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FLORISTIC COMPOSITION AND DIVERSITY OF WILD AND SEMI WILD EDIBLE TREE SPECIES IN CENTRAL ZONE OF TIGRAI, NORTHERN ETHIOPIA

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ABSTRACT

Even though the wild and semi-wild edible tree/shrub species play an important role in ecological balance and livelihood improvement, they are not being managed well. The objective of this study was to investigate the composition, diversity, and population structure of wild and semi-wild edible tree/shrub species in lowland agro-ecology of Mereb-leke district across different land use types (farmland, exclosure, riverine and homestead). A total of 38 sample plots, i.e. 6 plots from farmland, 8 from the riverside, 8 from exclosure, and 16 plots from homestead were used proportional to their size. Transects lines were laid out systematically parallel to each other in each of the land-use types to record the species composition, diversity, population structure. Along the transect lines, 50 m X 50 m quadrats with 100 m distance between the plots were systematically laid down and the distance between consecutive transect lines was 100 m. One way ANOVA was employed to analyze the difference in the diversity indices between the land use types. A total of 8 wild and semi-wild edible tree/shrub representing 7 families were documented. The diversity indices were not significantly varied (*P*=0.24) between farmland (0.3±0.14), exclosure (0.29±0.12), riverine (0.26±0.13), and homestead land use types (0.28±0.07) in the lowland. However, the abundance of wild and semi-wild edible tree/shrub species in homestead (42±9.6) was showed significantly higher (*P*=0.001) than the riverine (9.3±2.3), farmland (19±11.7), and exclosure (8.5±1.1). Except in homestead land use types, the population structure of wild and semi-wild species in farmland, exclosure, and riverine were unhealthy regeneration potential. The Homestead agroforestry system should be improved for the better regeneration potential of wild and semi-wild edible tree/shrub species in the Mereb leke district.

KEYWORDS: Mereb leke, Districts, Land uses.

1. NTRODUCTION

Ethiopia is not only rich in ecological diversity, but it is also rich in botanical diversity (Friis et al. 2005), and its extraordinary agro biodiversity resulting from its varied geography, climate, ethnic diversity, and strong food culture (Wiersinga & de Jager, 2009). In Ethiopia, there are about 370 indigenous food plants (belonging to 70 different families) out of which 182 species (40 families) are shrubs/trees with edible fruits/seeds and the large number of fruiting species are used for human consumption, and most come under the broad category of wild or semi-wild edible plants (Asfaw & Tadesse 2001). Edible fruit species refer to a subset of this broad category to pinpoint the plants in which the fleshy parts of the fruit (and sometimes seeds) are eaten raw, boiled, or roasted (Kidane et al., 2014). There have been several attempts to define the term "wild" and the term "wild" refers to indigenous plants that are growing only in natural environments, while "semi-wild" applies to those plants that are indigenous or introduced and naturalized To the region while nurtured also through encouragement or tolerance by people in their crop fields, home gardens, or borders (FAO,1999). Wild and semi-wild fruit resources are not only important as food but may also have several other functions and services (Motlhanka et al., 2008), such as medicinal applications or bee forage, although their relative importance depends on local circumstances. Due to their diverse functions, these resources maybe exposed to overexploitation or otherwise threatened, especially in periods of food scarcity. These threatening factors may vary from region to the region, depending upon the local socio-economic and ecological circumstances (Tabuti et al., 2004). The rich plant wealth is vanishing rapidly due to various factors mainly human activities and as a result, there is ecological imbalance resulting depletion in the wealth of wild plants including the wild edible fruit plants over time (Jamir, 1996). Many threats are similar to those that affect plant diversity as a whole and the most common threats reported were agricultural expansion, overgrazing

/overstocking, deforestation, and urbanization (Alemayehu, 2017). The reported anthropogenic pressures in the country have resulted in a loss of thousands of hectares of forest that harbour useful wild edible plants and the continuity of knowledge on the utilization of wild edible plants have also faced problems because of change in the feeding culture of the people (Molla et al., 2010). There are few studies and documents available on diversity and population status of wild and semi-wild species in Ethiopia but not yet in Tigrai. Therefore, the Objective of this study was to investigate floristic composition, diversity and population status wild and semi wild trees species in Tigrai region.

