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Homegarden Plant use and their Traditional Management Practice in Bule Hora District, West Guji Zone, Southern Ethiopia

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Abstract

Homegardens are one of the most diverse agroforestry systems and make a vital contribution to meet various household needs, especially for smallholder farmers in developing countries. Hence, this study aimed to assess the homegarden plant use and their traditional ways of management in Bule Hora district of Southern Ethiopia. A total of forty-eight households were randomly selected from three kebeles. Of which, seven key informants were selected purposively by criteria of age, good indigenous knowledge and long residence. Data were collected using focus group discussion, questionnaire, field observation and field work. Frequencies, relative frequencies, abundance and relative densities were used to analyze the data. A total of 70 plant species belongs to 39 families were identified. The Fabaceae had highest number of species 10 (14.29%), followed by Euphorbiaceae, Myrtaceae, Poaceae, Lamiaceae and Solanaceae with 4 (5.71%) species each. Tree accounted for the lion's share of the plant habit. The use category of homegarden plant showed that food crops (40.98%), income sources (32 %), construction (14%), medicinal (13.3%), fuel (13%), shading (10%), soil fertility (10%), ornamentals (9.6%), live fence (8.30%), spices (7%), stimulants (5.3%), and fodder were identified. The distribution of homegarden plant species showed that Ensete ventricosum, Coffee arabica and Brassica carinata were the first dominant and frequent plant species. The people manage their homegarden traditionally through hand weeding, nursery preparation, organic fertilizer application, fencing and runoff controlling. So, the community had strong tradition on agroforestry practices and domestication on economically important plants to improve their livelihood.

Keywords: Homegarden; Indigenous knowledge; Management; Species; Plant Uses

Introduction

Homegardens are one of the most diverse agroforestry systems and make a vital contribution to meet various household needs, especially for smallholder farmers in developing countries. Of course, the uses of homegardens vary, as some are used for subsistence agriculture and others for commercial production of food crops [1]. In the rural, homegarden gardeners usually grow fruits, vegetables, medicinal, fuels, construction materials, spiritual and ornamental plants [2]. Homegardens are dynamic in their evolution, composition and uses. Besides ensuring a diverse and stable supply of socio-economic products and services such as food, medicine, firewood, fodder, timber, etc. to the families that maintain them, home gardens are also recognized as important in situ sites of biodiversity conservation, especially of agro biodiversity [3]. It has proven to be an effective approach to improved household food [4,5]. So homegarden are a part of agriculture and food production system and it also reflects the wisdom of traditional culture and ecological knowledge about the surrounding environment that have developed over the years. Homegarden owners use various forms of plant management strategies in home gardening activities.

For years, farmers have developed a collection of complex indigenous agroforestry systems that are adapted to local conditions and designed to meet local needs [6]. These indigenous agroforestry systems are rich sources of knowledge about the cultivation of perennial species in different time and space arrangements with annual crops [6]. In the management of agroforestry, traditional or indigenous knowledge plays a critical role. It includes different sets of complex practices. The decisions related to the selection of crops, procuring inputs, harvesting, and management and forth are mostly driven by consumption and income generation needs of the households [7].

Of the countries in tropical Africa, south and south-western part of Ethiopia is one of where homegarden agroforestry is common and has been a dominant land use practice in the area [8]. The presence of homegarden in different areas of Ethiopia is indicated by different names applied in different cultures. Most common vernacular names equivalent for the term homegarden in Ethiopia are Yeguaro Atkilit, Yegibi Meret or Yeguaro Irsha, meaning the backyard crop/garden/farm in the Amharic language [9-11].

Homegarden also showed that culturally diverse ethnic groups in Ethiopia have their own unique lifestyle and perception towards their surroundings for growing, maintaining, conserving and utilizing biological resources. Most people living in rural parts of the Bule Hora are Guji agro-pastoralists' who use and classify their land through functional categories as grazing and browsing land, farming land, homegarden and forest land. Regarding to the homegarden plant diversity quantification, research was not conducted in selected study area before. However, the area is rich in different natural resources and prominent AF practices; they are being destroyed now due to human induced pressures such as deforestation for conversion of natural habitat into agricultural field and mono-cropping systems [8]. Unless the plant diversity, indigenous agroforestry knowledge and vital socio-economic relationship involved within homegardens are properly understood, achieving the goal is difficult task. Thus, the study was conducted to assess the plant species diversity, economic contributions and their management practice in the study area.

Materials and Methods

Description of the study area

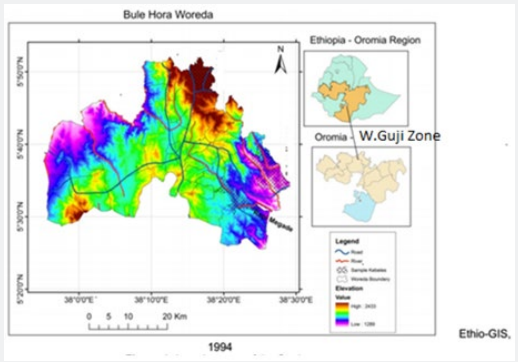

Figure 1: Location map of the study area.

The study was conducted in Bule Hora district (Formerly called Hageremariam district), Southern Oromia (Figure 1). Bule Hora district is located 467km away from Addis Ababa to the South and 100km North of Yabello, the capital of Borana Zone. The district lies between latitudes 50 26'and 5052'North and longitudes 370 56'and 380 310 East with a total area of about 488,861.3 hectares or 48,886.1km^2 of which 77.1% is middle land and 22.9% is lowland and the altitudinal range lies between 1465- 2300m a.s.l. The neighboring districts are Kercha to the north east, Kochere to the north, Gelana to the northwest, Burji to the west, and Dugda Dawa district to the south. The district is composed of 38 kebeles. The administration town is called Bule Hora [8].

