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Plant Species Diversity and Structure in Homegarden Agroforestry Systems of Bulen District, North-Western Ethiopia

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Abstract: Homegarden agroforestry system mostly constitutes complex multi-strata than other agroforestry systems. The aim of this study was to investigate the structure, composition and diversity of plant species growing in homegarden agroforestry system in *Bulen* district, North-West Ethiopia. The study was conducted in five kebeles of the district, which were randomly selected. Systematic random sampling procedure was employed to select households from each kebele. Thus, 138 households from each site were selected proportionally. The result from the surveyed 138 households indicated that 110 (80%) were practicing homegarden agroforestry system. The determination of vertical and horizontal structure of the vegetation was conducted for 110 homegardens. All woody species and herbaceous species were counted and recorded in 5m x 5m and 1mx1m quadrants, respectively. Furthermore, a total of 22 plant species belonging to 15 families were recorded in sampled homegardens in which about 3-5 different species of plants per quadrant were recorded. A higher Shannon diversity index of plant species in the study area were (H'=2.44) while the lower Shannon diversity index were (H'=2.21). The studied homegarden agroforestry system had complex structure both vertically and horizontally, which in turn provide economical benefit and ecological service to the households.

Keywords: Homegarden Agroforestry System, Vegetation Composition, Woody Plants, Herbaceous Plants, Species Diversity Index

1. Introduction

Land around the farmers house with trees are one of agroforestry practices known to be ecologically sustainable and diversifies livelihood of local community. Homegarden agroforestry system is the land use system involving deliberate management of multipurpose trees and shrubs in intimate association with annual and perennial agricultural crops and invariably livestock within the compounds of individual houses, being intensively managed by family labour [1]. Well-designed structure of homegarden agroforestry can give the desired benefit through efficient resource utilization. Homegardens are fundamentally different from large scale agricultural systems, mainly because they are small in size, intensively managed production systems and require low levels of agricultural inputs.

The structure of homegarden in the tropics is based on horizontal and vertical strata. Horizontal structure is determined by localization of each homegarden species with in the garden using farmer's house as a reference. Vertical structure reflects degree of species specialization and complexity [2]. In order to maintain agro-ecosystem resilience and to meet the homegarden products for requirements of the people during stress of climatic hazard like drought, flood, scientific information is required.

Homegarden agroforestry systems in the tropics are known for their structural complexity and diversity in crop and other

plant species [1]. The cultivation of different crops in homegardens is regarded as a strategy of farmers to diversify their subsistence and cash needs. Diversification also helps to stabilize yield and income in cases of incidences of disease and pests, and market price fluctuations. Although the positive impacts of crop diversity on homegarden sustainability have been widely discussed [3], the precise relation between diversity and sustainability is still in open debate [4]. A basic question is how diversity in homegardens can best be characterized. Normally, diversity is expressed as the average number of species per homegarden in a specific region. Currently, increasing attention is given to the diverse nature of species diversity and their variation in time and space. For instance, ecologists differentiate between alpha (the diversity in a particular area or ecosystem), beta (the change of species diversity between ecosystems) and gamma (the overall species diversity for the different ecosystems within a region) [5, 6].

Species composition, structure and function of homegardens may be influenced by ecological, socio-economic and cultural factors, such as distance from urban markets, household size and composition, environmental degradation and family tradition [7]. According toreference [8], homegardens, whether found in rural or urban areas, are characterized by a structural complexity and multi functionality, which enables the provision of different benefits to ecosystems and people. Lack of scientific knowledge on homegarden agroforestry systems structure and species diversity may pave the way for destruction of diverse plant species. There is no scientific study carried out on plant species structure, composition and diversity in homegarden of in the study area yet. It is imperative to undertake investigation into various aspect of biodiversityin homegarden agroforestry system. Thus, the study was designed with the aim to investigate the structure, composition and diversity of plant species in homegardens agroforestry systems of the study area.

2. Material and Methods

2.1. Description of the Study Area

The study was conducted in *Bulen* district, North-western Ethiopia. Geographically, the district is located at 10°36′10.6″ northern latitude and 36°04′57″eastern longitude. *Bulen* is one of the 20 districts in the Benishangul-Gumuz Regional state of Ethiopia. It is located at 634 km from the capital of Ethiopia, Addis Ababa in western part of the country and 585km from Assossa the capital of the Region in the Northern direction. *Bulen* district has a total area of 325233.75 ha and for administrative purpose; it is structured into 17 rural and 2 urban *Kebeles*. Topographically the district lies within an elevation range of 500 -1695 meters above sea level.

The district has three agro- ecological Zones: Dega (5%), Weyna dega (20%) and Kolla (75%). The annual temperature of the Districtranges from 28°C - 34°C and the annual rainfall ranges 1200 - 1500 mm. With regard to land use, the largest area, 144,583.25ha (44.45%), is cultivable land, 36,370 ha (11.2%) of the *district* is intensively cultivated for annual crops, 40,462 ha (12.44%) is a grazing land, 69,344 ha(21.32%) is forest land and 34,475 ha(10.6%) is covered by others.