2. MATERIALS AND METHOD

2. 1. Description of the study area

The study was conducted at lowland agro ecology categories of Mereb-leke district, the central zone of Tigrai. The absolute geographic location of the Mereb-leke district is found between 12^{0}40’7’’-12^{0}51’40’’N latitude 39^{0}25’20’’-39^{0}31’51’’E longitudes and the altitudinal range of the district is found between 1339 - 2948m.

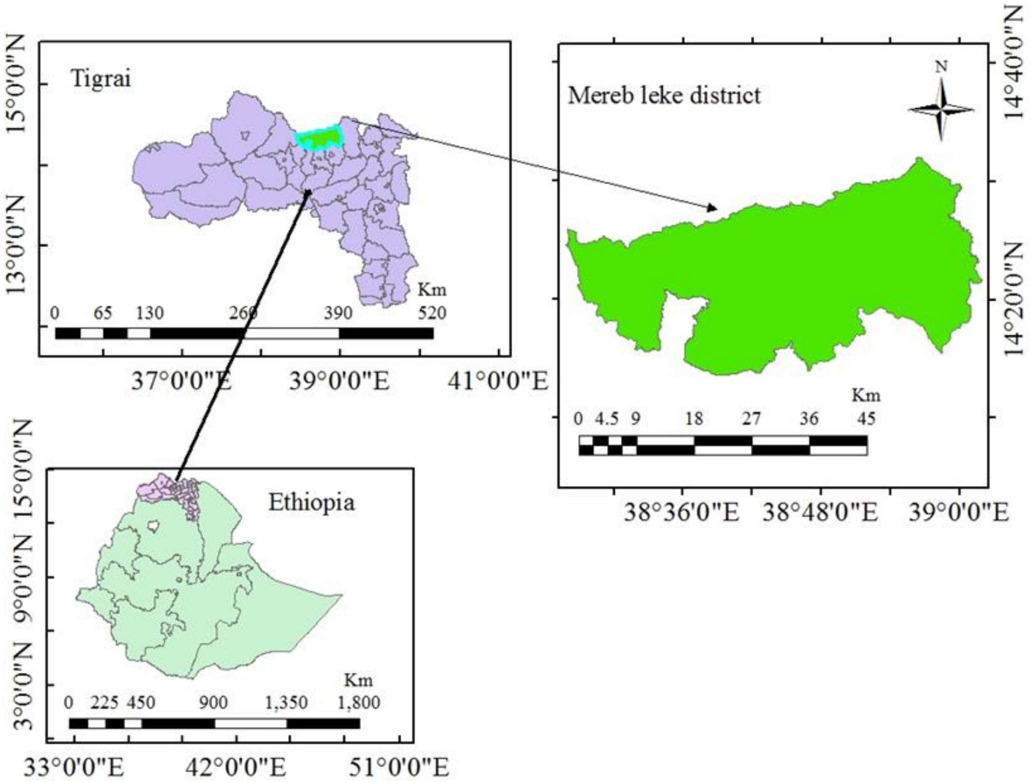

Figure 1: Map of the study area.

2.2. Sampling design

The systematic sampling design was used to collect the data of wild and semi-wild edible tree/shrub species from farmland, riverside, homestead, and exclosure land-use types. A total of 38 sample plots, i.e. 6 plots from farmland, 8 from river side, 8 from exclosure, and 16 plots from homestead were used proportional to their size to assess wild and semi-wild edible species. Transects lines were laid out systematically parallel to each other in each of the land-use systems to determine or record the species composition, diversity, population structure.

The first transect line was randomly selected and the others were laid down systematically at equal distance. Along the transect lines, 50 m X 50 m quadrat with 100 m distance between the plots were systematically laid down and the distance between consecutive transect lines was 100 m for vegetation data in farmland, homestead, and exclosures. However, 50 m X 50 m quadrat with 100 m distance between the plots was systematically laid down along the riverside for the riverine species data. All wild and semi-wild trees/shrubs in each plot at lowland agro ecology of the district were identified and recorded. The wild and semi-wild edible tree/shrub 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 and for individuals having ≤4 m height and clinometer for individuals having > 4 m height (Kindu et al., 2006). In order to know the regeneration or planted individual in the farmland 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 Useful trees and shrubs for Ethiopia (Bekele, 2007).