Data collection techniques

Purposive sampling method was employed to get basic information from selected kebeles (smallest administration units in Ethiopia). From a total of 38 kebeles, three Kebeles namely Ropi-Magada, Kilenso-Mokonisa and Oda-Muda were selected purposefully based on the extensive presence of homegardens. Regarding to this, six villages from each kebele purposely selected. Among these village 3 households from each, totally 48 household (16 from each kebele) were sampled. Of which, seven traditional elders as key informants were selected, similar selection method from [4], based on their long residence, good knowledge, and ability to express the functioning and historical development of the principal AF system and means of AF for the society [12]. To assess the species richness and the composition of plant species, 30 quadrants (10 quadrants or sample plots per kebeles) [13,14]; 5m x 5m (25m^2) for herbs and 10m x 10m (100m^2) for woody plants were delimited in the study area following standard conducted research [4]. Vital observations were made; species were counted and recorded after laying quadrants at appropriate sites within the homegarden. Plant specimens collected from the homegarden were identified with the help of reference to the volumes of the "Flora of Ethiopia and Eritrea book" and by comparing them with the authenticated specimens housed at the National Herbarium (ETH), Addis Ababa University (AAU) and further confirmation by taxonomic experts [13,14]. Ethnobotanical data were collected using semi-structured questionnaires, field observations and vegetation inventories [13,15].

Data analysis

A descriptive statistical method was used to summarize and analyze the data. The raw data from each household by focus group discussion, questionnaire survey, field observation and field work were entered an Excel spreadsheet. Then these data transferred to various forms as table and chart with possible combinations. Descriptive statistics methods such as densities, frequencies, abundance, relative frequencies and relative abundance were used to analyze the data.

Free listing: It was used by asking participants to list the name of all useful plants found in their homegarden and the uses of each plant.

Direct matrix ranking: This analytical tool was used for identification of multipurpose plants used for varied activities, based on [13] approach by entering the responses of key informants in data matrix. Each rank is given an integer value (1, 2, 3, 4 and 5) with the most important or preferred item being assigned the highest number. For instance, in a set of five objects the most preferred is rated '5' while the least liked is '1'. These numbers are summed for all respondents, giving an overall ranking for the objects by the sample group of respondents.

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Frequency: Frequency was calculated for plants in sampled homegardens. Frequency describes the distribution of species throughout the stands. It is determined by calculating the percentage of plots/quadrants in a sample area on which a given species occurs [13].

$$Frequency = \frac{Quadrant\ in\ which\ species\ occurs}{Total\ number\ of\ quadrants\ in\ sample} \times 100$$

Relative density: Relative density is the number of individuals of a species as a percentage of the total number of individuals of all species.

$$Relative\ Density = \frac{Number\ of\ individuals\ of\ a\ species\ in\ the\ sample}{Total\ number\ of\ individuals\ of\ all\ species\ in\ the\ sample} \times 100$$

Results and Discussion

Household characters

It was observed from the study that out of 48 surveyed families, 88.9% were male-headed households and the rest were female-headed households. The study revealed that the average age of the respondents was 52.75 with minimum of 30.0 and maximum of 90. Majority of the respondents (53.3%) falls between 40 to 60 while 34.2% and 12.5% of the respondents were between the ages ranges of 25-40 and >60, respectively. It is showed that most of the respondents were in the middle age category (52.75%). When we consider the land holding size of the respondents, 80% of the respondents have an average land size ranging from 0.5 to <1ha while 20% of the respondents have an average land size of 1 and 1.5ha. This home-garden size difference has brought variation of plant species richness. There more land holding size, the more species diversity is available and vice versa. This study is in line with the research done in homegarden of Jabithenan district of Ethiopia [16,17] in India (species richness was maximum (22) in medium homegarden at mid altitude and minimum (11) in small homegardens at high altitude). The survey also showed that 40% of the household respondents are illiterate, 30% of the respondents have an education level of 1-4 grade, and 25% of the households have learnt up to grade eight. And the remaining 5% of the respondents have an education level of secondary school. The range of education level of the respondents ranged from no formal education to secondary levels. Even if the communities manage the home-garden species through indigenous knowledge those literates are better than illiterate respondents in home-garden management. With regard to animal's ownership, 65% of household heads have all animal types namely cattle, sheep and goat and equines while 33% of the respondents rear only cattle and sheep whereas the rest 2% of the informants have no animals. It was observed from study that peoples had more property own more animals this also as a sign of prosperity and wealthy family. From this, we understand that those households having different animals are better to manage the fertility of their home-garden soils through animal manure than those households who have no animals.

Plant taxonomic diversity and use

Appendix 1: List of plants Scientific name, Local name, Amharic name, Family name, Parts used and Habit (N=70).

