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RESEARCH

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Ethnobotany of vascular plants use, conservation and management practice in the homegardens by the people of Dawuro in Southwestern Ethiopia

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Abstract

Background Homegardens (HGs) are well-time-honored traditional land use systems in small plots of land with purposely designed intricate structure and a mixture of planted vascular plants (VPs) for different purposes. Hence, the present study was initiated to investigate the ethnobotanical information of vascular plants of homegardens and their use, conservation and management practice by the people of Dawuro in southwestern Ethiopia.

Methods A total of 162 farmer informants were selected and interviewed within a distance of < 2 km, 2–4 km and > 4 km between the natural forest and homegardens, and 0.8–1 km between the homegardens. Quadrats of three 5 m × 10 m were laid (except front yard) around each living houses. Shannon–Wiener diversity index was used for analysis of diversity.

Results There were 345 vascular plants in the homegardens distributed in 252 genera and 79 families. The most frequently recorded plant families were Fabaceae with 38 (11%), Asteraceae 33 (10%), and Lamiaceae 26 (7.5%). The species richness recorded per homegardens ranged from 13 to 59. *Ensete ventricosum, Persea americana, Colocosia esculenta, Coffea arabica, Solanum capsicoides,* and *Ocimum basilicum* were the most frequently occurred species. The homegarden was enset-based agrobiodiversity system providing food, medicine and other uses where the highest, 290 species were for medicine. Men are responsible for planting and propagating large-sized plant species in the homegardens, while small-sized were managed by women and children. The α-diversity (*H'*) ranged from 1.4 to 3.4 and the gamma diversity was 4.2. Culture has positive effect on diversity however, the diversity of species is affected by distance from natural forest ($x^2 = 14.825$, df = 4, $p = 0.005$) at $P < 0.05$ level.

Conclusion Awareness raising designed and executed by farmer experts and researchers focusing on managing homegarden is necessary to fill the observed gaps in knowledge and attitude of the new generation. The enset-based homegarden management knowledge and practice as well as avoiding the diseases and other constraints of enset should be given attention. Furthermore, decisions on avoiding the growth and management of invasive exotic plant species like *eucalyptus* tree in the homegardens have to be made.

Keywords Biodiversity conservation, Culture, People of Dawuro, Ethnobotany, Homegardens, Plant biodiversity, Traditional medicinal plants, Vascular plants

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Introduction

Homegardens (HGs) are time-honored traditional land use systems in small plots of land with purposely designed intricate structure and a mixture of planted flora for subsistence production, income generation and to get a year-round supply of materials and services for households [1]. Local knowledge owned by a community is valuable information for researchers, to understand ecological aspects in order to utilize the environment and biological resources. The process of plant domestication whereby societies select as useful species from the wild is still currently taking place in some traditional agricultural systems [8]. Homegardens, including trees, shrubs, and herbaceous plants that grow in or near a homestead or home compound, are planted and managed by family members [71]. The goods and services of HG products are largely for household consumption and ornamental value [2]. The diverse plant resources and the complex cultural diversity including indigenous knowledge of the local communities in Ethiopia needs to be conserved and preserved. The high diversity of species in HGs plays wide socio-economic and ecological roles through the production of food and other products, such as medicinal plants, spices, condiments, fodders, ornamentals, firewood and dyes [2], cultural and spiritual [1, 2]. [3] Underlined the importance of HGs in prevention of environmental deterioration and as income generating sites and for in situ conservation of agrobiodiversity [4–6] and ex-situ conservation of landraces [7]. Other services of the HG include testing plots for new crops and as sites for domestication of wild plants and as nurseries for plantlets [8] and for sustainable development [9]. The improved, organized homegardens provided an important source of micronutrients and had a higher contribution toward the dietary diversity of households [10]. Climate change, soil erosion, soil fertility loss, and severe moisture stress can be solved using HGs [11; 12]. It is not only for plant conservation but also animals such as birds, reptiles, amphibians, small mammals like rodents, or arthropods [11] can thrive in well-managed HGs.

Culture has a great role in determining the structure and management system of the HGs, and continuing the associated practices and knowledge. HG study showed that different ethnic groups have their own unique lifestyle and perception toward their surroundings for growing, maintaining, conserving and utilizing biological resources [5]**.** The management of biodiversity in the HGs of different cultures helps for conservation [8]. Because the land use and management practices determine the plant species diversity [2; 3; 8]. Beautiful trees and other ornamental plants are important species that enhance the aesthetic value and harmony of the homestead environment in the HGs [9; 12]. The diversified surroundings of HGs provide favorable growing conditions for a wide diversity of useful plants.

The special arrangement of the crops in homegardens may be related to the various uses of the crops micro-environmental adaptation and their habit [2, 3]. HGs consist of vertically structured spatial arrangement with herbaceous layer near the ground, intermediate layer and a tree layer at the upper levels [9; 12]. The compositions of unique plants in HGs varies with ethnicity, food culture, religion, and spirituality [13–17] and have been passed from generation to generation and, neighbor to neighbor [12]. Diversity in HGs is also influenced by environmental factors and socio-economic characteristics [16]. In addition to these, unwise introduction of invasive exotic species could have negative effects on the local environment and on growth and productivity of biodiversity [18].

The ethnobotanical study of vascular plant species of HGs is useful to partially fulfill the basic requirements of households, to conserve vascular plants, to sustain ecology and perpetuate knowledge, practice and culture of the area [10]. In the study area, such information has not been yet properly evaluated and documented. Unwise and unsustainable use and management may result in the loss of these valuable diverse plants from HGs as well as the associated practice and knowledge. Hence, the present study was initiated to investigate how far the HG serves as site/source for vascular plants with medicinal value and their ethnobotanical information in the HGs by the people of Dawuro, southwestern Ethiopia. In other word, the practice of Dawuro people in diversifying, conserving and managing, and using vascular plants in the homegarden, taboos and norms/culture and the status to see the threatening factors on conservation and management of vascular plants with medicinal value in the homegardens.