2.3. Data analysis

Wild and semi-wild edible tree/shrub species Woody species diversity was measured for individual land use units. The Shannon-Wiener indices of diversity and evenness were used to look at the level of species diversity and evenness of species distribution (Shannon, 1948). Shannon index calculated by multiplying the abundance of a species (pi) by the logarithm of this number:

$$H' = -\sum_{i=1}^{m} \text{Pij} \ln(\text{Pij}) \ldots\ldots\ldots\ldots..(1)$$

Where:
H'= Shannon diversity index
s = number of species
Pi=the proportion of individuals or the abundance of the ith species expressed as a proportion of the total
ln= natural logarithm

Although as a heterogeneity measure Shannon index take into account the evenness of abundance of species, it is possible to calculate a separate additional measure of evenness. The ratio of observed Shannon index to maximum diversity (Hmax = ln S) can be taken as a measure of evenness.

Equitability (evenness)

$$J = \frac{H'}{H'_{\max}} = \frac{\sum_{i=1}^{s} P_i \ln P_i}{\ln s} \ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Where: s = the number of species
H', and P_i = as above

The higher the value of J, the more even the species is in their distribution within the sample.

Simpson's diversity index

Simpson's diversity index gives relatively little weight to the rare species and more weight to the most abundant species. The Simpson's index values range between 0 and 1. The closer to 0 the value is, the low diverse the ecosystem is while closer to 1 high diverse. It is moderately affected by sample size (Magurran, 1988).

The Simpson's diversity (D) was calculated as follow:

$$D = 1 - \sum_{i=1}^{S} \text{pi}^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

Where
D= Simpson's index of species diversity
S= number of species
Pi= proportion of total sample belonging to the ith species

Important value index (IVI)

The importance value index is used to describe and compare the species dominance of the different land uses (Senbeta, 2006). The important value index combines data for the three parameters of Relative frequency, Relative density and Relative abundance (Kent and Coker, 1992). The importance value index (IVI) for each woody plant in the two land uses are calculated as follows:

$$\text{The importance value index (IVI)} = (\text{relative dominance} + \text{relative density} + \text{relative frequency}) \ldots(4)$$

Where;

$$\text{Relative dominance} = \frac{\text{total basal area for a species}}{\text{total basal area of all species}} * 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Where, the basal area of each woody species having DBH ≥2.5cm are calculated using the formula:

$$\text{Basal Area(BA)} = \left(\frac{\pi D^2}{4}\right) (\text{Kent and Coker, 1992}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Where; D is a diameter in M

Woody species density is the number of individuals within a chosen area (*e.g.*, m^2/ hectare) so, **relative density**, the density of one species as a percentage of total density calculated as follows;

$$\text{Relative density} = \frac{\text{number of individuals of a species}}{\text{total number of individuals}} * 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Frequency, the percentage of total quadrats or plots that contains at least one individual of a given species; **relative frequency**, the frequency of one species as a percentage of total frequency and is calculated as follows;

$$\text{Relative frequency} = \frac{\text{frequency of a species}}{\text{sum of all frequencies}} * 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Prior to analysis, assumptions for the normality data on wild and semi wild edible tree species diversity were checked using the Shapiro – Wilk test. The significant difference between means of the diversity indices was determined by using one way analysis of variance (ANOVA) between the land use types using SPSS for windows version 20.

3. RESULTS AND DISCUSSION

3.1. Floristic composition and Diversity of Wild and semi-wild edible tree/shrub species

A total of 8 wild and semi-wild tree/shrub, representing 7 families from Mereb-leke district was recorded in farmland, homestead, exclosure and riverside land-use types. Of these, tree species represented 7(87.5%) under 6 families and 1(12.5%) were shrub species representing

1 family (Appendix 1). In this study, the wild edible species composition is lower than to (10 wild edible species reported by Agbahoungba et al. (2016) in lama forest. This difference might be due to the ecological difference between the areas and unequal human disturbance. The most dominant family was Moraceae which represented by 2 species and followed by the other families represented by one species (Appendix 1). The dominance of the Moraceae family was also reported by Khaple et al. (2012) in which more Moraceae family under wild edible fruit species in Kodagu, and this family contribute food for humans and animals. This indicated that such a 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).

3.1.1. Diversity of Wild and semi-wild edible plant species

The Shannon diversity index, Simpson's diversity index_ 1-D, species richness and equitability of wild and semi-wild edible tree/shrub species was showed no significant difference between riverine, homestead, farmland and exclosure land use systems at the lowland agro ecology in Mereb leke district (Table 1). However, the abundance of species was significantly higher (*P*=0.001) in the homestead land-use system (42± 9.6) than the exclosure (8.5± 1.1), farmland (19± 11.7), and riverine (9.3± 2.3) land-use systems.