S. No	Scientific Name	Vernacular Name (Oromifa)	Amharic Name	Family Name	Pu	Ha
1	*Aloe monticola** Reynolds	Hargiissa	Ret	Aloaceae	La	H
2	*Acacia seyal* Del.	Wacho	Grar, Wacho	Fabaceae	St, fl, L	T
3	*Acmella caulirhiza* Del.	Jiloo qaldhaa	Yemdr Berberie	Asteraceae	L and St	H
4	*Acokanthera schimperi* (A.D.C.) Schweinf	Qarraruu	Merenz	Apocyanaceae	St, Fr, L, R	S
5	*Aframomum korarima* (Braun) Jansen	Korereema	Korerima	Zingiberaceae	Se	H
6	*Allium cepa* L.	Kulibi dima	Qey Shnkurt	Alliaceae	Bu	H
7	*Allium sativum* L.	Kullubi	Nech Shenekuret	Alliaceae	Bu	H
8	*Ananas comosus* (L.) Merr.	Ananas	Ananas	Bromeliaceae	Fr	H
9	*Annona senegalensis* Pers.	Gishta	Gishta	Annonaceae	Fr	T
10	*Albizia schimperiana* Oliv.	Sesa	Sasa	Fabaceae	Ba	T
11	*Balanites aegyptiaca* (L.) Del	Bedeno	Bedeno	Balanitaceae	Fr, St	T
12	*Bersama abyssinica* Fresen.	Xibirruu	Tibero	Melienthaceae	St	H
13	*Brassica carinata* A.Br.	Raafuu/shanan	Gomen	Cabombaceae	L	H
14	*Calpurnia aurea* (Ait.) Benth.	Ceekata	Digeta	Fabaceae	L	S
15	*Canavalia ensiformis* (L.) DC.	Adenguare	Adenguare	Fabaceae	Se	C
16	*Capsicum annuum* L.	Barbaree	Kariya	Solanaceae	Fr	H
17	*Carica papaya* L.	Papaye	Papaye	Caricaceae	Fr	T
18	*Catha edulis* (vahl.) Forssk.ex.Endl.	Caati	Chat	Celastraceae	L	S
19	*Celtis africana* Burm.f	Metekoma	Chay	Ulmaceae	Fr, L	T
20	*Coffea arabica* L.	Bunna	Buna	Rubiaceae	Se	S

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21	*Colocasia esculenta*	Goderie	Goderie	Araceae	Tu	H
22	*Cordia africana* Lam.	Waddessa	Wanza	Boraginaceae	Fr, St, L	T
23	*Croton macrostachyus* Del.	Mokkonnisa	Bisana	Euphorbiaceae	L, Fr, Ba, St	T
24	*Cupressus lusitanica* Mill.	Hindessa	Tsid	Cupressaceae	St	T
25	*Cymbopogon martini* (Roxb.) Wats.	Tej sar	Tej Sar	Poaceae	L	H
26	*Dioscorea bulbifera* L.	Boyena	Boyena	Dioscoreaceae	Tu	C
27	*Ehretia cymosa* Thonn.	Uraaga	Mukereba	Boraginaceae	L, St	S
28	*Ensete ventricosum* (Welw.) Cheesman.	Warqiicha	Enset	Musaceae	L,R, St	H
29	*Erythrina melanacantha* Taub. ex Harms	Weleensuu	Korch	Fabaceae	St	T
30	*Eucalyptus camaldulensis* Dehnh.	Bargemo-diima	Qey Bahr Zaf	Myrtaceae	St, L	T
31	*Eucalyptus globulus* Labill	Baargamoo-adii	Nech Bahr Zaf	Myrtaceae	L, St	T
32	*Euclea divinorum* Hiern.	Mi'eessaa	-	Ebenaceae		T
33	*Euphorbia ampliphylla* Pax.	Hadaama	Kulkual	Euphorbiaceae	La, St	T
34	*Ficus vasta* Forssk	Qilxaa	Warka	Moraceae	St	T
35	*Leucas discolor* Sebald	Xuxiyee	-	Lamiaceae	L	S
36	*Lippia adoensis* var. kosert Sebsebe	Wudo	Koseret	Verbenaceae	L	S
37	*Ipomoea batatas* L.	Maxaxasha	Skuar Dinich	Convolvulaceae	Tu	H
38	*Lycopersicon Esculentum* Mill.	Timatimii	Timatim	Solanaceae	Fr	H
39	*Malus sylvestris* Mill.	Pom	Pom	Rosaceae	Fr	T
40	*Mangifera indica* L.	Mangoo	Mango	Anacardiaceae	Fr	T
41	*Manihot esculenta* Crantz	Cassava	Cassava	Euphorbiaceae	Tu	S
42	*Medicago sativa* L.	Alfelfa	Alfalfa	Fabaceae	L	H
43	*Millettia ferruginea** (Hochst.) Back	Dhaadhatu	Birbira	Fabaceae	L	T
44	*Moringa stenopetala* L.	Moringa	Shferaw; Aleko	Moringaceae	L, Fr	T
45	*Musa x paradsiaca* L.	Muzii	Muz	Musaceae	Fr	H
46	*Ocimum basilicum* L.	Besobila	Besobla	Lamiaceae	L	H
47	*Olea europaea* L.ssp. Cuspidata (Wall.ex G. Don) Cif	Ejeersa	Weyra	Oleaceae	L and St	T
48	*Pentas lanceolata* (Forssk.) Defl.	Chunfaa	-	Rubiaceae	L	H
49	*Persea americana* Mill.	Abukatoo	Avokado	Lauraceae	Fr	T
50	*Phaseolus lunatus* L.	Boleke	Boleke	Fabaceae	Se	C
51	*Pisdium guajava* L.	Zeytunaa	Zeitun	Myrtaceae	Fr, L	T
52	*Podocarpus falcatus* (Thumb.) Mirb.	Birbirsa	Zigba	Podocarpaceae	St, L	T
53	*Polyscias fulva* (Hiern) Harms	Telia, Guduba	Yeznjero Wenber	Araliaceae	St	T
54	*Premna schimperi* Engl.	Urgessa	Chocho	Lamiaceae	St	S
55	*Rhamnus prinoides* L`He`rit	Geshoo	Gesho	Rhamnaceae	Se, L	S
56	*Ricinus communis* L.	Qobboo	Gulo	Euphorbiaceae	L, Se	S
57	*Rosmarinus officinalis* L.	Kora	Yetbs Qtel	Lamiaceae	L	S
58	*Rubus steudneri* Schweinf.	Gora	Enjori	Rosaceae	L, Fr	S
59	*Ruta chalepensis* L.	Xeenaada mii	Tena Adam	Rutaceae	L, Se	H
60	*Saccharum officinarum* L.	Shenkora	Shenkora	Poaceae	St	H
61	*Sesbania sesban* (L.) Merr.	Ceka	Shewshewe	Fabaceae	L, St	T
62	*Solanum incanum* L.	Hidi	Embay	Solanaceae	Fr, L	S
63	*Solanum tuberosum* L.	Dinich	Dinich	Solanaceae	Tu	H
64	*Sorghum bicolor* L.	Mashela	Mashela	Poaceae	Se	H