Materials and methods

Description of the study area

Dawuro Zone is one of the six zones in southwestern Ethiopia. Dawuro lies in between 6° 36' to 70 21' north latitudes and 36° 68' to 37° 52' east longitudes [19]. In 2014, the population of Dawuro was estimated to be 600,121 according to the annual statistical abstract of CSA and reported by Bureau of Finance and Economic Development (BoFED) of SNNPRS and its population density is 135.28/km^2 [20]. There are 10 districts and one Town administration in the Zone: namely Tarcha Zuria, Zaba Gazo, Gena, Loma Bosa, Zisa, Maraka, Mari Mansa, Tocha, Kechi and Esara Districts in the Zone and Tarch Town Administration. Tarch Town Administration, Tarcha Zuria, Maraka, Mari Mansa, Tocha, Kechi and Esara districts were selected purposely and data

collected on vascular plants of HGs [Fig. 1; 21]. The districts are characterized by highly undulating surfaces with extremely dissected terrain/topographic formations. The highest point (peak in 'Gibra' PA in Tocha District) is 2820masl and the lowest 501 masl in Esara District [20].

The zone has three agroecological areas: Dega climate (> 2300 masl); Kolla (< 1500 masl) and Woina dega agroecology, where altitude ranges from 1500 to 2300 masl [19]. The annual average maximum and minimum temperature is 29 °C and 16 °C, respectively, with annual rainfall of 900–1620.3 mm [20]. The study area gets rainfall almost throughout the year and the amount is high in northern summer as moisture comes from the Gulf of Guinea [20]. About 85% of the population depends on agriculture and the other 15% on different jobs including government workers or professionals [19]. The vegetation varies from *Combretum-Terminalia* types, broad-leaved, deciduous woodland in lowland areas, Dry Evergreen Montane Forest and Grassland Complex in midland and moist evergreen forest, broad-leaved evergreen forest types in the highlands [20]. The forest cover of Dawuro Zone is 137,308.825 ha, which is 30% cover of the land; of this, the study area forest covers 53,201.575 ha. In addition, *E. ventricosum*, source of the staple food in the area, provides vegetation cover and creates green scenery [22, 23].

Methods

The ecological study was carried out to see the diversity, abundance and distribution of vascular plants in the homegardens and the structure of homegardens of the study area. This method was also used to get some information of the status of vascular plants with medicinal value in the homegarden. Semi-structured interviews, focus group discussions, participant observation and walk-in-the-homegardens methods were used for gathering ethnobotanical information. That is, the use, conservation and management, taboos and norms/culture, threats of vascular plants in the homegardens and the homegarden system information data in the study area were addressed through face to face interview which was triangulated by sociodemographic information, focus group discussion and participant observation.

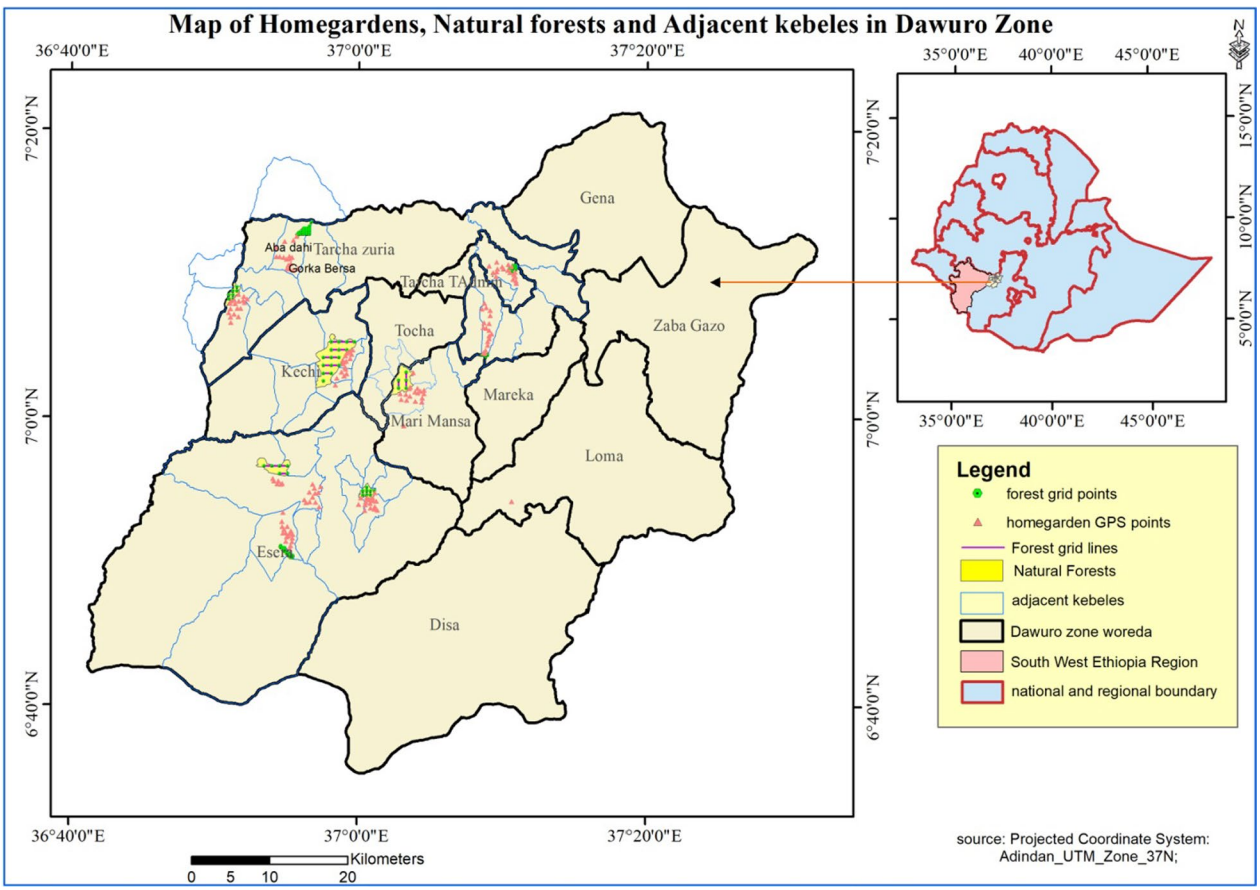

Fig. 1 Map showing the study area and its location in southwestern Ethiopia

Sample size determination and Sampling techniques

Ecological

The natural forests from three different agroecology Kola (< 1500 masl), Woina dega (1500–2300 masl) and Dega (> 2300 masl) were selected purposely and considered as reference to see the effect on the vascular plant diversity of HGs. The total of nine kebeles was selected purposely following the natural forests selection. Lowland natural forests: from Chawud kebele-Abale natural forest, Abadahi-Paka, Tarcha Zuria-Wono; mid agroecology: from Gudumu kebele-Buba Yilga natural forest, Manta Guchuli-Gabini, Shaba Yoyo-Arka; and Highlands: from Bale kebele-Bira, Kechi-Tuta-Yama, and from Samu kebele Guda natural forests were selected purposely. The HG that got the chance of falling systematic distance measurement was purposely selected for ecological study.

