlings and saplings are an empirical indicator of the establishment of young individual species to facilitate the regeneration capacity of trees species in a given area (Tilahun *et al.*, 2015).

Despite the existence of disturbance by farmers during land preparation and livestock browsing, there are few dominant trees/shrubs which are capable of regenerate across both the midlands categories. Therefore, regeneration status of the current study was threatened because mature trees/shrubs were stand with lack of seedlings and/or saplings. Furthermore, deteriorating soil seed banks due to long years of continuous cultivation will make regeneration increasingly difficult (Tolera *et al.*, 2008). Even the seedlings and saplings which germinated via resisting the prevailing challenge would have vulnerable to survive in the cultivated land use type because of the continuous tillage operation. Farmers are also allowed to free access of livestock to the agricultural land scape after harvesting their productivity (personal observation). These all resulted that, the proportional pattern of development stage across both farmland trees/shrubs were comprised as seedling < sapling < mature trees/shrubs (Figure 6). Hence, such configuration demonstrated poor reproduction and hampered regeneration of trees/shrubs due farmers' preferences and in addition to the natural burden. Thus, mature trees/shrubs stand alone could never be approved sustainably rather they intended to disappear in the future. Therefore, these farmland trees/shrubs require upper most conservation and restoration.

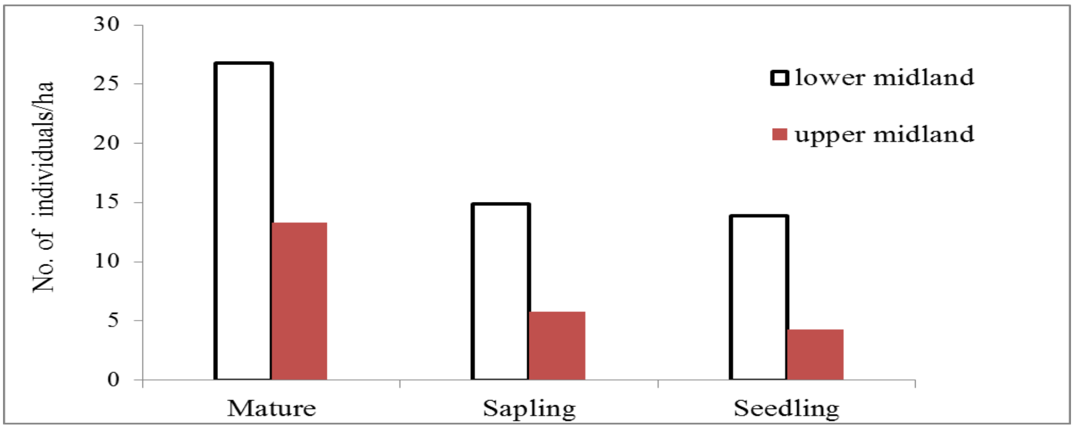

Figure 7: Developmental structure of all habit forms at both farmland trees/shrubs.

An investigated of canopy area was conducted at both midland categories. Subsequently, higher canopy area was estimated in the lower midland than in the upper midland and exhibited highly significant ($P<0.001$) varied. This variation could be due to topographic variables, moisture availability and nutrient availability. This could also be related with, species adaptability in different area; farm characteristics such as farm size, shade and nature of cropping pattern (Rebecca *et al.*, 2007). Thus, farmers' are chosen woody plant species due to their shade, soil fertility improvement, less competitive effect to field crops and income generation such as fuel wood and timber production. Therefore, farmers in this study area tried to manage trees mixed with crops by pruning, pollarding tree branches and even coppicing is applied in order to save crops from competition of basic growth factors.

In general, the lower midland category has larger DBH and taller height classes than the upper midland category and exhibited highly significant ($P<0.001$) varied. This implies, the highest number of individual DBH ≥2.5 cm class size and >2 meter height classes were documented in the lower midland (Table 2).

Table 2: Mean individual Spp. ha-1, height, DBH, BA and Canopy area across both farmland trees/shrubs (mean ± SE).