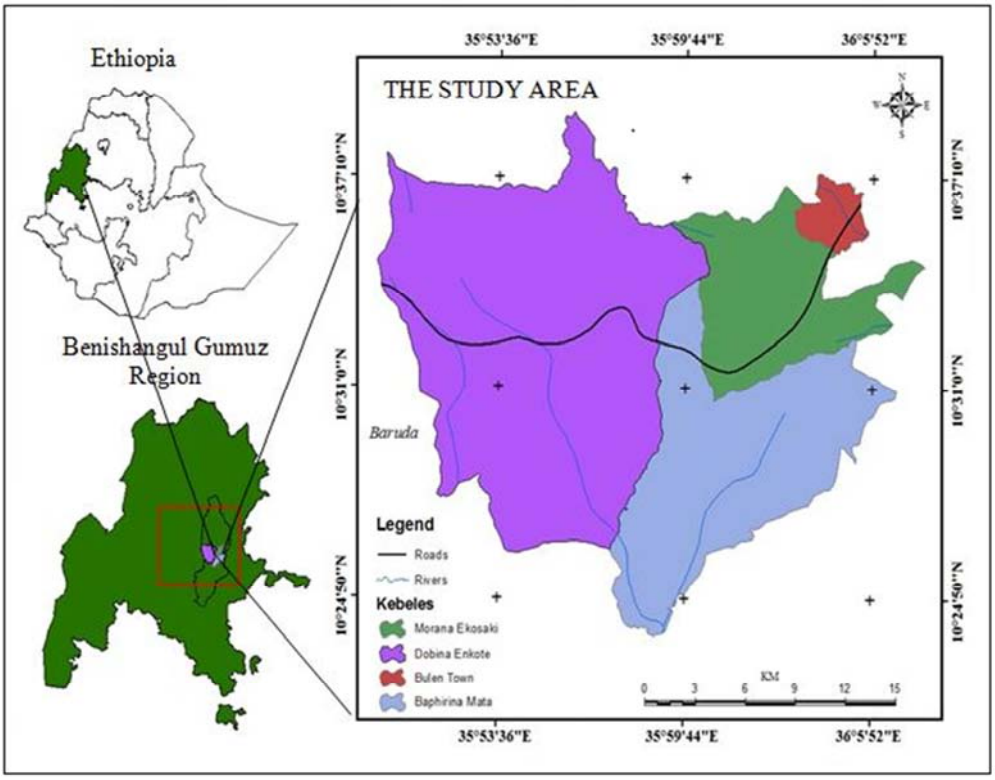


Figure 1. *Location map of the study area.*

2.2. Research Method and Design

The research methodology employed for this study was exploratory research methods. This method is preferred because there is no evidence that shows about structure of plant species diversity in homegarden and its economic contribution to household. From among exploratory research methods, descriptive and economic survey was used to identify plant species diversity and its economic contribution to household.

2.3. Sample Size and Sampling Procedure

The study was conducted in five randomly selected *kebeles* of the district*,* namely: Baruda, Bulen 01, Dobina Enkonti, Baphirina Mata, and Morana Ekosaki. Then, systematic random sampling used to select households from each *kebeles*. There were 747, 746, 922, 519 and 319 of total household members in each *kebeles,* respectively.

To determine sample distribution and the corresponding target population, the following formula was used

$$N=\frac{z^2(1-p)p}{e^2}=\frac{1.96^2(1-0.9)0.9}{0.05^2}=138$$

where; z = the z-value the desired degree of confidence, p = an estimate of the population proportion, and e = the absolute size of the error in estimating p that the research is willing to permit.

Table 1. *Sample distribution and the corresponding target population.*

Name of *kebeles*	Total No. of households	Percentage (%)	Sample size of households
Baruda	747	23	32
Dobina Enkonti	922	28	39
Baphirina mata	519	16	22
Morana Ekosaki	319	10	13
Bulen 01	746	23	32
	3253	100	138

Source: Bulendistrict Office of Agricultural and Rural Development.

2.4. Data Collection Methods

The data were collected using the following data-collection instruments.

2.4.1. Household Survey

Out of the 3253 household heads of the five *Kebeles*, household for survey were selected based on the following formula;

$$N = \frac{Z^2(1-p)p}{e^2} \text{ [9]}$$

Where; N= sample size

Z = the z-value the desired degree of confidence.

P =an estimate of the population proportion.

e=absolute size of the error in estimating p that the research is willing to permit.

2.4.2. Sampling of Homegardens

Homegarden size, horizontal and vertical arrangement of homegarden units, and plant species in different units were recorded in each garden. Horizontal structure was classified following [10]. Dividing homegarden into four quadrats, which means the first quadrat start from the farmers home to 10m, the second quadrat from10m to 20m, the third quadrat from 20m to 30m and the fourth quadrat from 30m to 40m horizontally were employed using farmer's house as reference and the different species within quadrat was recorded. Moreover, the number of vertical strata and the plant species occupying each stratum were recorded following the classification given to tropical homegarden by reference [11, 12]. Accordingly, four vertical strata, (<1m, 1-5m, 5-10m, and >10m) were used for this stratification. Height measurement was carried out using clinometers for trees and measuring tape for herbaceous crop and also caliper for measuring DBH (Diameter at Brest Height) of each species. The numbers of plants per species were measured by counting all perennial plants and annual crops, in sample quadrats in systematically selected 5mx5m ($25m^2$) and 1 × 1 m ($1m^2$) quadrats, respectively.

2.5. Data Analysis

For this study both quantitative and qualitative data analysis technique were used. Descriptive statistics methods such as densities, frequencies, abundance, dominance, relative frequencies, relative abundance, relative dominance, importance value index, Shannon and Wiener index for species diversity and Sorensen's Index of similarity were used to analyze the data collected in sample quadrats of 1 × 1 m ($1m^2$) and 5 m x 5 m ($25m^2$) in 110 homegardens.

2.5.1. Structural Data Analysis

Species structure (frequency, density, abundance, basal area, and importance value index (IVI) of plant species in the homegarden were analyzed. Importance value index (IVI) was calculated by summing up relative frequency (RF), relative density (RD) and relative dominance (RDO) values. The total number of species (species richness) were calculated by summing up the number of all the species encountered in homegardens. The importance value index (IVI) indicates the importance of individual tree/shrub species in the land use systems. It is a composite index based on the relative measures of species frequency, abundance and dominance [13]. This index were used to determine the

overall importance of each species in the community structure. To calculate IVI of each species in the study area first the basal area and dominance of each species were calculated as:

$$BA=\pi r^2 \text{ or } BA=\pi d^2/4$$

Dominant most conspicuous and abundant species in the studied area and calculated as:

$$\text{Dominance}=\frac{\text{Total basal areaof the species}}{\text{Totalsampled area}}$$

Where: BA= basal area, π=3.14, *d*= diameter at breast height of tree/shrubs, *r*=d/2.

Relative dominance Dominance of a species is determined by the value of the basal cover. Relative dominance is the coverage value of a species with respect to the sum of coverage of the rest of the species in the area.

$$\text{Relative dominance} = \frac{\text{Total basal area of species}}{\text{Total basal area of all species}}\text{x}100$$

Density is an expression of the numerical strength of a species where the total number of individuals of each species in all the quadrats is divided by the total number of quadrats studied. Density is calculated by the equation:

$$\text{Density} = \frac{\text{Total no.of individuals of } species in all quadrats}{Total no. of quadrats studied}$$

Relative density is the study of numerical strength of a species in relation to the total number of individuals of all the species and can be calculated as:

$$\text{Relative density} = \frac{\text{Number of individual of species}}{\text{Number of individual of all species}}x100$$

Frequency describes the distribution of a species throughout the stands. It is determined by calculating the percentage of plots/quadrants in a sample area on which a given species occurs [14]. It was studied by sampling the study area at several places at random and recorded the name of the species that occurred in each sampling units. It is calculated by the equation:

$$\text{Frequency (\%)} =\frac{\text{Number of quadrats in which the species occured}}{\text{Total number of quadrats studied}}\text{x } 100$$

Relative frequency is the number of occurrences of a species, as a percentage of the total occurrences of all species [14].

$$\text{Relative frequency} = \frac{\text{Frequency of a species}}{\text{frequency of all species}}\text{x}100$$

Abundance-It is the study of the number of individuals of different species in the community per unit area. By quadrats method, samplings are made at random at several places and the number of individuals of each species was summed up for all the quadrats divided by the total number of quadrats in which the species occurred. It is represented by the equation:

$$\text{Abundance} =\frac{\text{Total number of individuals ofa species in all quadrats}}{\text{Total number of quadrats in which the species occurred}}$$

Relative abundance The quantitative pattern of rarity and commonness among species in a sample.

$$\text{Relative abundance}= \frac{\text{Number of individuals of species}}{\text{Total number of individuals}}\text{ x } 100$$

Finally, IVI=RA+ RD + RF; where, IVI-Important value indices, RA-relative abundance, RD-relative dominance and RF-relative frequency.