Ethnobotanical

The householders or HG owners whose home got the chance of falling of systematic distance measurement were purposely selected for interview from nine kebeles. The informant number was determined following the small-sized kebele (Chawuda in Esara District) purposely selected for study. Based on distance-based sampling in the small-sized kebele, eighteen HHs were selected from each kebele.

Data collection methods

Ecological data collection

The 162 HGs were selected by considering distance < 2 km, 2–4 km and > 4 km) from each sampled forest toward urban areas where each 800 m-1 km distance far apart from each other (Fig. 2). From the edge of a clean area of the home toward the farm field, a quadrat of 15 m × 10 m and 2 m × 2 m was laid for trees and shrubs, and herbs , respectively. Species richness and similarity data was collected from a plot following Whittaker Quadrat Sampling Method [24] technique (Fig. 3).

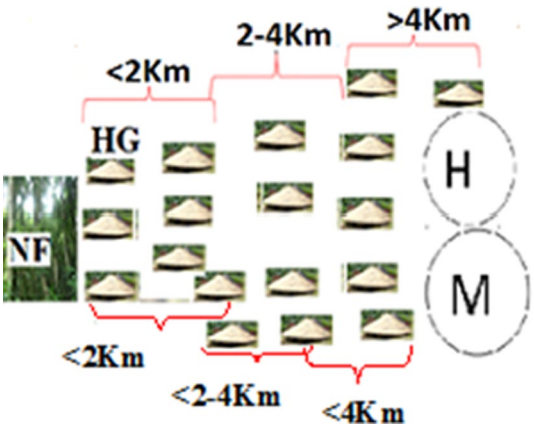

Fig. 2 The group and design of distance of HG from natural forest

Ethnobotanical data collection

Semi-structured interviews, focus group discussions, participant observation and walk-in-the-homegardens and natural forest patches were the methods used to collect ethnobotanical data as described by [33–35]. Data was gathered from January 2020 to July 2020. At the beginning of the research, nine focus group discussions were held in nine kebele (12 individuals representative from different groups of community sex, age, religion, education, admin, youth, woman, and economic status, experts of health, agriculture, and education in each kebele). That is, about 108 people from purposely selected nine kebeles of the study area took part in group discussions on the resource perception, classification-related issues, on use, conservation and management, taboos and norms related to plant use, conservation and management, and threats of vascular plants of HGs, knowledge, and practice of HG management system. The information was recorded following consensus of groups. The 162 households whose home got a chance of systematic distance measurement for ecological study (Fig. 2; Fig. 4) were purposely selected for an interview. Some of the interview questions include: Why do you plant/grow VPs more specifically traditional medicinal plants in the HGs? Is there any taboo in using, planting/not planting/different type's plant species in the homegarden? Who is responsible for management of vascular plants in the HG? What are the threats you think affect both vascular plants in the homegarden and its system? Since inhabitants speak Dawuro language, semi-structured interview questions were translated into Dawuro language for ease of communication and communicated to collect data. The sociodemographic factors were recorded to see the effect on the diversity of vascular plants in the HGs.

Data analysis

Ecological data analysis

Frequency shows the presence or absence of a given species within each sample plot. Two frequency values

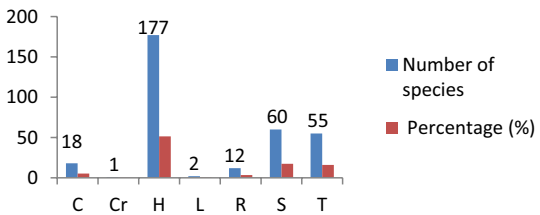

Fig. 3 The growth form of vascular plant species recorded in the HGs of the study area (where *C* = climber, Cr = creeper, *H* = Herb, *L* = liana, *R* = runner, *S* = shrub and *T* = tree)

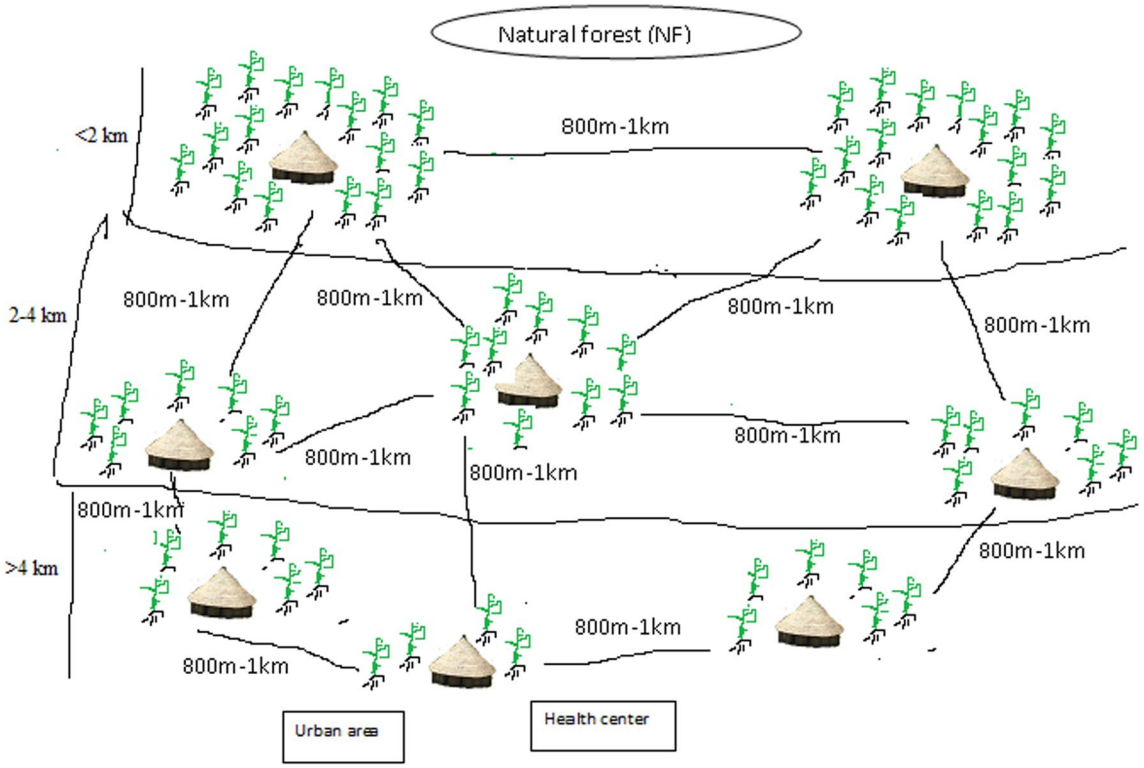

Fig. 4 Effect of the distance of HGs from natural forests toward urban area on diversity of vascular plants

were computed for each species encountered within the study plots: the absolute frequency and the relative frequency.