Table 1: Diversity indices of wild and semi wild edible tree/shrub species in the different land use types in Mereb leke (Means ±SE).

Land use	Species richness	Abundance	Simpson_1-D	Shannon_H	Equitability_J
Farmland	2.0 ± 0.0^a	19 ± 11.7^b	0.16 ± 0.02^a	0.3± 0.14	0.5± 0.22
Riverine	1.8 ± 0.9^a	9.3 ± 2.3^b	0.14 ± 0.076^a	0.26± 0.13	0.26± 0.12
Exclosure	1.6 ± 0.3^a	8.5 ± 1.1^b	0.18 ± 0.078^a	0.29± 0.12	0.37± 0.15
Homestead	1.7 ± 0.2^a	42 ± 9.6^a	0.17 ± 0.049^a	0.28± 0.07	0.37± 0.06
P_value	0.73	0.001	0.26	0.24	0.7

The columns with similar lowercase letters are not significantly different ($P>0.05$), while the difference letters in column indicates significant difference ($P<0.05$) between the land use types.

The value of the Shannon diversity index in the different land-use types was ranged from 0.26± 0.13 (riverine) - 0.3± 0.14 (farm land). However, the normal range for the Shannon diversity index value varies from 1.5 - 3.5 (Kent and Coker, 1992). Hence, the Shannon diversity index of wild and semi-wild tree/shrub species in farmland, riverside, exclosure, and homestead is categorized at a very low value. The reason for the low value of the Shannon diversity index of wild and semi-wild species could probably be due to overutilization of the species by the community and more susceptibility to drought. The other reason for the low diversity value in the study could be the fact that only wild edible trees and shrubs were selectively registered (other species are not assessed).

The Shannon diversity index of the wild and semi-wild trees in the farmland, exclosure, riverside, and homestead was lower than the diversity of wild fruits under moist deciduous vegetation (H') =4.29 (Elouard, 2000) and in Kodagu (H') = 4.48 (Khaple et al., 2012). The difference in wild edible tree species diversity could probably be due to the variation of agroecology and other biotic and abiotic factors. The low species diversity in this study might be due to the existence of low woody community interaction. The other factor for the non-variation of diversity indices between the land use types in the lowland agro-ecology might be due to fact that the wild edible species growing in each land-use types are non-competitive to each other.

The Simpson _(1-D) diversity value in this study ranged from 0.14 - 0.18; this indicates that few competent species were dominant in the site and more probably low interaction among the species in each land-use type. Simpson's index values range between 0 and 1. Values that are closer to zero indicates, low diversity ecosystem and values closer to 1indicates high diversity (Magurran, 1988). Therefore, the Simpson diversity value of all the land use types showed low diversity (farmland (0.16±0.02), exclosure (0.18±0.18), riverside (0.14±0.07), and homestead (0.17±0.05)) of wild and semi-wild edible trees. Additionally, the equitability value was observed non-significant difference (*P*=0.7) between the different land-use types and this indicates that even representation of individuals of all wild and semi-wild edible species encountered in all land-use types.

In Mereb leke district the abundance of wild and semi wild edible tree/shrub species in homestead land use type showed a significantly higher value (42± 9.6) than the other land use types, this result indicates farmers are good at managing the wild edible trees in their homestead. This result is confirmed with Mengistu and Asfaw (2016) farmers are selective in growing and managing species around their homestead due to their economic and ecological importance of the species. This could be explained by the fact that farmers are intensive species selection for different uses and coping strategies. The other factor might be due to the availability of high soil seed bank of wild and semi wild edible species in homestead land use type. However, the low availability of wild and semi wild species abundance in exclosure, farmland and river side might be due to human and animal disturbance and this in line with Bhuyan et al.(2003) which says reduction of stem density of wild edible fruits in many tropical forest has been observed due to human induced factors. The variation of wild edible species abundance from one land use type to another may be explained by the difference in slope, disturbance, moisture, soil characteristics within each land use type. For instance, the plant density increases in an environment where the optimum conditions are met (Emrich et al., 1999).