2.5.2. Similarity and Dissimilarity Indices

Variation in species composition among the different homegardens were determined using Beta diversity, calculated as β=1- Cj, where Cj is Jaccard's similarity index [5], C j = j/(a + b – j), where; j = the number of species shared by any two sites a and b, a = the number of species in site a, and b = the number of species in site b.

2.5.3. Species Richness, Diversity and Dominance Indices

The species richness of the vascular plants was calculated by using the method 'Margalef's index of richness' (Dmg) [5].

Dmg = (S-1)/ In N.

Where, S = Total number of species. N = Total number of individuals.

2.5.4. Shannon and Wiener Diversity Index

The Shannon-Weiner Index is the most commonly used diversity indicator in plant communities, and it takes a value of zero when there is only one species in a community, and a maximum value when all species are present in equal abundance [15]. To determine the diversity of plant species we calculated species richness, Shannon index and Evenness measure (E). Shannon diversity index is calculated as (H')= $-\sum_{i=1}^{s} pi \ln pi$.

where; pi is the proportion of crop area composed of species i. The measure of evenness (E) which is the ratio of observed diversity to maximum diversity is calculated as E = H'/Hmax, =H'/ln [5], where; H' is a diversity index, Hmax and ln the highest and lowest values of this index for the given number of species and the sample size.

3. Results and Discussion

3.1. General Features of Homegarden Agroforestry

The spatial arrangement in homegarden agroforestry wasfound to be variable in the study area. About 83% of homegarden agroforestry is located in the backyard while a few were located on the other side of the homestead. Most of the studied homegarden agroforestry (78%; n=110) were surrounded by live fence of the species *Justiciaschimperiana, Azadirachtaindica, Erythrinaabyssinica, Cordiaafricana, Crotonmacrastachyus, and Acacia nilotica*and the rest 22% were semi-fenced and open.

Table 2. *The number of homegarden found in different size category.*

HG category	Range of category	No. of HG	Percent(%)
Small	0.031-0.25ha	41	38
Medium	0.25-0.5ha	58	54
Large	0.5-0.75ha	11	8
Total		110	100

From the surveyed 138 households in *Bulen* district, it was demonstrated that, (80%) were practicing homegarden to grow different types of plants to fulfill various needs of household members. The overall size of homegardens in the study area ranges from 0.031 to 0.75 ha. The size range observed in this study was also considerably larger than the range reported for most Ethiopian gardens (0.004-0.05ha) [16]. The range of homegardens sizes in the three categories were 0.031ha-0.25, 0.25-0.5ha and 0.5- 0.75ha in small, medium and large sized homegardens, respectively. 54% of the households had medium sized homegardens ranging between 0.25-0.5ha followed by 38% (small) and 8% (large) ranked in first, second and third, respectively (Table2). So the result of this study was dissimilar with the finding reported by other [17]. In their study 100% of the surveyed households in the area practicing homegarden agroforestry while in this study area 80% of the households practiced homegarden agroforestry and the size of homegardens in their study area ranges from 250m^2 – 2000m^2 with an average of 665.42m^{2}while in this study 310m^2-7500m^2. In this study area90% of households have their own farm land on the field and have less attention on producing homegarden agroforestry. Most of the surveyed homegardens (70%) in Bulen district had rectangular shape while the remaining were irregular and square shape.

3.2. Structure of Homegarden Agroforestry System

3.2.1. Horizontal Stratification

Most common plant species recorded in the homrgarden agroforestry system of the area were Maize (20%), *Cucumis sativus L* (9%), *Azadirachta indica* (9%), *Cordia africana* (9%), *Sesbania sesban* (7%), *Croton macrastachyus* (6.5%) and *Mangifera indica* (5.8%) (Figure 2). These plant species provide multiple functions to the household like, food, income source, fuelwood and building materials. maize had the highest percent (20%) followed by *Cucumis sativus L*(9%)*, Azadirachta indica* (9%)*, Cordia africana* (9%) and S*esbania sesban (*6.5%).

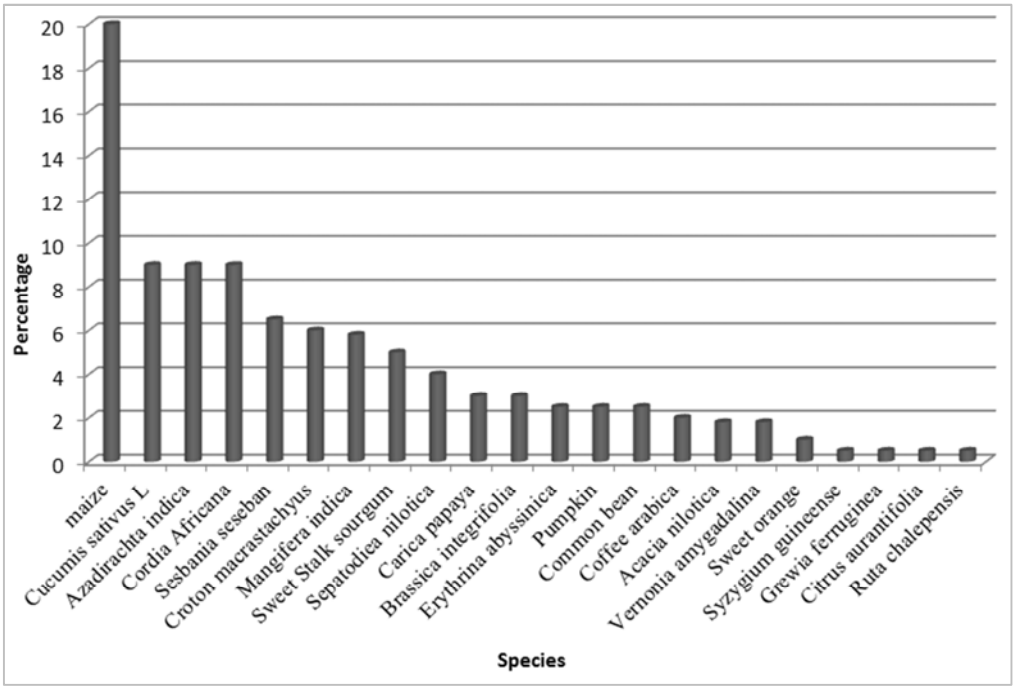


Figure 2. *Percentage of plant species recorded in the studiedhomegardens.*

The species composition varies highly with increase in the size of homegardens. For all sampled homegardens the horizontal structure of species was determined by the owner of the household. Generally, the studied homegardens showed a distinct horizontal structure arrangements zone between perennial plants and annual crops. It was found that in the middle of the gardens, vegetables, cereal crops and fruit trees were typical features of most of the gardens (Figure 3). This finding was in line with the finding reported by reference [18]. Horizontal structure of the species declined as one goes from the first quadrat to the fourth quadrat or out of the garden. Similar finding was reported by reference [19].