Alpha diversity, i.e. species richness, was determined by recording plant species in a study unit, each HG. Beta diversity, a measure of the extent to which the diversity of HGs found in three agroecological spatial units differs, whereas gamma diversity was obtained by summing all species encountered at a study area level was determined through Whitaker's [36] method:

$$\beta W = \frac{Sc}{S} - 1$$

where, βW is Whitaker's beta diversity,

Sc is the number of species in the composite sample, and S is the average species richness in the entire set.

Shannon–Wiener diversity index was calculated to measure species diversity of identified plant communities [32] in Dense Forest, using: H'= Σpilnpi, where, pi is the proportion of individuals of the *i*th species; whereby H' = Shannon diversity index, s = number of species, = proportion of individuals or abundance of the species expressed as a proportion of total cover in the sample; and ln = the natural logarithm.

Species evenness is a diversity index, a measure of biodiversity which is used to measure the homogeneous distribution of tree species in sample plots. Shannon's evenness index (J) was calculated following [32].

Ethnobotanical data analysis

Preference ranking and direct matrix ranking exercises, following but with some modifications [33] and [34], use value (UV) of traditionally useful species following Phillips and [37].

Chi-square (χ2) tests were used to verify possible associations between vascular plant diversity and distance from natural forests and with other like sociodemographic factors too. The fitness of the multiple logistic regression model was checked ($r^2 = 0.454$) and one-way ANOVA was significant at $p < 0.05$ level ($p = 0.000$). The plant species diversity data were analyzed by using paleontological statistical software (PAST version 4.10). Descriptive statistics, statistical tests were used either to compare results or to determine relationships and the outputs were presented using tables and figures.

Plant sample collection

Plant sample gathering was enormously done with conscientiousness for the completion of the research in maintenance with [38] procedure adaptation 1:4b from January 2020 to July 2020. Botanical naming of the plants was undertaken using Ethiopian Flora books

from volumes 1–8 and by evaluation with valid voucher specimens at the National Herbarium of Ethiopia (Addis Ababa University) and further confirmed by a senior taxonomic expert there (Prof. Sileshi Nemomissa). Finally, the identified triplet sample voucher specimens with their numbers and labels were deposited there at the National Herbarium of Ethiopia, the Herbarium of Arba Minch University and the Mini-Herbarium of Dawuro Historical and Cultural Museum (Supplementary data).

Ethical consideration

The data collection was made in accordance with the access and benefit sharing regulation of Ethiopia [39] and ethical principles for human subjects [40]. The study was reviewed and approved by the Ethical Clearance Committee of Arba Minch University, Ethiopia. The research was done with common consent and willingness of the study area households, administrators and the university. The support letter of "cooperation for research work" from Arba Minch University was written to the study area Administration Office. The respected study area Administration Office in turn wrote a letter to kebele Administrators. Permissions were obtained from the district and Kebele Bureaus of Agriculture and Naturals Resource Development to carry out the field work. Verbal consent was obtained prior to interviewing farmers. Respondent's oral consent was realized by their willingness to interview and allowing their HGs to be studied.

Result

Vascular plants diversity in the HGs of the study area

Vascular plant species richness and their taxa in the HGs of the study area

The study area HG was recorded with highest taxa 345 vascular plant species, 252 genera and 79 families, respectively (Supplementary 1). *Fabaceae* was recorded with 38 (11%), *Asteraceae* 33 (10%), and *Lamiaceae* 26 (7.5%) species, respectively, as top utilized taxa in the study area.

Most of HGs were recorded with high species richness (13–59) and abundance (37–677) in the study area. Female headed HG was recorded with high species richness and low species abundance compared to males. *E. ventricosum*, *and P. americana*, were the pinnacle frequently appeared and abundantly distributed vascular plants in almost all HGs and agroecology and serving people in different aspects (Table 1).

Table 1 Vascular plants in the HGs of the study area found to be more frequent and abundant (where Abun = abundance, Freq = frequency, IC = informant consensus, NU = No. of uses, Rf = relative frequency, UR = use reports, UV = use value)

S. no	Scientific name	NU	UR	UV	IC (%)	Abun	Freq	Rf	Rank
1	*E. ventricosum*	10	162	0.14	100	3007	161	99.38	1
2	*P. americana*	7	160	0.04	98.77	124	124	76.54	2
3	*Colocasia esculenta*	4	137	0.02	84.57	1196	119	73.46	3
4	*C. arabica*	5	162	0.03	100	1092	110	67.9	4
5	*S. capsicoides*	3	160	0.02	98.77	92	92	56.79	5
6	*O. basilicum*	2	162	0.01	100	90	90	55.56	6
7	*Ruta chalepensis*	2	162	0.01	100	88	88	54.32	7
8	*Ricinus communis*	10	158	0.06	97.53	86	86	53.09	8
9	*Brassica oleracea*	3	162	0.02	100	1016	77	47.53	9
10	*Rumex nepalensis*	3	141	0.02	87.04	95	76	46.91	10
11	*Capsicum annuum*	2	162	0.01	100	152	66	40.74	11
12	*Cordia africana*	9	160	0.06	98.77	62	62	38.27	12
13	*Brassica carinata*	3	162	0.02	100	1120	61	37.65	13
14	*Dioscorea abyssinica*	2	145	0.01	89.51	59	57	35.19	14
15	*Zea mays*	6	162	0.04	100	165	55	33.95	15
16	*E. camaldulensis*	8	149	0.05	91.98	53	52	32.1	16
17	*Mangifera indica*	10	155	0.06	95.68	53	52	32.1	17
18	*J. procera*	12	161	0.07	99.38	51	51	31.48	18
19	*Carica papaya*	3	160	0.02	98.77	115	50	30.86	19
20	*Coriandrum sativum*	2	148	0.01	91.36	289	50	30.86	20
21	*Musa x paradisiaca*	8	159	0.05	98.15	67	50	30.86	21
22	*Vernonia auriculifera*	10	114	0.06	70.37	50	50	30.86	22

The structure and composition of HGs

Most of the recorded vascular plants in the HGs of the study area were herbs (177, 51.45%) followed by shrubs (60, 17.44%) and trees (55, 15.94%) (Fig. 3). Most of the time the parts of the plant were used in combination; especially with the whole part 181 (52.62%). Few vascular plants in the HG were mentioned for use of the leaf part only (43, 12%), whole (24, 6.98%), seed (11, 3.2%), fruit (10, 2.91%) and others.