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65	*Syzygium guineense* var. (Wild.) DC.	Baddessa	Dokma	Myrtaceae	Fr, St	T
66	*Teclea simplicifolia* (Engl.) Verdoorn	Haadhessa	-	Rutaceae	L	S
67	*Tephrosia pentaphylla* (Roxb.) G.Don	Darguu	-	Fabaceae	L	H
68	*Vernonia amygdalina* Del. *	Eebicha	Girawa	Asteraceae	L	S
69	*Zea mays* L.*	Boqqolloo	Beqolo	Poaceae	Se	H
70	*Zingiber officinale* Roscoe*	Zingibila	Zinjible	Zingiberaceae	Rh	H

Note: Ha= Habit, Pu=Parts used, T= Tree, S=Shrub, C=Climber, H= Herb, L= leaf, St=Stem, R=Root, La=latex, Fl=Flower, Fr=Fruit, Se=Seed, Bu=Bulb, Ba=Bark, Tu=Tuber, Rh= Rhizome

The total number of plants species that observed and identified were 70 (42 woody and 28 herbaceous). This result is comparable with a study done in Dilla Zuria district of Ethiopia, a total of 75 plant species were recorded [18]; a total of 69 plant species also recorded and identified in Jabithenan district in Northern part of Ethiopia [16,19] reported 52 plant species in three agroecological Zones of Dilla Zuria District. The study identified 39 families comprising of 68 angiosperm and 2 gymnosperms. Fabaceae was the dominant family with 10 species followed by Euphorbiaceae, Myrtaceae, Poaceae, Lamiaceae and Solanaceae each 4 species while others Alliaceae, Asteraceae, Boraginaceae, Musaceae, Rubiacea, Rutaceae and Zingiberaceae with two species. The remaining families contain only one species each (Appendix 1). Similarly, [20] reported that Fabaceae were dominant family recorded in Jharkhand, India, respectively.

Table 1: Number of families and their number of species in the study area.

S. No	Name Family	Number of Species	Percentage (%)
1	Fabaceae	10	14.30%
2	Euphorbiaceae	4	5.70%
3	Lamiaceae	4	5.70%
4	Poaceae	4	5.70%
5	Solanaceae	4	5.70%
6	Myrtaceae	4	5.70%
7	Alliaceae	2	2.86%
8	Asteraceae	2	2.86%
9	Boraginaceae	2	2.86%
10	Musaceae	2	2.86%
11	Rubiacea	2	2.86%
12	Rutaceae	2	2.86%
13	Zingiberaceae	2	2.86%
14	Aloaceae	1	1.43%
15	Anacardiaceae	1	1.43%
16	Annonaceae	1	1.43%
17	Apocyanaceae	1	1.43%
18	Araceae	1	1.43%
19	Araliaceae	1	1.43%
20	Balanitaceae	1	1.43%
21	Boraginaceae	1	1.43%
22	Bromeliaceae	1	1.43%
23	Cabombaceae	1	1.43%
24	Caricaceae	1	1.43%
25	Celastraceae	1	1.43%
26	Convolvulaceae	1	1.43%
27	Cupressaceae	1	1.43%
28	Dioscoreaceae	1	1.43%

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29	Ebenaceae	1	1.43%
30	Lauraceae	1	1.43%
31	Melienthaceae	1	1.43%
32	Moraceae	1	1.43%
33	Moringaceae	1	1.43%
34	Oleaceae	1	1.43%
35	Podocarpaceae	1	1.43%
36	Rhamnaceae	1	1.43%
37	Rosaceae	1	1.43%
38	Ulmaceae	1	1.43%
39	Verbenaceae	1	1.43%

Most plants managed in homegardens were trees (27 species, 38.6%) followed by herbs (24 species, 34.3%), shrubs (16 species, 22.86%) and climbers (3 species, 4.3%) see Figure 2. This result agreed with that of [5] study revealed that tree species were highly distributed in homegarden than shrub and herbs (Table 1).

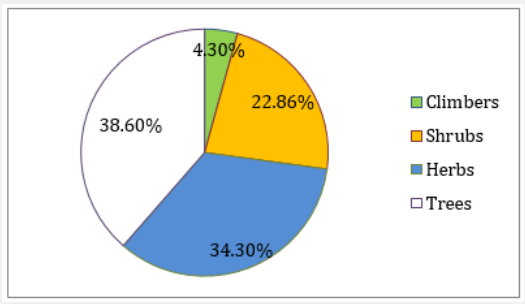

Figure 2: Percentage of habit of homegarden plant species.

Table 2: Average score of direct matrix ranking for multiple uses of 6 tree species.