The species recorded in each quadrat were grouped into functional groups and their extent of horizontal distribution was quantified as percent share relative to each other in the 110 studied homegardens. For functional groups distribution in the gardens, most woody species were recorded in the fourth quadrat; whereas, fruits and vegetables were frequently recorded in the second quadrat and cereal crops, pulse and spices were recorded in quadrat one.

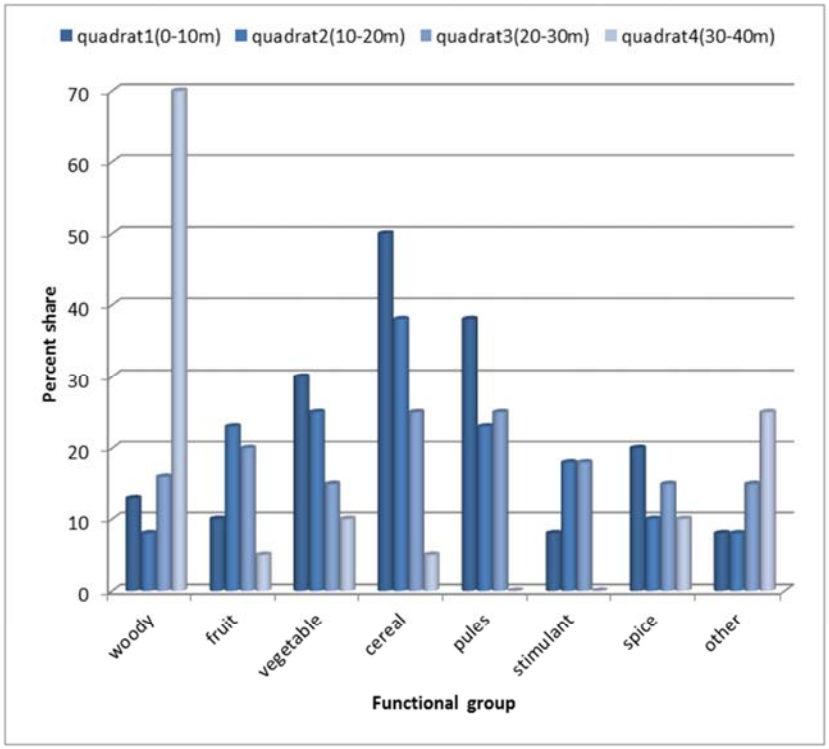


Figure 3. *Functional group of plant species across horizontal stratification.*

On the boarder of the gardens tree species like *Justicia schimperiana, Azadirachta indica, Erythrina abyssinica, Cordia africana, Croton macrastachyus, Acacia nilotica, Spatodia nilotica* and *Vernonia amygdalina* were the dominant and each individual species was also distributed haphazardly in each quadrant (Figure 4).

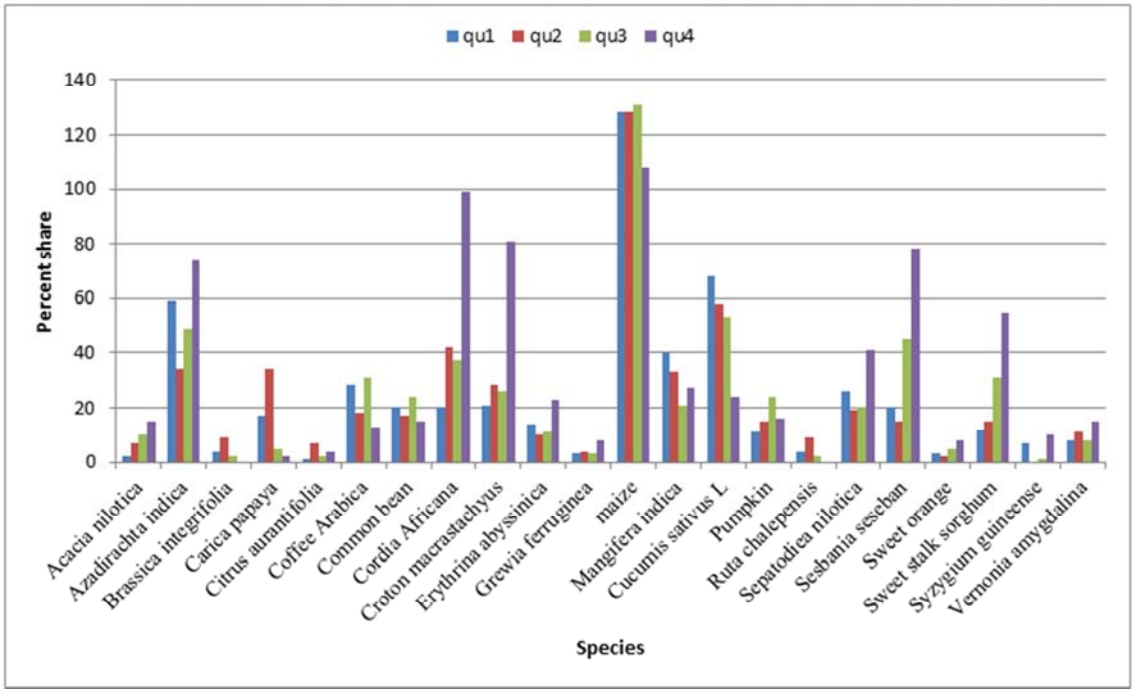


Figure 4. *Horizontal distribution of individual species in each quadrat.*

Proportion of top five species per quadrat across horizontal structure of homegarden agroforestry system was presented in Figure 5. It was indicated that species in the first quadrat have high contribution than the other three quadrats. The result indicated that as one cross from first to fourth quadrat the relative percent contribution of the species decreases.