Vascular plant species diversity in the HGs of the study area

The maximum Shannon's diversity index (*H'*) of the study area is 4.2343. The Shannon's diversity index (*H'*) of beta diversity in lowland, midland and in highland is 3.9868, 4.0717 and 4.0822, respectively, but no significance differences were observed at $p < 0.05$ (Table 2). The vascular plants diversity of each HG (α-diversity) *H'* of the study area was ranged from 1.3871 to 3.3956 where about 114 (70.4%) of HGs had 3, and 47 (29%) and 1 (0.6%) HGs had 2 and 1 α-diversity (*H'*), respectively. It was observed that the diversity of VPs decreases as the residence is far away from natural forests, as it approaches urban areas (Fig. 4).

The use of vascular plant species in the HGs of the study area

The matrix of the uppermost multipurpose vascular plants in the HGs of the study area showed that the most frequently appearing vascular plants were managed in the HGs because of their multi-use and their continuous service for the household's livelihood even in the dry period. There were about 51 uses of vascular plants recorded in this study. There were about 290 vascular plant species recorded with traditional medicinal use, 153 animal feed, 141 with beeforage use, 48 food and others (Supplementary data). Some vascular plant species were recorded with highest informant consensus and use value which were with up to 23 general uses. For *E. ventricosum* 23 uses were recorded, *Syzygium guineense* subsp *guineense* (20), *Prunus africana* (18), *Schefflera abyssinica (18)*, *Polyscias fulva (16)*, *Maesa lanceolata*, and *Psydrax schimperiana* with 14 uses.

Vascular plant species conservation and management in the HGs of the study area

Sociodemographic effects on management of vascular plants in the HGs of the study area

Sociodemographic and labor division effect on HG management: Vascular plant diversity of HG is determined by age, family size, farm size and distance from natural forest. The statistics of socio-economic information indicated that most 132 (81.5%) of the HG owners were middle aged males (38–57 years), and 140 (86.4%) were married and have 5–8 family members (Fig. 5) and 90 (55.6%) have 2-4ha sized farm field and 137 (84.6%) were stayed for 11–92 years, 91 (56.2%) of HG owners were not attended formal education. It is these socio-economic impacts that the high vascular plants' diversity from 2.5 to 3.3956 to be recorded. Most 158 (97.5%) of them claimed that the size of family and labor division on the management of HG plants allowed the vascular plants to be more diversified.

Table 2 Shannon's diversity index, Simpson's diversity and evenness of vascular plants in study area (where *C* = community, CT = community type, CNS = No. of common species, *D* = Simpson's diversity index, EH' = Shannon's equitability, *H'* = shannon's diversity index, Hd = highland, HP = hind part, Ld = lowland, LS = left side of HG, Md = midland, NS = no. of species, RS = right side of HG, SA = study area)

Analysis parameters	Agroecology of HG				Spatial type of HG		
	Ld	Md	Hd	SA	RS	HP	LS
H'	3.9868	4.0717	4.0822	4.2343	4.3101	3.5126	4.0506
D	0.038693429	0.03351775	0.03604432	0.03187641	0.0275038	0.05545779	0.03687092
SD = 1 – *D*	0.961306571	0.96648225	0.96395568	0.96812359	0.9724962	0.94454221	0.96312908
EH' = *H'*/LnS	0.735499064	0.73689784	0.7562248	0.7246055	0.76539949	0.67641647	0.73098205
S =	226	251	221	345	279	180	255
LnS =	5.420535	5.5254529	5.3981627	5.8435444	5.6312118	5.1929569	5.5412635

CT	NS	CNS in C1 & C2	CNS in C2&C3	CNS in C1&C3
Lowland (C1)	226	166	165	138
Midland (C2)	251	332	330	276
Highland (C3)	221	477	472	447
CC = 2c/S1 + S2	345	0.696	0.699	0.617