Use category	*C. africana*	*E. globulus*	*M. ferruginea*	*C. macrostachyus*	*P. falcatus*	*P. americana*
Income	35	35	25	19	35	35
Medicinal	11	35	11	35	8	8
Shading	31	8	35	10	30	25
Construction	34	35	27	32	35	25
Soil Fertility	20	-	35	7	11	13
Fuel	19	35	15	30	10	10
Total	150	148	148	133	129	116
Rank	1st	2nd	2nd	3rd	4th	5th

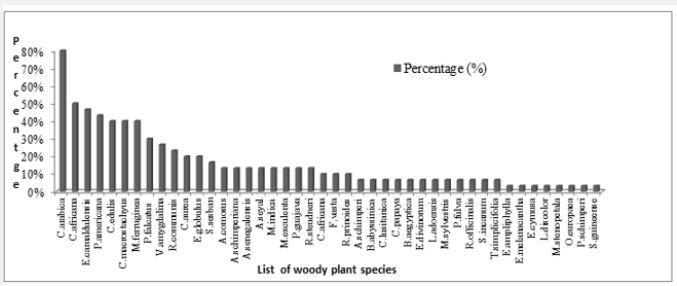

Figure 3: Frequency of woody plant species in the study area.

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Farmers in the study sites keep various plants based on space availability and their compatibility with agricultural crops. The plant species richness of the three study kebeles was calculated (Table 2). Based on this, species richness was higher in Ropi-Megada kebele (46 Species) followed by Oda-Muda kebele (29 species) and Kilenso-Mokonisa kebele (26 species). The average number of plant species per farm plots in the study site was founded to be 9.5 ranging from 4 to 15 throughout the homegarden. As the farmers said, to get fullest benefit from their farmland, they accommodated higher number of plant species within the limited area. Mostly abundances of the plants in the farm is maintained based on farmers preference and agricultural consistent or compatibility with crops. Most interestingly, abundance of plants reflects social and economic as well as ecological role in the garden. Floristic heterogeneity could be expressed in terms of frequency of occurrence of a species in each quadrants of the study area [16]. Accordingly, of the total of woody species which is found in the homegarden, Coffee arabica (80%) was found to be the most dominant species followed by *Cordia africana* (50%), *Eucalyptus camaldulensis* (46.67%), *Persea americana* (43.33%), *Croton macrostachyus* (40%), *Millettia ferruginea* (40%) and *Podocarpus falcatus* (30%), respectively (Figure 3).

The total herbaceous plants recorded at the study sites *Ensete ventricosum* with frequency of occurrence (86.67%) was found to be the most dominant species (Figure 4) followed by *Brassica carinata* (70%) and *Zea mays* (66.67%), *Musa x paradsiaca* (56.67%) and *Phaseolus lunatus* (43.33%), respectively. Over all *Ensete ventricosum*, *Coffee arabica* and *Brassica carinata* were the first dominant and frequent plants in the farmers' garden. This implies that farmers preferred and protected frequently in their garden due to ecological and economical aspects of the plants (Appendix 2).

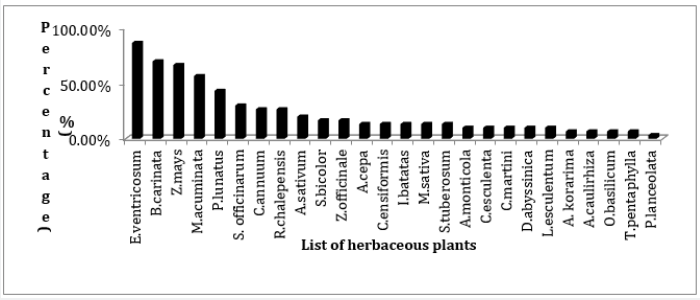

Figure 4: Frequency of herbaceous plant species in the study area.

Appendix 2: List of plants scientific name and number of quadrant (N=70).

No.	List of Species	No of Quadrant
1	*E. ventricosum*	26
2	*C. arabica*	24
3	*B. carinata*	21
4	*Z. mays*	20
5	*M. acuminata*	17
6	*C. africana*	15
7	*E. camaldulensis*	14
8	*P. americana*	13
9	*P. lunatus*	13
10	*C. edulis*	12
11	*C. macrostachyus*	12
12	*M. ferruginea*	12
13	*P. falcatus*	9
14	*S. officinarum*	9
15	*C. annuum*	8
16	*R. chalepensis*	8
17	*V. amygdalina*	8
18	*R. communis*	7
19	A. *sativum*	6

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20	*C. aurea*	6
21	*E. globulus*	6
22	*S. bicolor*	5
23	*S. sesban*	5
24	*Z. officinale*	5
25	A. *cepa*	4
26	A. *comosus*	4
27	A. *schimperiana*	4
28	A. *senegalensis*	4
29	A. *seyal*	4
30	*C. ensiformis*	4
31	I. *batatas*	4
32	*M. indica*	4
33	*M. sativa*	4
34	*M. esculenta*	4
35	*P. guajava*	4
36	*R. steudneri*	4
37	*S. tuberosum*	4
38	A. *monticola*	3
39	*C. africana*	3
40	*C. esculenta*	3
41	*C. martini*	3
42	*D. abyssinica*	3
43	*F. vasta*	3
44	*L. esculentum*	3
45	*R. prinoides*	3
46	*A. korarima*	2
47	A. *schimperi*	2
48	*A. caulirhiza*	2
49	*B. abyssinica*	2
50	*C.lusitanica*	2
51	*C. papaya*	2
52	*B. aegyptiaca*	2
53	*E. divinorum*	2
54	*L. adoensis*	2
55	*M. sylvestris*	2
56	*O. basilicum*	2
57	*P. fulva*	2
58	*R. officinalis*	2
59	*S. incanum*	2
60	*T. pentaphylla*	2
61	*T. simplicifolia*	2
62	*E. ampliphylla*	1
63	*E. melanacantha*	1
64	*E. cymusa*	1