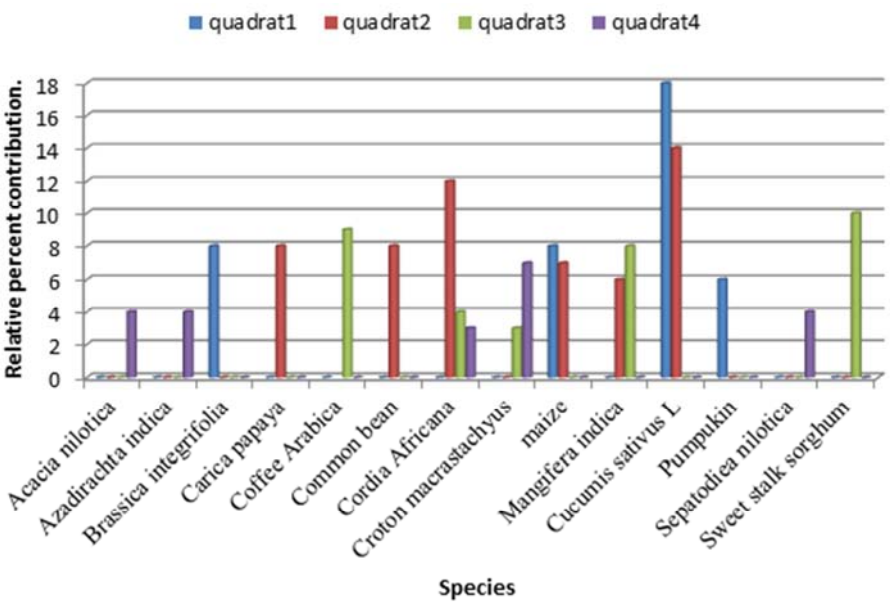


Figure 5. *Proportion of top five species per quadrat across horizontal stratification.*

The species richness also showed declining trend as one goes from quadrat one to quadrat four (Figure 6). Species richness varies from quadrat to quadrat indicating decrease with increasing distance from quadrat one to quadrat four. Quadrat one had the highest species richness than the other quadrats. Refernece [18] reported similar result in study of plant species richness and structure of homegarden agroforestry in *Jabithenan* District, North-Western Ethiopia.

Cereal and pulse crops dominant in the first quadrat, vegetable and fruit were in the second and third quadrat, respectively while woody species dominate in the fourth quadrat. This finding was disparity with the result reported by reference [18]. In the current study area farmers grow cereal crops in the homegarden using spatial arrangement for the different components. woody species are planted in the fourth quadrat to use trees as live fence, windbreak and avoid shading effect on other crops. The result revealed that a total of seven functional groups of plant species were recorded in the homegardens of the area. Out of the total of 22 plant species, most species were woody plants (28%) followed by cereal crops (25%), fruit crops (15%) and vegetables (12%). These functional groups included pulses (7%), stimulant (5%), spices crops (4.5%) and the other group (3.5%).

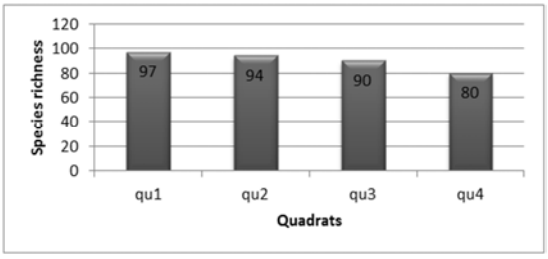
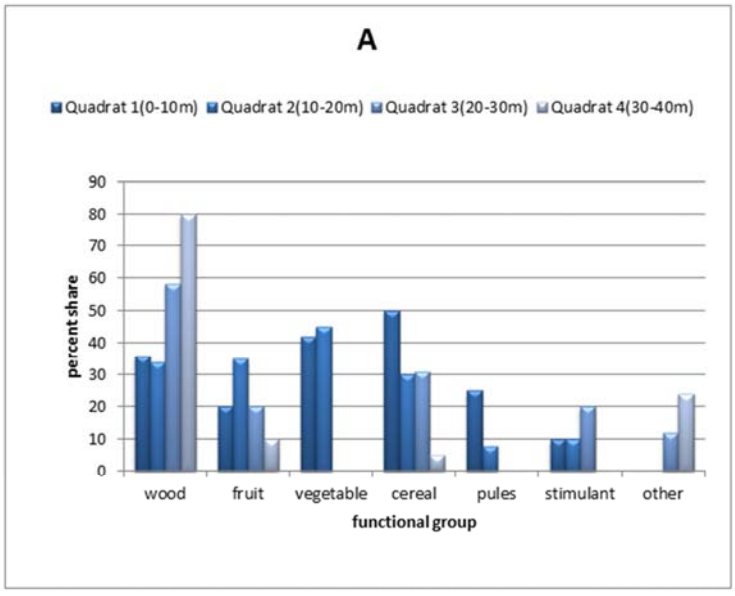
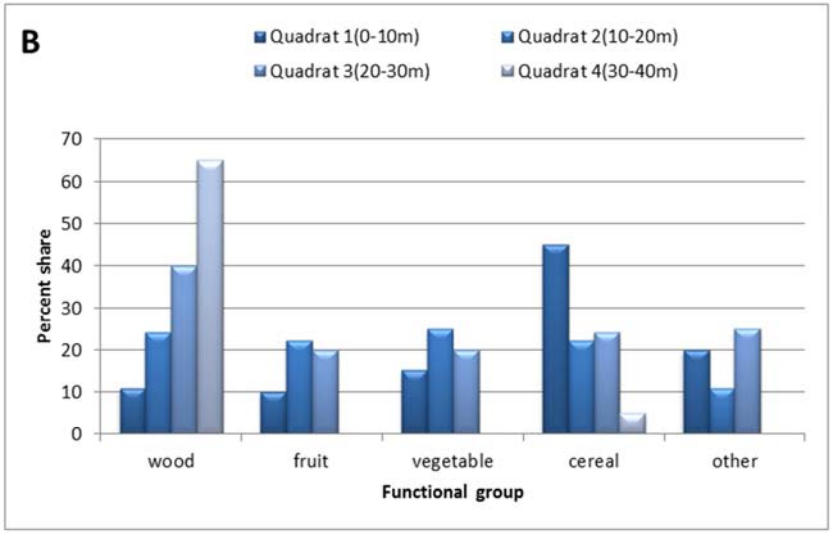


Figure 6. *Species richness across homegarden agroforestry in each quadrat.*




B
Quadrat 1(0-10m)
Quadrat 2(10-20m)
Quadrat 3(20-30m)
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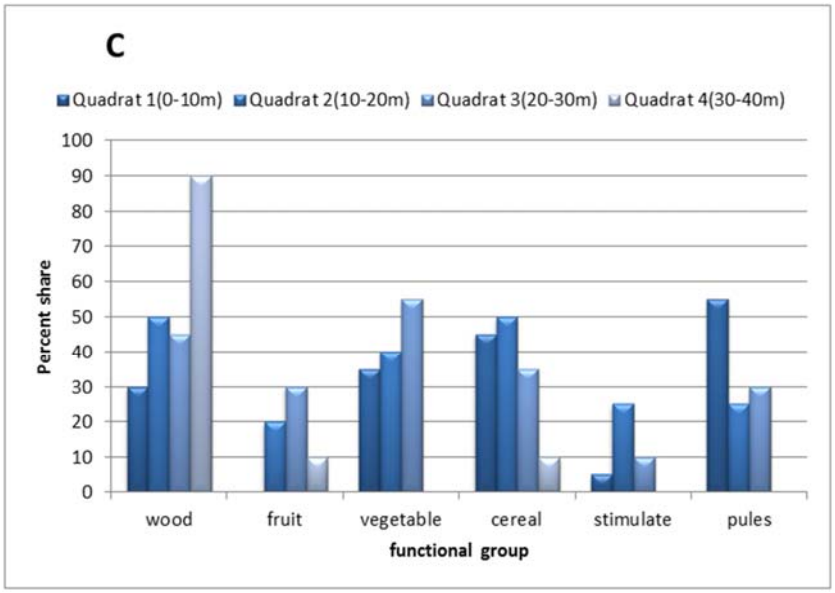
Functional group