Sorenson's similarity coefficient (CC) = 2c/S1 + S2 + S3

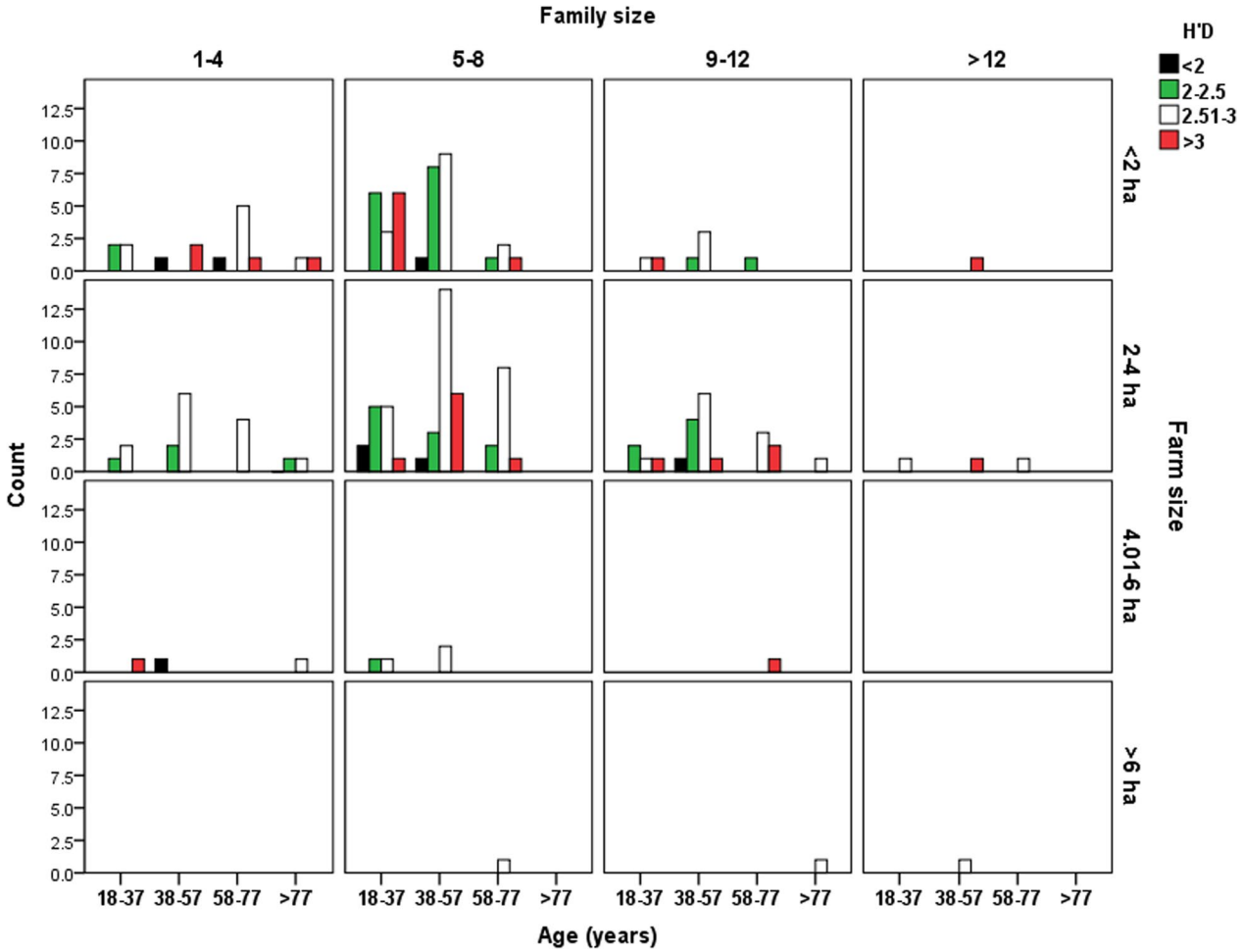

Fig. 5 the effect of age, family size and distance from natural forest (DF) on diversity of vascular plants (H'D) in the HG

Cultural effect on management of vascular plants in the HGs of the study area

There are cases where culture and social factors (e.g. gender and age) influence HG patterns and plant composition. Most 158(97.5%) informants claimed that males are responsible for planting and propagating large-sized HG plants including enset, coffee, mango, avocado, shade trees like ficus, cordia, eucalyptus, bamboo tree and others. While the management of those plants and planting and managing of small-sized vascular plants including spices, condiments, medicinal plants, vegetables and ornamental ones is left for females and children. Hence, the managed plants in the HG are mostly for immediate access for healthcare, seasoning, for ease of eating staples and aesthetic purposes.

Allowing the emergence of wild plants in the HGs of the study area is another cascaded positive effect of culture. There were about 26 multipurpose wild edible plants recorded in the HGs of the study area including *Bridelia scleroneura, Carissa spinarum, Cordia africana, Dioscorea schimperiana, Ficus sycomorus, Piliostigma thonningii, Rubus apetalus, Strychnos innocua, Syzygium macrocarpa, Syzygium guineense, Tamarindus indica* and *Vitex doniana* (Suplementary data).

Threats of the management of vascular plants in the HGs of the study area

Effect of the attitude of young generation on management of HGs in the study area The 126 (77.78%) of elders claimed that the negative effect of the attitude of the new generation for continuation of their traditional practice of managing HGs considered it as backward remote activity. They attempt the reason that the new generation focuses on learning education to search for other job opportunities not to participate in agricultural activities including HGs. The generation follows the new lifestyle not the traditional practice derived from culture. The remaining 36 (22.22%) informants ensured that they train and pass their skills and knowledge of managing HGs on time.

Perception on effect of exotic species on vascular plants of the homegardens

Some of the sampled HGs were recorded with some types of exotic species like *Eucalyptus camaldulensis* 52 (32.1%), *Juniperus procera* 51 (31.48%), *Grevillea robusta* 22 (13.58%), *Eucalyptus globules* 10 (6.17%), and *Cupressus lusitanica* 7 (4.32%) trees (Supplementary data). *Acacia mearnsii, Azadirachta indica*, *Cuscuta kilimanjari*, *Jacaranda mimosifolia, Jatropha curcas* and *Parthenium hysterophorus* were also some of the observed invasive exotic species. From the interviewed 162 farmers, about four (2.5%) of them grow those species intentionally and the others 158 (97.5%) claim on the negative effect of these species which were recorded in 92 (57%) HGs of the study area. For Example, *Eucalyptus* tree was recorded with at least eight uses in 62 (38.27%) HGs of the study area. In addition to this there is *Cuscuta kilimanjari* exotic plant species recorded 12 (7.4%) in the HGs inhibiting the growth and productivity of HG and farm field crops.

The effect of distance of urbanization and settlement on management of vascular plant diversity in the HGs

Urbanization and settlement infrastructure is thought to be done at distant places from natural forests. There is an effect of natural forest on diversity of vascular plants which was significant in two tailed Chi-Square tests ($x^2 = 14.825$, df = 4, $p = 0.005$) at $P < 0.05$. Most of the HGs and the residence (107, 66%) are found near (< 2 km) the natural forest but the rest (43, 26.5%) and 12 (7.4%) are far 2–4 km and > 4 km, respectively (Fig. 4).

Discussion

Vascular plant species diversity in the HGs of the study area

Vascular plant species taxa, richness and abundance in the study area

The HGs of Dawuro revealed the presence of high number of vascular plant taxa (345) compared to other areas from 30 to 258 species which is 159, 75 and 258 in south [6; 41; 42]. It also revealed the use of highest families and concentrated the same on use of Fabaceae, Asteraceae, and Lamiaceae compared to the study reported to Wolaita [41], Hawassa [43], Sebeta [17] and Gozamin of east Gojjam [44] in Ethiopia. This is due to the sharing of common culture in different ethnic groups of Ethiopia that enforces them to manage a lot of plants in their HGs. The other reason is that people focus on sustainable actions of health and food of their children and domestic animals.

Species richness is negatively correlated with education, farm size, and slope. This is because, the educated individuals give attention on professional works, which seeks for other job rather than agriculture including HG management; households with large-sized farm field focus on out field crop works and management that brings large amount of products for income and consumption rather than HG; and as the slope increases the degradation of fertile soil in the area also increases which consequently results in decreases of the growth and appearance of vascular plants.

Most of HGs were recorded with highest vascular plant species richness ranging from 13–59 (average 36) in the study area compared to the report ranging from 10 to 45 throughout the HGs to other areas [45, 83] of Ethiopia, Uganda [47] and Meghalaya of north-east India [1]. The highest species richness per HGs were recorded in mid altitude followed by highland and in lowland in that order which is different from the report to Kerala, India [46] that showed low elevation lands. This indicates in the midland region which can be attributed to the water availability due to the presence of different natural forests around as source for this and better soil fertility with lower slope of the lands.