Mean variables	Farmland trees/shrubs	
	Lower midland	Upper midland
Individual *spp*.ha^{-1}at DBH≥2.5 cm and>2 m	26.75±1.9^{a}	13.3±2.04^{b}
Height(m)	5.84±0.1^{a}	4.14 ±0.11^{b}
DBH(cm)	23.72±0.73^{a}	13.45±2.04^{b}
BA(m^{2} ha^{-1})	1.81± 0.05^{a}	0.33±0.01^{b}
Canopy area (m^{2} ha^{-1})	338.45±1.13^{a}	135.61±1.16^{b}

Different letters in the same row are highly significantly different at ($P<0.001$).

Majority of this significant variation was due the larger DBH and taller height class attributed from *Ziziphus spina-christi* and *Faidherbia albida* trees which were found abundantly in the lower midland category. This is because those species have positive impact on soil fertility and farmers are tending them to enhance crop productivity. Often farmers incurred more than two utilities for one species with the most important ranked as the primary utility and others as secondary and thirdly utility (Asaah *et al.*, 2011).

4.1.4 Basal area and important value index of farm land trees/shrubs

The mean basal area of lower and upper midland categories were 1.81± 0.05 m^2 ha^{-1} and 0.33± 0.01 m^2 ha^{-1} respectively (Table 2) and displayed highly significantly ($P<0.001$) differences. The reason for this was the contribution of DBH class to the total farmland trees/shrubs density (Table 3). Hence, the contribution of DBH class to the total farm land trees/shrubs density of the upper midland category had less than the lower midland DBH class contribution of trees/shrubs stand density. Similar finding was reported by (Mohan *et al.*, 2007) that there is direct relationship between DBH class size and basal area.

Table 3: Attributes of DBH class to density ha-1 and basal area (m2 ha-1) of trees/shrubs across in the agricultural small holder farmland trees/shrubs.

DBH class(cm)	lower midland			upper midland		
	Individual stand stem	Density	Basal area (m^2ha^{-1})	Individual stand stem	Density	Basal area (m^2ha^{-1})
<2.5	574	28.700	0.000	201	10.050	0.000
2.5-10	101	5.050	0.027	100	5.000	0.022
10.1-20	159	7.950	0.170	110	5.500	0.095
20.1-30	150	7.550	0.382	39	1.950	0.086
30.1-40	69	3.450	0.330	11	0.550	0.050
40.1-50	26	1.300	0.203	4	0.200	0.033
50.1-60	5	0.250	0.062	2	0.100	0.022
>60	25	1.250	0.631	0	0.000	0.000
Total	**1109**	**55.450**	**1.807**	**467**	**23.350**	**0.308**

The DBH class >60 cm was accounted 0.631 BA (m^2ha^{-1}) for the lower midland but zero (0 m^2ha^{-1}) basal area for the upper midland of farmland trees/shrubs. Because, there was not recorded >60 cm DBH class size in the upper midland of farmland trees/shrubs.

The basal area of the woody plant species of the lower and upper midland of farmland trees/shrubs was interrupted shape and concentrated in the middle DBH class (Figure 7).

In general, the current result was consistent with a study reported by Nikiema (2005) from parkland Agroforestry in semi-arid West-Africa, Burkina Faso that basal area is being lower on highly intensively farmed land because of the lower density of larger DBH class size trees. In contrast, it was lower as compare with the reported by Endale *et al.* (2017) which could be related to management, farm size, species type, soil type and geology. The DBH class contribution to basal area was found low because of the lowest individual stand stem density of larger DBH class size tree species across each small holder farmland. This implied that, trees/shrubs growing in agricultural land scape unlike intact forest would be affected by farmers' species preference. In addition, the regeneration and density of other lower diameter class size (seedling and sapling) tree/shrub species were affected by browsing and trampling by livestock which could be hindrance from reaching to larger DBH class size. This is consistent with the reported by Tolera *et al.* (2008), farm lands tend to gradually thin the woody species in their field crops for construction, fencing and fuel wood for house hold consumption and sale for market purposes.