C
Quadrat 1(0-10m)
Quadrat 2(10-20m)
Quadrat 3(20-30m)
Quadrat 4(30-40m)
Percent share
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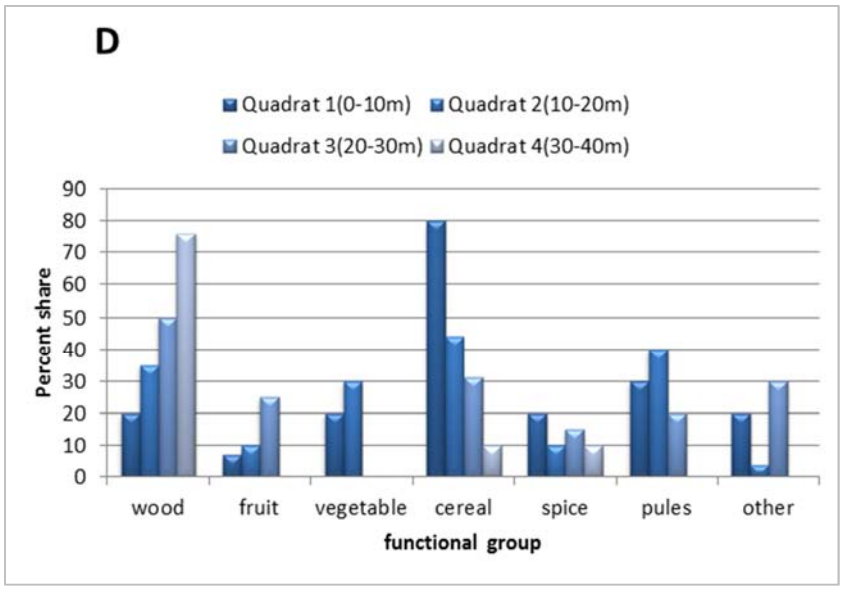
D
Quadrat 1(0-10m)
Quadrat 2(10-20m)
Quadrat 3(20-30m)
Quadrat 4(30-40m)
Percent share
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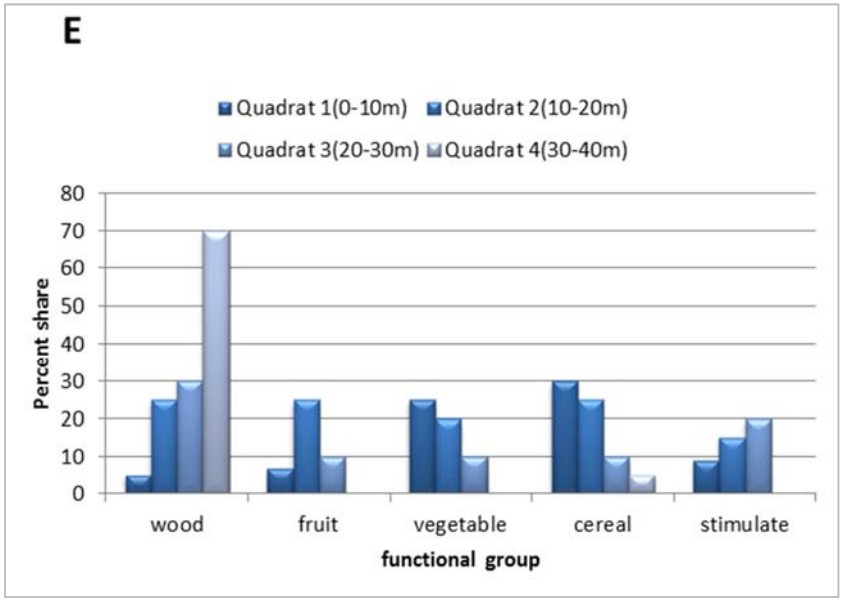

Figure 7. *Horizontal stratification of different functional groups in Baruda (A), Dobi (B), Mata (C), Mora (D) and Bulen 01 (E) kebeles.*

3.2.2. Vertical Stratification of Plant Species

The relative percent contribution of each species, species richness and species distribution in each height strata, are shown Fig.8, 9 and 10. The bottom layer was dominated by vegetables, shrub layer dominated by cereal crops and fruits, while the main canopy and upper storey layer were dominated by woody plants (Figure 8).

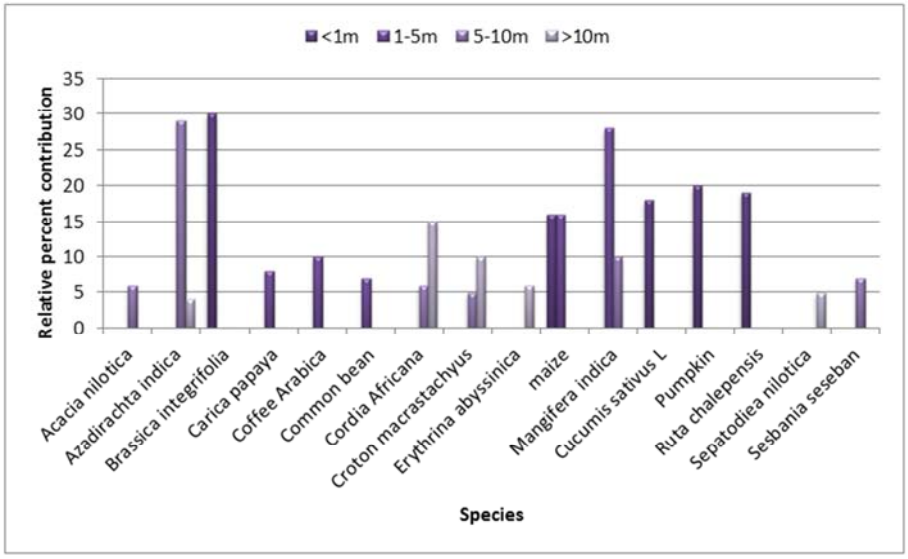

Figure 8. *The top five relativ percent contribution of homegarden plant species to different height class.*

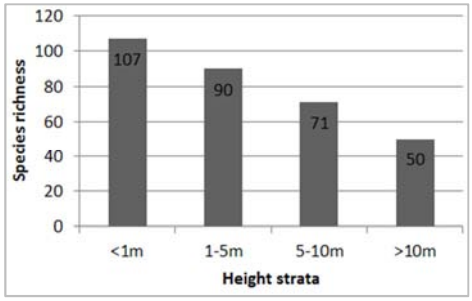

Figure 9. *Species richness across homegarden agroforestry in each height strata.*

The species richness decreased with increasing height from the bottom layer to upper storey of height strata (Figure 9). This result was in line with the finding reported by reference [18]. The bottom layer were highly dominated by vegetables, shrub layer dominated by fruit, stimulant and cereal crops, canopy layer dominated by some fruit and woody species while the upper storey highly contributed by wood species.