The difference in species richness from place to place could be attributed to attitude, income difference, and personal preference of species, soil type and size of HG. The same report was suggested in study of Kerala, India [46] and Holeta Ethiopia [14]. However, more species richness records were seen in the HGs of female heads than males. This is because in male headed HG: 1. Culture enforces them to be worth wealth in plant agrobiodiversity: agroforestry (mainly enset, coffee and fruits- avocado, mango etc. with large size) and domestic animals (mainly cattle and equus for rich but sheep, goat and poultry for poor—at least one in each case) to sustain family life and the respect from community waits for him otherwise it is considered as taboo. 2. For this matter, he has to manage a lot of vascular plants with multipurpose in his homestead (HGs and farm fields) by planting intentionally, allowing the appearance of wild plants with multipurpose, domesticating the known wild edible and medicinal types of plants which are few in number because they need large space for management. He gives mandate for his family members, wife and children to closely manage; then after he follows every day it is in his entrance and out going from home. The same was reported to Hawassa city in Ethiopia [17]. In contrast, the higher species diversity in female headed homegardens is because of: 1. The owner's interest, intentionally planted to get their multipurpose service 2. It may be accredited to enhanced and exhaustive effort of planting, weeding, watering, fencing, digging, applying animal dung and pruning and coppicing for the leaf, branches or canopy and height management by family labor (women and children) [16] 3. Culture enforces females to avoid

some weeds and make clean around her home, leaving only managed or cultivated types like vegetables, spices, condiments and ornamental ones for immediate access and sustainable supply 4. She is also enforced to come up with multifood items in dining table; the staple food (in Dawuro case bread made from kocho of enset, wheat, maize and sorghum) with other cereals, root and tubers, vegetables, spices, condiments, boiled coffee leaf, milk, fruits or/and others for ease of eating; otherwise it is considered as taboo. These crops are herbs and shrubs those need small space and can be produced in large 5. Finally, she has the prior responsibility of a family member for care of family health to manage medicinal, nutritionally and economically important vascular plants in her HG for immediate access and sustainable harvest. The same was reported to Hawassa city Ethiopia [16].

The least species richness and abundance was recorded in few HGs due to size of HG, personal interest, attitude, busyness in other income generating job (daily laborer or professional worker), time of establishment (the newly established HG) and environmental factors like water stress, climate, soil type, elevation, slope, aspects, hillshade and toposhape layers. Some of them were the same factors reported to Hawassa city in Ethiopia [16] and to Ilam province of Iran [73].

The structure and composition of HGs

HGs of the study area are characterized by a structural complexity and multi-functionality which enables the provision of different benefits to people and ecosystems. For example, homegardens could be regarded as a relatively safe place for conserving specific endemic and threatened species. The horizontal and vertical structures of HGs, their composition, the richness, abundance and the size of vascular plants to be managed in the HG is determined at the beginning based on the size of the HG. A renowned structural characteristic of the HG was recorded with the great diversity of species varying from those creeps on the ground to tall trees. The identical was reported to homegardens of southern Ethiopia [48], West Java, Indonesia [61], Shan communities in Thailand [76] and elsewhere [62]. This is because; culture enforces the cleanness, neatness, and diversification of HG as well as the diet they eat which give the room for setting the type of HG. In spatial (vertical and horizontal) management of vascular plants immediately next to the clear area of the home, especially in sloppy areas, most of these plants with dwarf size were grown in the upper side or front-right side of home in order of height. The dwarf sized plants like spices, medicinal plants and ornaments were managed in the upper side of home and the long sized ones were at the lower side of home. This is because; 1. To protect contamination and to give well odder to the guests 2. To avoid the odor of animal pens in the house which is released/disposed to the lower side of the home 3. In order to protect the graving of species into sedimented materials those were eroded from the upper side of the resident 4. Those don't need a high amount of manure. 5. Deeply rooted plants which make it hard to dig and pick the root from dregs in the lower part. 6. Those can be grown abundantly (small and thin) to protect or reduce erosion/flood.

Vascular plant species diversity in the HGs of the study area

The study result has revealed high Shannon's diversity index (*H'*) recorded in the homegardens from 1.3871 to 3.3956 compared to other study reports in central Ethiopia from 3.016 to 3.28 in Holeta area [14] and in Uganda ([47]. The shannon's diversity index (*H'*) of beta diversity in different agroecology, in altitude gradient variation (lowland, midland and highland) has no significance differences were observed among themselves but the study reported to Kerala, India [46] showed that high vascular diversity in low elevation lands. The beta diversity of the study area is higher (3.97 to 4.08) than other areas HGs' report to Hawassa city [16] recorded in four sites from 3.29 to 3.87 and Dilla area of Gedeo Zone [42] in seven sites from 3.34 to 3.52 in the country, Ethiopia.

The diversity of each plot (alpha diversity, *H'*) of the study area was recorded with higher range than the similar study reported elsewhere in the above comparison. This is because 1. The households were from the same ethnic group of a community governed by (practice) the same culture in the study area that forced them to diversify their HGs. 2. High species richness and abundance was recorded. 3. Suitable sociodemographic factors like age, education of household, family size, marriage, sex, traditional healer being the owner of household, and year of stay in the area were considered 4. Suitable surrounding factors like distance from natural forest and from urban areas, elevation, slope, soil and moisture availability were confidently predictable; these have an effect on the diversity of vascular plants in the study area.

The use of vascular plant species in the HGs of the study area

HG of the study area is a fixed plot of land comprising multipurpose nature plants which were harvested at different times to meet diverse people's requirements and adapt to the environmental stress, climate change. These vascular plants were grown like for food security, nutritional, healthcare, economical, cultural value and to cope up the size of land they own. In the study area HG has use as site for food production economically that saves the expense on produce and food costs every season, shorten the commodity chain, save fuel-demanding

transportation and reduce pressure on natural forests, health benefit, economic value, ecosystem service and provide a place for households to share knowledge and skills. The same was reported in Ethiopia [43], in Minneapolis of USA [65], in Sri Lanka [18; 66] and in Uganda [47].

HGs of the study area were enset with an agrobiodiversity-based agricultural system on landscape management which has great potential for ecological balance, climate change solution, carbon sequestration and subsidiary reimbursement as natural forest provides. The same was reported elsewhere [66]. Most of the recorded vascular plants in the study area were herbs followed by shrubs and trees, respectively. This is because, 1. They grow the freshly used and accessible vascular pants 2. The agrobiodiversity and agroforestry were encouraged by culture which enforces the household to grow in their HG 3. Individual interests of growing plants with multipurpose were some of the reasons. Most of them are used in combination but few vascular plants in the HG were used alone like leaf and whole parts. This is because the culture in the study area enforces to use fresh potherb species (seasoning, medicinal plants and vegetables) for daily consumption; using spoiled materials is taboo, called as "samaa"local saying meaning putrid/ stale.