3.1.2. Population structure of wild and semi wild edible tree/shrub species

An inverted 'J' shaped pattern of population structure of wild and semi-wild edible tree/shrub species was observed in homestead land-use type. However, 'J' shaped population structure was observed in the riverine land use of the same agroecology. Farmlands and exclosures were observed irregular patterns of population structure based on the diameter class distribution (figure 2). The discontinuous type of vegetation structure distribution follows a Gauss distribution pattern and indicates poor reproduction and recruitment that may have resulted from complete removal or presence of only a few seed-bearing tree species. The poor regeneration potential of wild and semi-wild edible tree/shrub species might be due to the physical suppression of the other species over the use full wild edible tree species and the presence of few competent seed-bearing wild fruit species in the ecosystem (Khaple et al., 2012). The result indicates that, except in the homestead land use system, the population structures of the other land use systems (farmland, exclosure and river side) were unhealthy. Analysis of the population structure can be provided information on the history of past disturbance and used to predict the future trend of the population structure (Wale et al., 2012).The unhealthy pattern of distribution for diameter class might be resulted due the several factors like human and animal disturbance acting on the existing species. This result is in agreement with Feyissa et al. (2013) the presence of human induced factors like removal tree/shrub species leads to irregular population structure.

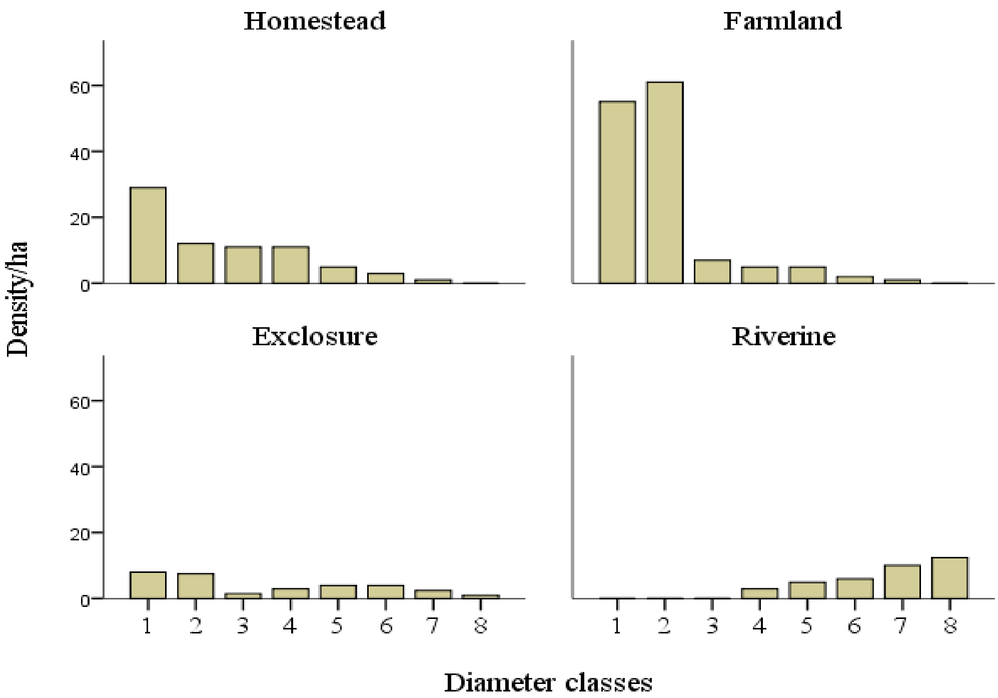

Figure 2: Diameter class distributions of wild and semi wild edible species in M/leke district in different land use types: Where 1=<2.5, 2=2.5-10, 3=10.1-20, 4=20.1-30, 5=30.1-40, 6=40.1-50, 7=50.1-60, 8 >60.

3.1.3. Important value index

The IVI value of the dominant and most ecologically important wild edible tree species in the farmland areas are *Z.spina-chiristi* and *B.aegyptiaca* with the IVI values of 87.22 and 113.78 respectively. Similarly the highest IVI value of wild edible trees/shrubs in the riverine land use are *D.mespliformis* (165.5) *T.indica*) (50.2) *Z.spina-chiristi* (20.7) *B.aegyptiaca* (16.6) and *F.sycomorus* (46.8) (Table 2). The species with the highest IVI value of in the exclosure were *F.vasta* (35.92), *Z.spina-chiristi* (150.28), and *B.aegyptiaca* (111.89). In homestead agroforestry, the wild edible tress/shrubs species with the highest IVI value were *C. africana* (91.23) *Z. spina-chiristi* (124.53), *B.aegyptiaca* (71.83), *G.flavescens* (13.08). The IVI value is considered to show greater ecological significance in plant species distribution (Forsberg, 1961). Similarly, the most dominant and ecologically important species might also be the most successful species in the regeneration and attraction of seed predators that facilitate seed dispersal within the existing environmental conditions (Kebede, 2010). The reason why they have higher IVI value in this study was due to the higher relative density, relative frequency, and relative abundance compared to other species in all land-use types. IVI analysis is used for setting conservation priority (Gurmessa et al., 2011). Those species which receive lower IVI values: like *G.flavescens in homestead*, *Ficus vasta* in exclosure, *Tamaridus indica* in riverside needs high conservation efforts while those with higher IVI values; like *D.mespliformis* in the farmland, *Z.spina-chirist* in the exclosure and homestead needs monitoring and management.