Vertical structure of vegetation in an individual household reflected the species degree of specialization and complexity. The studied homegardens were an assemblage of multipurpose trees, fruits, vegetables, cereal crops, stimulants

and spice with some climbers in the boarder. Vertical stratification of the studied homegardens can be categorized into four major strata; upper storey(>10m), main canopy (5-10m), shrub layer (1-5m) and bottom layer <1m. The upper storey was dominated by broadleaved trees (*Cordiaafricana, Croton macrostachyus*, *Azadirachta indica*, *Erythrina abyssinica, Acacia nilotica, and Sepatodiea nilotica).* The main canopy was occupied by fruit trees like *Carica papaya, Mangifera indica*, *Citrus sinensis (L), Citrus aurantifolia*; Shrub layer was dominated by stimulants (*Coffea arabica*), cereal crop (maize) and bottom layer by vegetables (*Cucumis sativus* L, *Brassica integrifolia*, *Cucrbitapepo L*, spice crops (*Ruta chalepensis*) (Figure 10).

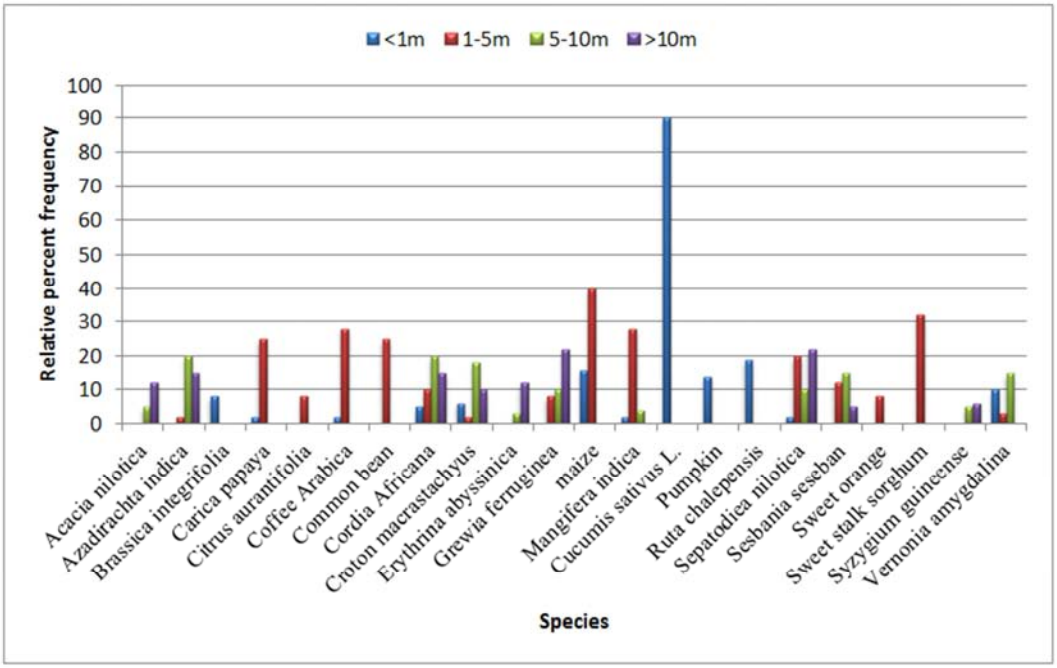

Figure 10. *Vertical distribution of individual species in each height strata.*

3.2.3. Composition and Diversity of Plant Species

A total of 22 plant species were recorded in the homegardens of the study area. These plant species were classified into 15 families. The families recorded were *Fabaceae, Rutaceae, Poaceae, Cucurbitaceae, Maliaceae, Brassicaceae, Caricaceae, Rubiaceae, Boraginaceae, Euphotbiaceae, Tiliaceae, Anacardiaceae, Bignoniaceae, Myrtaceae* and *Asterceae*. Similar result were reported by reference [17]that Fabaceae, Poaceae and Cucurbitaceae families were recorded in *DillaZuriyaDistrict*, Gedeo Zone, South, Ethiopia. In the studied homegardens dominantly represented families were Fabaceae in which recorded 4 species belong, followed by Rutaceae, Poaceae and Cucurbitaceae in the second and third rank, with 3,2 and 2 species. Other 11 families were on the 5th rank with one species recorded in each family.

Most of the studied homegardens were covered by different functional groups; 25% cereal crops, 15% fruit trees, 7% pulse crops, 5% stimulant,12% vegetable crops, 4.5%spice crops,28% woody species and 3.5% by other species(Figure 7). From the total number of species recorded *Cucumis sativus L* (98%) was the most frequent species, followed by Zea mays L (88.54%) and *Grewia ferruginea* (83.3%). The value of Shannon-Wiener diversity index of sites ranged from 2.21 to 2.44 (Table 3). The shannon diversity index showed a higher diversity of plant species in Baphirina Mata homegarden (H'=2.44) as compared to the homegardens of Baruda and Morana Ekosaki (H'=2.36), Bulen 01 (H'=2.23) and Dobina Enkonti (H'=2.21). Dominance index showed that only a few species dominated the homegardens in DobinaEnkonti (λ= 0.226) as compared to Baruda (λ=0.095), Baphirina Mata (λ=0.095), Bulen 01 (λ=0.096) and MoranaEkosaki (λ=0.137). The evenness index showed that in DobinaEnkonti and Baphirina Mata homegardens most of the species were equally abundant (E=0.92); Baruda and Bulen 01 (E=0.89); and Morana Ekosaki (E=0.85). The diversity index value was the lowest for Dobina Enkonti homegardens suggesting that only few plants species were abundant.