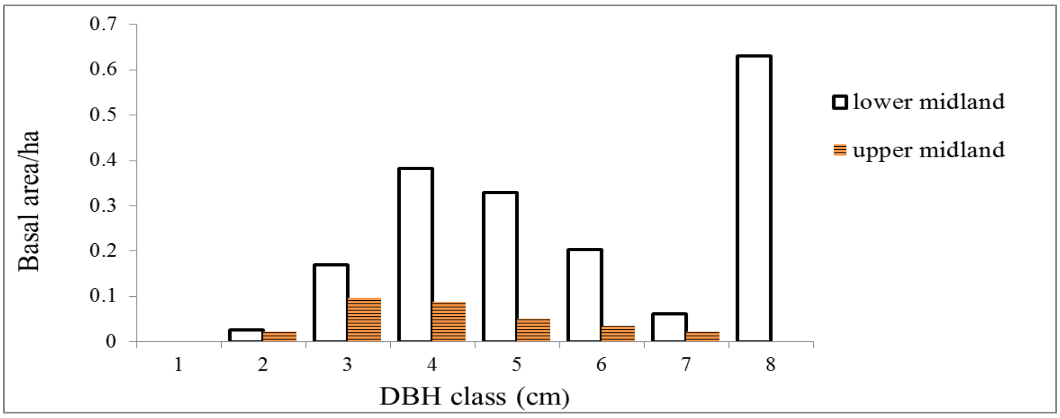

Figure 8: DBH class in relation to the total basal area of each farmland trees/shrubs.

Where (1 =<2.5 cm, 2 = 2.5-10 cm, 3 = 10.1-20 cm, 4 = 20.1-30 cm, 5 = 30.1-40 cm, 6 = 40.1-50 cm, 7 = 50.1-60 cm, 8 = >60).

Importance value index (IVI) helps to assess the contribution of each trees/shrubs at both midland categories. The highest importance value indices of the current study were *Ziziphus spina-christi* (89.35) and *Faidherbia albida* (84.3) for lower midland, and *Acacia lahai* (103.11) and *Croton macrostachyus* (48.23) for the upper midland. The overall IVI of the whole trees/shrubs across both small holder farmland trees/shrubs were more than half of IVI was covered by very few species. For instance, *Ziziphus spina-christi* and *Faidherbia albida* in the lower midland and *Acacia lahai* in the upper midland of small holder farmland trees/shrubs were the leading dominant and ecologically most significant. Since, they could be the most successful species in the regeneration relative to other farm land trees/shrubs. This is in line to the finding of Shibru and Balcha (2004) who described, species with highest importance value indices are the leading dominant of certain vegetation. The dominance of these species in both farmland trees/shrubs were linked to their higher socioeconomic and or ecological roles in the farmland trees/shrubs. This is in line to Ewuketu *et al*. (2014); Tefera *et al.* (2016) which show that, species with multiple uses showed higher importance value index. Simultaneously species with high IVI is associated with the land uses and based on farmer's species preference (Mengistu and Asfaw, 2016). Therefore, a place where few species found dominantly and majority of the species have least dominant indicated that, problem of with no seedling and sapling (Mengistu and Asfaw, 2016). Woody plant species with the lower IVI had low contribution to the total IVI and it implies their low ecological significance in a certain area (Tilahun *et al.*, 2015).Consequently, species which had the lowest contributed to the total IVI in both midland categories were found at risk of local extinction so that they require upper most conservation priority and those with higher IVI need monitoring and management.

5. CONCLUSIONS

Similar woody species diversity with equal woody species composition was observed between the lower and upper midland categories. However, the lower midland category had higher stand density than the upper midland category. Similarly the highest DBH class size, height class, basal area and canopy covers were also recorded more from the lower midland category.

In general, parkland agroforestry can play a significant role in the conservation of woody species diversity that can fulfill the farmer's interest beside to mitigate the issue related to climate change. Farmland trees/shrubs species are vulnerable due to the anthropogenic factors, which leads to irregular inverted J-shape population structure pattern. Therefore, any important policy instruments like agri-environmental schemes (AES) such as farmers oriented incentives is requested for establishment of collaborative land management activities to enrich the regeneration potential of multipurpose tree species.