Table 2: Basal area (m^2 ha^{-1}), Density (ha^{-1}), Relative Density (RD %), Frequency, Relative Frequency (Rf %), Relative Dominance (Rd %) and Importance Value Index (IVI) of individual woody plants entire land use system.

Farmland							
Scientific name	D/ha	RD (%)	BA(m2)	RDO (%)	FR	RF (%)	IVI (%)
Ziziphus spina-chiristi	62	36.90	0.007	0.31	100	50	87.22
Balanites aegyptiaca	106	63.10	0.015	0.69	100	50	113.78
Total	168	100	0.022	1.00	200	100.00	201.00
Riverine							
Scientific name	D/ha	RD (%)	BA(m2)	RDO (%)	FR	RF (%)	IVI (%)
Diospyros mespliformis	33.5	90.5	0.2	17.8	100.0	57.1	165.5
Ziziphus spina-chiristi	1.5	4.1	0.0	2.4	25.0	14.3	20.7
Tamarindus indica	1	2.7	0.4	33.2	25.0	14.3	50.2
Balanites aegyptiaca	0.5	1.4	0.1	8.1	12.5	7.1	16.6
Ficus sycomorus	0.5	1.4	0.5	38.4	12.5	7.1	46.8
Total	37	100.0	1.3	99.8	175.0	100.0	299.8
Exclosure							
Scientific name	D/ha	RD (%)	BA(m2)	RDO (%)	FR	RF (%)	IVI (%)
Ficus vasta	1.00	2.94	0.06	25.29	12.50	7.69	35.92
Ziziphus spina-chiristi	25.50	75.00	0.05	21.44	87.50	53.85	150.28
Balanites aegyptiaca	7.50	22.06	0.13	51.37	62.50	38.46	111.89
Total	34.00	100.00	0.25	98.10	162.50	100.00	298.10
Homestead							
Scientific name	D/ha	RD (%)	BA(m2)	RDO (%)	FR	RF (%)	IVI (%)
Cordia africana	33	42.3	0.04	37.84	18.70	11.08	91.23
Ziziphus spina-chiristi	42	53.8	0.03	29.94	68.75	40.75	124.53
Grewia flavescens juss	1	1.3	0.01	8.09	6.25	3.70	13.08
Balanites aegyptiaca	2	2.6	0.02	24.80	75.00	44.46	71.83
Total	78	100.0	0.10	100.67	168.70	100.00	300.67

4. Appendix 1: List of wild and semi- wild edible trees and shrubs. T=Tree, S=Shrub

No.	Scientific name	Local name	Family	Growth habit
1	*Balanites aegyptiaca* (L)Delile	Mekie	Balanitaceae	T
2	*Cordia africana*	Akui	Boraginaceae	T
3	*Diospyros mespliformis*	Aye	Ebenaceae	T
4	*Ficus sycomorus*	Sagla	Moraceae	T
5	*Ficus vasta*	Daero	Moraceae	T
6	*Grewia flavescens juss*	Mesequa	Tiliaceae	S
7	*Tamarindus indica*	Humer	Fabaceae	T
8	*Ziziphus spina-chiristi*	Gaba	Rhamnaceae	T

5. CONCLUSION AND RECOMMENDATIONS

The diversity indices of wild edible tree/shrub species in Mereb leke district showed no significance difference among the different land-use types. However, significantly higher abundance in homestead was observed than the other land-use types. Except in homestead, unhealthy population structure distribution was observed in all the other land uses (farmland, riverine, and exclosure land-use types). From the analysis of population structure, certain species with low

IVI values were identified as a priority for conservation, while those with higher IVI values needs management.

Strong focus should be given to foster homestead agroforestry systems that has good regeneration potential for the lowland agro ecology. Conservational demand is highly needed for the wild and semi-wild edible tree species which are growing in the riverside, farmland, and exclosure land-use types.

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