Table 3. *Species evenness, Simpson's index of dominance, Species richness and Species diversity.*

Site	Evenness (E)	Simpson's index of dominance $\Sigma (p_i)^2$	Species richness $D=S/\sqrt{N}$	Species diversity $H=-\sum(pi)(lnpi)$
Baruda	0.89	0.095	0.58	2.36
Dobi	0.92	0.226	0.57	2.21
Mata	0.92	0.095	0.70	2.44
Mora	0.85	0.137	0.73	2.36
Bulen01	0.89	0.096	0.63	2.23

Similarity index of the species ranged from 0.31 - 0.64 that indicated 60% of the similarity index is greater than 0.5 and 40% is less than 0.5 indicating the existence of high similarities/low species diversity among the studied sites (Table 4). There were high similarities in plant species composition among the studied *kebeles*. The closely located Dobina Enkonti and Bruda had the highest similarity index which showed that they shared 64% of the plant species. On the other hand, Baphirina Mata and Dobina Enkonti had the least similarity index which indicated that they share 31% of the plant species.

Table 4. *Level of Similarity index among sites in composition of plant species.*

Site	Baruda	Dobina Enkonti	Baphirina Mata	Morana Ekosaki	Bulen 01
Bullen 01	0.5	0.53	0.62	0.47	1
MoranaEkosaki	0.55	0.5	0.42	1	
Baphirina Mata	0.44	0.31	1		
DobinaEnkonti	0.64	1			
Baruda	1				

Species like *Zea mays L, Cordia africana, Sorghum bicolor, Azadirachta indica,* and *Sepatodiea nilotica* were more abundant than others in the Dobina Enkonti but many other species were equally abundant in the Baphirina Mata, Baruda, Morana Ekosaki and Bulen 01 homegardens, species like *Mangifora indica, Croton macrostachyus, Acacia nilotica, Coffea arabica, Carica papaya, Citrus aurantifolia, Grewia ferruginea,* and *Erythrina abyssinica*(Table5).

Table 5. *Dominance, frequency, abundance, relative dominance, relative frequency, relative abundance and important value index plant species.*

Species name	Dominance		Frequency		Abundance	Relative dominance	Relative frequency	Relative abundance	IVI	
		rank		rank						rank
Acacia nilotica	0.036	16th	50	17st	1.7	16.22	20.78	22	59	15th
Azadirachtaindica	0.049	13th	72.2	7st	1.78	24	28.76	20.89	73.65	10th
Brassica integrifolia	0.029	21th	55	15st	3.37	17.84	18.21	25.94	62	14th
Carica papaya	0.045	15th	45	20st	3.93	23.41	28.82	30.48	82.71	6th
Citrus aurantifolia	0.033	19th	50	17st	1.8	14.65	17.82	20.52	53	17th
Coffee arabica	0.074	6th	77.5	4st	3.18	30.88	28.89	34.54	94.4	5th
Phaseous vulgaris L	0.035	17th	57.77	12st	2.0	12.58	18.25	15.13	45.96	21th
Cordiaafricana	0.64	1st	59.55	11st	2.5	24	24.86	22.45	71.31	11th
Croton macrastachyus	0.068	8th	73	6st	2.17	24.22	27.54	23	74.76	7th
Erythrinaabyssinica	0.072	7th	54.2	16st	2.6	30.05	23.6	20.1	73.75	8th
Grewiaferruginea	0.062	10th	83.3	3st	1.78	13.6	25	12.4	51	18th
Zea mays L	0.13	3rd	88.54	2st	5.15	52.55	32.7	41.27	126.52	2nd
Mangiferaindica	0.053	12th	69.82	8st	1.82	18.34	25.63	18.98	62.95	13th
CucumissativusL	0.156	2nd	98	1st	10	58.6	38.23	48.05	144.88	1st
CucrbitapepoL	0.034	18th	57.1	13st	2.01	15.77	18.12	14.35	48.24	20th
Rutachalepensis	0.021	22th	50	17st	2.33	12	14.13	16.5	42.63	22th
Sepatodieanilotica	0.058	11th	61	10st	2.02	23.79	26.42	23.52	73.73	9th
Sesbaniaseseban	0.123	4th	56.3	14st	9.9	44.55	21.31	51.35	117.21	3rd
Citrus sinensis(L),	0.033	19th	75	5st	2.12	21.77	26.65	19.4	67.82	12th
Sorghum dochna	0.08	5th	41.66	22st	5.18	38.85	24.14	39.82	102.81	4th
Syzgiumguineense	0.047	14th	43.75	21st	2.37	14.25	14.22	21.05	49.52	19th
Vernoniaamygdalina	0.068	8th	67.85	9st	2.43	16.62	23.28	18.45	58.35	16th

4. Conclusions

Agroforestry homegardens are common in most tropical countries and they play a vital role in supporting households in many diverse ways, including provision of food, fuel wood, building materials, fodder for livestock and income. The aim of this study was to investigate the structure, composition and diversity of plant species growing in homegarden agroforestry system and to assess the economic contributions of homegardens to households in *Bulen* district, North-west Ethiopia. The study was conducted in five *kebeles* of the *District*, namely *(*Baruda, Bulen 01, Dobina Enkonti, Baphirina Mata, and Morana Ekosaki) which were randomly selected. Systematic random sampling procedure was employed to select households from each *kebele*. All woody species and herbaceous species were counted and recorded in 5m x 5m ($25m^2$) and 1mx1m ($1m^2$) quadrats, respectively. The studied homegardens area coverage ranged from 0.031ha - 0.75ha. In a survey of plant species diversity in 110 homegardens a total of 22 plant species within 7 functional groups were recorded. On average 6 plant species were recorded per homegarden. The highest Shannon diversity index in the study area is (H'=2.44) and the lowest is (H'=2.21).

There were high similarities in plant species composition among the studied *homegardens of the area*. The closely located Dobina Enkonti and Bruda had the highest similarity index of 0.64 compared to Baphirina Mata and Dobina Enkonti *kebeles* which had the least similarity index of 0.31.

species dominance and evenness index values rrecorded showed variation among the studied sites.

Generally, the studied homegardens showed a distinct horizontal structure arrangements zone between perennial plants and annual crops and horizontal structure of the species declines as one goes from the first quadrat to the fourth quadrat or out fields. Vertical stratification of vegetations in the homegardens was categorized into four major strata; the upper storey is dominated by broadleaved trees, the main canopy containing fruit trees, Shrub layer dominated by stimulants and bottom layer by vegetables. The homegardensof the study areawere covered by different plant functional groups of 25% cereal crop(maize), 15% fruit trees (*Carica papaya*, *Mangiferaindica*, *Citrus sinensis(L), Citrus aurantifolia*), 7% pulse (common bean), 5% stimulants (*Coffeaarabica*), 12% vegetable (*CucumissativusL*, *Brassica integrifolia*, *Cucrbitapepo L*) 4.5%spice species (*Rutachalepensis*), 28% woody plants such as *Acacia nilotica*, *Azadirachtaindica, Cordiaafricana, Croton macrostachyus, Sepatodieanilotica, Erythrinaabyssinica, and Grewiaferruginea*, and (3.5%) by other species.

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