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65	*L. discolor*	1
66	*M. stenopetala*	1
67	*O. europaea*	1
68	*P. lanceolata*	1
69	*P. schimperi*	1
70	*S. guineense*	1

Major uses of categories

In this study, there are different plants species used ranging from as a source of food including fruits, vegetables, spices, and cash crops used for income source, and further importance with ten different uses were identified (Figure 5). So, communities of the study areas were entirely depending on homegarden species for food supply, income generation and other purposes. Accordingly, food crops (40.98%), income sources (32%), construction (14%), medicinal (13.3%), fuel (13%), shading (10%), soil fertility (10%), ornamentals (9.6%), live fence (8.30%), spices (7%), stimulants (5.3%), and fodder were identified. In this regard plant species with more than one use values have been counted again under each use category. As the result showed most useful plant species cultivated in the homegardens of study area were food plants and income source plants followed by shading plants. This result is like the study by [5] who identified homegarden plants use categories as primarily used for food and income sources. Most of respondents said that homegardens provide food supply round year for the households. In other way, homegarden owner sold their products from home either to buyers who came to them or to neighbors. There is no poverty within the community. Because within the homegarden there are many cereal crops like Maize, barley and Haricot Bean.

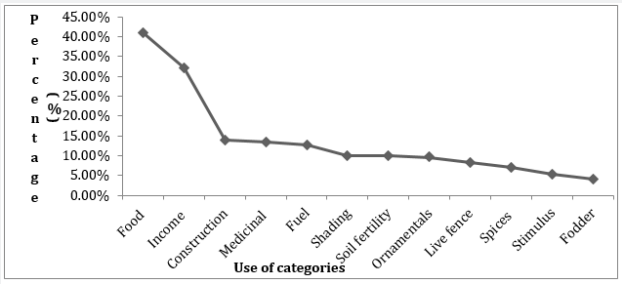

Figure 5: Major identified use categories plant species in the study area.

Furthermore, fruits such as Avocado, Banana, Custard Apple, Pineapple and Papaya are also the household's food sources in addition to cereals. Most commonly used food item is enset. Enset is a multipurpose plant which is used as human food, animal fodder, making rural house roof and income sources besides its critical ecological contributions like erosion control, shed for human and animals and enhancement of soil moisture content. Hence, food security is in place within the community as confirmed by the informants of the study areas. Enset is used for fattening services to get better profit from bulls. Even milk production is high for household consumption due to sufficient fodder during wet and dry season. *Leucas discolor*, *Sesbania sesban*, *Tephrosia pentaphylla*, *Calpurnia aurea* and *Celtis africana* are also common plants used as animal fodder. Livestock keeping provides people with another important source of household food security by keeping a variety of domestic animals in their homegarden for several uses. Keeping these animals provide employment to rural farmers, food and can provide income [21].

Additionally, homegardens are a vital source of income for subsistence economy and contribute to the self-sufficiency of many rural households. Currently more than subsistence it was used as source of profitable production system. It can be contributed to household income in several ways. Income from homegardens comes from selling cereal crops, fruits, vegetables and other cash crops [22]. With high relative density the communities' income is generated from *C. arabica* (51%) and *E. ventricosum* (19%) production, respectively while 13%, 4%, 4%, 4%, 2%, 2% and 1%, of the communities' income is generated from *B. carinata*, *Z. mays P. americana*, *C. annuum*, *Musa x paradsiaca*, *P. lunatus* and *C. edulis* , respectively. Therefore, coffee is the major sources of the communities' income followed by enset and Ethiopian Kale in the study area. They also get huge income from fattening activities since there is better livestock food. Besides to this, they obtain some income from honey production. As the result, their livelihood is improved.

Traditionally the communities also selected different plants around their home which used to treat both human and animal diseases. Some highly valued medicinal plants were *Vernonia amygdalina*, and *Allium sativum*, dominantly used as a means of treating different human ailments followed by *Croton macrostachyus*, *Eucalyptus globulus*, *Cymbopogon martini*, *Albizia schimperiana* and *Ruta chalepensis*. Similar study by [22] reported

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that *Allium sativum* as one of the top most medicinal plants used in the garden. Interestingly, stem of *Acmella caulirhiza* is traditionally known plant for treatment of toothache in all current study area. Plants such as *Teclea simplicifolia*, *Solanum incanum*, *Podocarpus falcatus*, *Albizia schimperiana*, *Vernonia amygdalina* and *Capsicum annuum* are used for treatment of livestock diseases. This ensures that the community saves their income through harvesting of homegarden species rather than paying the surrounding clinic centers. The majority of the medicinal plants were herbs 6 (42.86%). Tree species and shrubs accounted for (5) 35.71% and (3) 21.42% respectively. The most frequently used plant part in the study area is the leaf with 64.28%; followed by stem (21.42%), fruit and bark each (14.28%), respectively.