REFERENCE

1. Asaah EK, Z Tchoundjeu, RR Leakey, B Takousting, J Njong and I Edang, Trees, agroforestry and multifunctional agriculture in Cameroon. *International Journal of Agricultural Sustainability*, 2011; 9(1): 110-119.
2. Atsbeha G, Floristic composition of herbaceous flowering plant species with emphasis to ethno-botanical importance of wild grasses in Laelay and Tahtay Michew Districts, Central Zone of Tigray, Ethiopia. Unpublished MSc.thesis, Addis Ababa University Addis Ababa, Ethiopia, 2012.
3. Bayala J, J Sanou, Z Teklehaimanot, A Kalinganire and SJ Ouédraogo, Parklands for buffering climate risk and sustaining agricultural production in the Sahel of West Africa. *Current Opinion in Environmental Sustainability*, 2014; 6: 28-34.
4. Bekele-Tesemma A, Useful trees and shrubs of Ethiopia: identification, propagation, and management for 17 agroclimatic zones. *RELMA in ICRAF Project, World Agroforestry Centre, Eastern Africa Region*: Nirobi, Kenya, 2007; 552.
5. Benton TG, Managing farming's footprint on biodiversity. *Science-New york then Washington-*, 2007; 315(5810): 341.
6. Bishaw B and A Abdelkadir, 2003 Agroforestry and Community Forestry for Rehabilitation of Degraded Watersheds in the Ethiopian Highlands. Intern Symp Contemporary Devel Iss Ethiopia, 78.
7. Dayamba SD, H Djoudi, M Zida, L Sawadogo and L Verchot, Biodiversity and carbon stocks in different land use types in the Sudanian Zone of Burkina Faso, West Africa. *Agriculture, Ecosystems and Environment*, 2016; 216: 61-72.
8. Dibaba A, T Soromessa, E Kelbess and A Tilahun, Diversity, structure and regeneration status of the woodland and riverine vegetation of Sire Beggo in Gololcha District, Eastern Ethiopia. *Momona Ethiopian Journal of Science*, 2014; 6(1): 70-96.
9. Elias M, Influence of agroforestry practices on the structure and spatiality of shea trees (Vitellaria paradoxa CF Gaertn.) in central west Bur kina Faso. *Agroforestry systems*, 2013; 87(1): 203-216.
10. Endale Y, A Derero, M Argaw and C Muthuri, Farmland tree species diversity and spatial distribution pattern in semi-arid East Shewa, Ethiopia. *Forests, Trees and Livelihoods*, 2017; 26(3): 199-214.
11. Ewuketu LM, Zebene A and Z Solomon, Plant species diversity of home garden Agroforestry in Jabithenan district, North- western, Ethiopia. *International Journal of Biodiversity and conservation*, 2014; 6(4): 301-307.
12. Faye MD, JC Weber and TA Abasse, Farmers' preferences for tree functions and species in the West African Sahel.*Forests Trees and Livelihoods*, 2011; 20(2-3): 113-136.
13. Gebrehiwot K, Dry land agro-forestry strategy for Ethiopia. Paper presented at the dryland agroforestry