Multipurpose trees

The habit of people growing plants in their backyard as means of food and income is indispensable. In the study site the majority local people cultivated the most important ones with varied uses such as medicine, firewood, shading, soil fertility, furniture and construction. Seven (7) selected key informants were asked on six plants to assess the relative importance of the plants. So, plant species that are utilized for multiple purposes can be analyzed through direct matrix. Accordingly, Cordia africana is found to be highly used by the local people for multiple purposes, followed by equally (*Eucalyptus globulus* and *Mellitia ferruginea*), *Podocarpus falcatus*, *Croton macrostachyus* and *Persea americana* (Table 2). Enset was not included in this use matrix because the attributes selected were trees. However, enset is a multipurpose plant that was recorded with more than 10 uses: that is as human food, animal fodder, making rural house roof and income sources besides its critical ecological contributions like erosion control, canopy for other small species, wrapping material, shed for human and animals and enhancement of soil moisture content. Hence, food security is in place within the community as confirmed by the informants of the study areas.

Traditional management of homegarden plant species

According to the field observation, the communities of the study area manage the homegarden agroforestry traditionally or by their indigenous knowledge. The respondents pointed out that this knowledge is orally passed from generation to generation or got by trial and error. Even if both men and women are involved in the management activities of homegardens; women are more participants during cultivation, harvesting and marketing activities. This is in line with the study conducted by [23] in Southern Ethiopia, Sidama zone of Dale woreda. Accordingly, Women do the planting activity for fruit and vegetables, manuring, harvesting, storage, transportation and marketing of homegarden products. In many communities, women have key role in managing the garden and utilizing its produce, either in their own kitchen or by selling it in the market [24,25]. Keeping the homegarden cleaning is one of management activities in the community. It so surprised how the garden and the way of road towards the garden is sanitized and attractive. So, it is not difficult to understand how the people have great respect and consume their long time on their garden management. In the study areas, peoples use various way of homegarden management which includes; weeding, watering during dry season, fencing, digging, making erosion canal, using animal dung and tree lopping.

Hand weeding

Hand weeding plays pivotal role in removing unimportant vegetation which compete for light, water, and many nutrients [26]. As we observed weeding by hand is one of the most important management aspect of home garden species particularly at their early stages. Weeding of homegarden species contributes much in delaying the competent species for water and other nutrients [27]. Weeding is one of the homegarden management in which women have direct involvement [28,29]. As the informants said, women play critical roles in the management of home garden species since they stay at home for caring of family members. As it was confirmed in similar manner in the Dale woreda, even if weeding is mainly done by family labor, majority of the activities are done by women [23,24] in the same way pointed out that in many communities of Ethiopia, women play pivotal roles in managing and utilizing of the homegarden species. This indicates that women are the main participants in planting, protecting and managing plants. It is not only weeding; but also females are dominants in harvesting products. Based on this, male farmers or house headers believe that women are effective managers of the home-gardens species.

Figure 6: Photo showing Hand weeding of HG species.

Nursery preparation: Nursery site contribute much in growth and continuity of homegarden species acquired for planting material [6]. As most of the respondents replied during the dry season of the year, some essential homegarden species

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are selectively planted and grown in their small-scale nursery site through care and effective protection. Some of the dominant species which are planted and grown in the nursery area include; *Coffea arabica*, *Enset ventricosum*, *Sesbania sesban*., *Millettia ferruginea*., *Cupressus lusitanica*, *Vernonia amygdalina* and *P. Americana* (Figure 6).

According to the respondents those communities having small river area (wetland) in and around their farm land have higher opportunities to produce more young plant species. Farmers who produce in manner even generate huge amount of income from it. In contrast, those who do not have Small River (wetland) in their farm area sometimes produce young plants around their home areas through collecting water from river and runoff from roofs which require huge amount of labor and time. As the respondents said, young plants produced in this condition are small. As young plant species are produced in the nursery area during dry season, they are transplanted to the home area to expand home garden species as the rainfall begins. Hence, we confirmed that nursery site preparation is effective process for homegarden species sustainability.

Fencing: Fencing of homegarden is important to protect homegarden species from damage by animal [6,29]. This way of homegarden species management is also important to control damage by human [30]. The data collected from the study areas revealed that fencing is important as wind breaker and shelter; as to protect homegarden species from predators and to control the free movement of human and animals. As the respondents said, the animal and human feet cause the soil compaction which does not allow the proper growth of species. Therefore, they revealed that to control the impact of human and animal feet, fencing is indispensable. Some dominant species Such as Euphorbia, *Erythrina melanacantha*, *Acacia seyal*, *Cupressus lusitanica* and Eucalyptus are grown for the purposes of fence. [31] also pointed out that tropical homegarden management through fencing controls the human, animal and other wild animals attack which can damage the species growing stage (Figure 7).

Figure 7: Fencing of homegarden in the study areas.

The communities across the tropical region prefer different species which can give service as fence. As the respondents said, in most cases the tree species giving many services are more preferred. The multi-purpose nature of trees is the primary criterion for selection of trees by households managing home garden agroforestry systems. Trees which are best for fuel wood, shade, soil fertility improvement, medicine, fodder, construction and other purposes are more preferred [23]. Although several trees can be used for the same purpose, preferences for selecting them depend upon several factors such as suitability for fuel wood, fast growth, ease of management, ease of establishment.

Organic fertilizer application

Organic fertilizer in agricultural system is used to produce food and fiber in contrast to chemically-based conventional farming systems. It is also called biological or biodynamical fertilizer because it improves soil biology, enhances soil's natural fertility, and promotes plant biodiversity. It is a system that comprises a host of environmentally friendly agricultural practices to sustain crop production [30]. Organic fertilization enhances soil fertility [30] and promotes homegarden species productivity [27]. Cover crops, manuring, residue mulch, and compost are among the alternative sources of nutrients used in organic farming to increase vegetation diversity. It encompasses all crops (e.g., grains, cotton, vegetables, flowers), and animal products and processed foods. One way of achieving and maintaining a fertile soil is to apply organic matter. This improves the cohesiveness of the soil, increases its water retention capacity and promotes a stable aggregate structure. Organic material may be added as green manures, straw or manure which can enhance the soils' nutrient contents to facilitate the growth of different plant species [31]. In the same way, the local communities informed that mulching in and around the home garden would greatly reduce the presence of weeds besides increasing soil fertility in the garden. Mulches are effective tool in reducing weed populations by inhibiting weed germination and cost-effective kind of fertilizer.