workshope. *World Agroforestry Centre-ICRAF*, 2004; 1-20.
14. Kanzler A, Genotype x Environment Interaction in Pinus patula and its implications in South Africa, 2002.
15. Kassa H, K Gebrehiwet and C Yamoah, Balanites aegyptiaca, a potential tree for parkland agroforestry systems with sorghum in Northern Ethiopia. *Journal of Soil Science and Environmental Management*, 2010; 1(6): 107-114.
16. Kent M and P Coker, Vegetation Description and Analysis. A Practical Approach. *Belhaven Press*, London, UK, 1992.
17. Kindu M, G Glatzel, Y Tadesse and A Yosef, Tree species screened on nitosols of central Ethiopia: biomass production, nutrient contents and effect on soil nitrogen. *Journal of Tropical Forest Science*, 2006; 173-180.
18. Kuyah S, GW Sileshi, J Njoloma, S Mng'omba and H Neufeldt, Estimating aboveground tree biomass in three different miombo woodlands and associated land use systems in Malawi. *biomass and bioenergy*, 2014; 66: 214-222.
19. Larwanou M, Y Yemshaw and M Saadou, Prediction models for estimating foliar and fruit dry biomasses of five Savannah tree species in the West African Sahel. *International Journal of Biological* and *Chemical Sciences*, 2010; 4(6).
20. Mengistu B and Z Asfaw, Woody species diversity and structure of agroforestry and adjacent land uses in Dallo Mena district, South-East Ethiopia. *Natural Resources*, 2016; 7(10): 515-534.
21. Merritt DJ and KW Dixon, Restoration seed banks-a matter of scale. *Science*, 2011; 332(6028): 424-425.
22. Moges Y, The impact of overstorey trees on sustainable coffee (*Coffea arabica* L.) Production in southern Ethiopia. Ph.D Dissertation, Horizonte Bd. 25, Der Andere Verlag, Tonning, Lübeck and Marburg, 2009.
23. Mohan S, PR Nair and AJ Long, An assessment of ecological diversity in homegardens: a case study from Kerala State, India. *Journal of sustainable agriculture*, 2007; 29(4): 135-153.
24. Molla A and G Kewessa, Woody species diversity in traditional agroforestry practices of Dellomenna District, Southeastern Ethiopia: Implication for maintaining native woody species. *International Journal of Biodiversity*, 2015.
25. Nair PR, VD Nair, BM Kumar and SG Haile, Soil carbon sequestration in tropical agroforestry systems: a feasibility appraisal. *Environmental Science and Policy*, 2009; 12(8): 1099-1111.
26. Negash M, E Yirdaw and O Luukkanen, Potential of indigenous multistrata agroforests for maintaining native floristic diversity in the south-eastern Rift Valley escarpment, Ethiopia. *Agroforestry systems*, 2012; 85(1): 9-28.
27. Nikiema A, *Agroforestry parkland species diversity: uses and management in semi-arid West-Africa (Burkina Faso)*. PhD thesis Wageningen University, Wageningen, 2005.
28. Powell B, C Sand brook, T Sunderland and TN Tu, The Historical, Environmental and Socio-economic Context of Forests and Tree-based Systems for Food Security and Nutrition. *Forests and Food*, 2015; 73.
29. Rebecca LB, JL Anne and KP Robert, Species Richness: Small Scale Encyclopedia of life sciences. *John Wiley and Sons, Ltd.*, 2007.
30. Samuel D, A Derero, Z Kebebew and KM Hadgu, Tree species diversity and spatial distribution patterns on agricultural landscapes in sub-humid Oromia, Ethiopia. *Agroforestry Systems*, 2018; 1-15.
31. Shannon CE, A mathematical theory of communication. *Bell system technical journal*, 1948; *27*(3): 379-423.
32. Shibru S and G Balcha, Composition, Structure and regeneration status of woody species in Dindin Natural Forest, Southeast Ethiopia: An implication for conservation. *Ethiop. J. of Biol. Sci*, 2004; 1(3): 15-35.
33. Sørensen T, A method of establishing groups of equal amplitude in plant sociology based on similarity of species and its application to analyses of the vegetation on Danish commons. *Biol. Skr*, 1948; *5*: 1-34.
34. Takimoto A, Carbon sequestration potential of agroforestry systems in the West African Sahel: an assessment of biological and socioeconomic feasibility (Doctoral dissertation, University of Florida), 2007.
35. Tefera Y, A Wendawek and T Bogale, Woody plants species diversity of homegarden agroforestry in three agroecological zones of Dilla Zuria district, Gedeo zone, southern, Ethiopia. *International Journal of Fauna and Biological Studies*, 2016; 3(3): 98-106.
36. Tilahun A, T Soromessa and E Kelbessa, Structure and regeneration status of Menagesha Amba Mariam Forest (Egdu Forest) in central highlands of Shewa, *Ethiopia. Advances in Life Science and Technology*, 2015; 34: 60-80.
37. Tolera M, Z Asfaw, M Lemenih and E Karltun, Woody species diversity in a changing landscape in the south-central highlands of Ethiopia. *Agriculture, ecosystems and environment*, 2008; 128(1-2): 52-58.
38. Woldemichael LK, T Bekele and S Nemomissa, Vegetation Composition in Hugumbirda-Gratkhassu National Forest Priority Area, South Tigray. *CNCS:* Mekelle University, 2010; 2: 27-48.
39. Yakob G and A Fekadu, Diversity and Regeneration Status of Woody Species: The Case of Keja Araba and Tula Forests, South West Ethiopia. *Open Access Library Journal*, 2016; *3*(4): 1-15.
40. Zomer RJ, A Trabucco, R Coe and F Place. Trees on farm: analysis of global extent and geographical patterns of agroforestry. *ICRAF Working Paper-World Agroforestry Centre*, 2009; (89).