To maintain the garden sustainability, to regenerate the plants as well as to increase the level of soil fertility, peoples prepare traditional compost or fertilizer from cattle dung, house waste material, leaf litter and kitchen waste manure. This kind of application also plays great contribution for homegarden

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productivity and sustainability [26,27]. There are variety of mulch sources that can be used safely in-home garden such as enset residue, coffee fruit residue and particularly fallen leaves of *M. ferruginea* is effective and common natural fertilizer. Additionally, the local communities mentioned that organic fertilizers like animal dung is used for compost preparation. To sum up, compost and decomposed materials of some tree leaves are important sources of traditional fertilizer for the growth and productivity of home garden species. Similar study was concluded by Madalcho and Tefera [29] in Gununo Watershed of Wolaita Zone. Therefore, as the result of species management through indigenous knowledge of organic fertilizer, home garden species are more productive in the study areas (Figure 8).

Figure 8: The importance of animal dung and enset residue for soil fertility.

Runoff controlling

Soil erosion is the chronic problem mostly across the developing countries. Management and conservation of soil are critical to human well-being. Their prudent use and management are more important to meet the high demands for food production and satisfy the needs of an increasing world population [31]. As the respondents revealed, the local communities control the overland flow through the establishment of micro basins, contour ploughing and channels of overland flow. Hence, home gardens are free of erosion problem as it was carefully observed in the study areas. In addition, some species such as *Ensete ventricosum* and *Vernonia amygdalina* are important to protect soil erosion problems. Few homegarden owners stated that to reduce soil erosion some herbs such as Cymbopogon martini are dominantly planted in and around their home. This is in line with the study conducted in Sebata-Awas Distict by [22] which highlight the communities' practice effective home garden erosion management through plantation of tree species.

Digging, watering and Pruning: To be effectively grown and to give different socio-economic and ecological contributions homegarden species need proper management systems [29]. The respondents said that digging using traditional hoe and watering of the homegarden areas are the common activities which initiate the growth of homegarden species. Pruning is important to remove the branches of tall tree species which blocks the sunlight from the home garden species. As they revealed both watering and digging of homegarden are dominantly performed by women whereas pruning is the major role of men. The same result was also concluded by [23,29] based on the study conducted on useful plant species diversity in homegarden of Hawassa city and Sidama zone of Dale woreda respectively.

Major constrains of homegarden species: According to the respondents there are many challenges that hinder the productivity of homegarden species. As the informants identified disease, climate change, small size of homegarden area, lack of improved seed (seed technology) and rodent infestation (rat) are the major challenges facing the communities. For example, Marmot (Filfel in local language) was reported as the main problems for enset production. Rust (Wagi in local language) also affects the productivity of most of the homegarden species. [6] In similar way pointed that disease is the major problem of homegarden species based on the research he conducted in the Gimbo District of South West Ethiopia. Furthermore, [28] confirmed that scarcity of rainfall and garden size are the main constraints facing farmers to produce home garden species in Wolayta Zone of Southern Ethiopia.

Conclusion

The homegarden of the study area has different plants species used ranging from as a source of food including fruits, vegetables, spices, and cash crops used for income source, and further importance recording about 70 plant species with twelve different uses were identified. So, the practice of homegarden for the society is means a lot. The number of food crops diversity in the study area is higher. Over all *Ensete ventricosum*, *Coffee arabica* and *Brassica carinata* are the first dominant plants in the farmers'

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garden. This implies that farmers preferred and protected frequently in their garden due to ecological and economical aspects of the plants. In the study area *Cordia africana*, *Eucalyptus globulus*, *Mellitia ferruginea*, *Croton macrostachyus*, *Persea americana* and *Podocarpus falcatus*, are multipurpose tree which used and maintained in farmers garden. As the respondents said, traditionally the communities select different plant around their home areas used to treat both human and animal diseases. This ensures that the community saves their income through harvesting of homegarden species rather than paying the surrounding clinic centers. According to the field observation, the communities of the study area manage the homegarden agroforestry traditionally.

Appropriate management of homegardens in traditionally way has a great potential for biodiversity conservation, alleviate food insecurity and it maintains ecosystem services. Generally, the respondents confirmed that the communities of the study areas entirely depend on homegarden species for food supply, animal food, traditional medicine, income generation and other purposes.

Recommendations

Based on the findings of the study, the following recommendations are provided.

a. The study sites have many species diversity. These species should be protected to reduce the degree of extinction.

b. The concerned bodies (Governmental and Non-Governmental organization) should give due attention to the multipurpose species which are identified in the study sites through continues awareness creation for management.

c. Since the communities of the study areas are dependent on home garden species for income generation, further research is important to investigate the economic contribution of home garden in detail.

d. The indigenous homegarden management system should be supported by the Agricultural experts at different levels.

e. Training should be given for the communities to inform about the characteristics of home garden to strengthen adoption technologies.

Authors' Contributions

Yirefu Tefera conceptualized the studies and wrote the manuscript. All authors are involved in collection of data on Homegarden Plant Use, Composition and Management Practices as well as read and approved the final manuscript.

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