Almost all householders' manage vascular plants in their homegardens mainly for food use and others come next. However, in general, most of the recorded uses were with traditional medicinal value compared to other areas reported. HGs of the study area service as a source of traditional medicinal plants was assured for the study area [50; 80]. This study report is similar to the report of the study in Northeast India [57] and for keniya [79]. The reason why they manage a lot of vascular plants in their HGs is 1. Culturally they know that the food they eat is medicine by itself. 2. Most of them are from low status (the poor) and cannot afford the price either to buy the food with medicinal value from the market or to buy drugs from modern pharmacies 3. The multipurpose nature of the plant catches the attention of the interest of householders 4. The householder might be traditional healer who cultivated or allowed them to emerge there for immediate access for service delivery.

Enset ventricosum, C. arabica, Mangifera indica, Carica papaya and *P. americana* were considered important and most cultivated in the HGs of the study area. The same study report confirmed species composition in the HGs of Gamo in Ethiopia [67] and Uganda [47]. The perennial crop *E. ventricosum* among the dominant plant species existing in almost all sampled HGs and agroecology in the study area. Similar was reported to central Ethiopia [63; 65] and as it was reported to elsewhere [68]. This is because; these plant species serve as the main economic and food source of the daily diet of the livelihood of the farmers.

Based on the previous studies [52;69;70] and compilation of Institute of Biodiversity Conservation (Endemic plants of Ethiopia: Preliminary working list of Endemic plants of Ethiopia) was produced from published flora of Ethiopia and Eritrea and Gullele Botanic Garden (GBG) (http://gullelebotanicgarden.yolasite.com/endemic-species-in-ethiopia.php) there were more than 10 endemic vascular plant species recorded in the homegardens of the study area: namely *Coccinia abyssinica, Crotalaria rosenii, Echinops kebericho, Erythrina brucei, Impatiens rothii, Milettia ferruginea, Pycnostachys abyssinica, Satureja paradoxa, Trifolium decorum, Vepris dainellii, Crassocephalum macropappum, Lippia adoensis.* From this what can be drawn is homegarden plays the reservoir role of both native and introduced plant species for generation. Since this landscape is the area where domestication of the wilds, testing of modified species, introduction of exotic species and maintaining and propagation site of indigenous and land-races [10; 14; 15; 16] focus should be given for conservation and sustainable utilization of the resource at hand.

Therefore, its composition of various vascular plants including agrobiodiversity played a fundamental role in sustaining and strengthening food, nutrition, health, domestic energy needs and livelihood security, as well as environment. Because of these values, the plants in the HG were maintained and hence, HG is considered as a conservation site for rare and threatened species.

Vascular plant species conservation and management in the HGs of the study area

Sociodemographic and labor division effect on management of vascular plants in the HGs of the study area

The statistics of socio-economic information indicated that most of the HG owners did not attend formal education; middle aged males married bearing more than 4 family members and stayed in the area by managing more than 2ha farm field for more than 10 years. This information indicates that the factors were conducive for households to apply HG management culture of the study area, to have more diversified vascular plant species and to pass the trend easily to the next generation. Similar was reported to Shewarobit District in Northeast Ethiopia [71]. Marriage, family size, age and year of stay in the area has positive correlation with the diversity of vascular plants of the study area. This is because, as the year of stay and age increases the marriage will happen and family size will increase; consequently to sustain family members and to fit with culture one has to collect a number of vascular plants with multipurpose either by growing and/or allowing the appearance which has

contribution in diversity. In addition to this, the conditions make it an easy way of labor management to reduce the expense in the HGs management.

Based on sex and age, there is labor division in managing HGs. Males above 18 years were responsible to plant large-sized agroforestry plants including enset, coffee, mango, avocado, eucalyptus, bamboo tree and shade trees cordia, cupressus, ficus and others. Females and children were responsible to plant and manage small-sized vascular plants like spices, condiments, medicinal plants, vegetables and ornament ones. The same was reported in the Assosa area of Ethiopia [72] and in Bule Hora District, West Guji Zone, Southern Ethiopia [6]. Therefore, the well-managed HGs have contributed to the diversity of vascular plants apart from fulfilling the needs of the family. The same was reported in Nepal [21].

In plane area (flat surface), it is simply managed as needed and in order of height to protect wind and canopy stress as well as to protect their products from predatory birds and small mammals. Out crop plants like bean and tef were recorded in the HG because of dropping while preparing for either market (selling) or storing or, consuming at home and there was household waste. Most of the time, in educated household, plants on all sides of the home (in the HG) was manured in any way. In illiterate cases, plants that do not need more water were planted in the upper side of the home but the others in the lower part and hind part/side of the house.

Cultural effect on management of vascular plants in the HGs of the study area

The indigenous practice becomes a trend when its knowledge and skill is shared by others. The frequent application of trends for many years yields culture and the culture finally produces many social factors among the practitioners [56]. The strategy of diversification of vascular plants in the HGs has already been set in the culture (through taboos and some speeches) by coining life standard, dining table, marriage, labor division (family contribution) for the sake of daily family needs: nutrition, health, economy, and others. In Dawuro, HG is culturally considered as a symbol of social status. Households with no diversified agrobiodiversity in his/her HG, small HG or do not own it, otherwise bringing single or only two food item/s to the feeding table is considered as a lower social rank. Similar results were reported to Bule Hora [6], Holeta [14], Yayu (southwest) in Ethiopia [75], in European HGs [55] and sociocultural variables study elsewhere [77]. This is because beside culture, people develop a strong preference for managed plants for food, medicine and other benefits.

In Dawuro, the culture encourages people to have plants with multiple uses by planting intentionally, allowing the appearance of wild plants with multipurpose, domesticating the known wild edible and medicinal types of plants. The same was reported to Hawassa city in Ethiopia [16] and Kenya [74]. Appearance of wild edible plants in the HGs is encouraged in the study area for immediate access like for medicinal, food, shade and others. The same was reported to Gozamin District of east Gojjam in Northwest Ethiopia [44]. This might be because of 1. The owner's interest, intentionally planted to get their multipurpose service. 2. HG owners might leave them for their multipurpose behavior while degrading others 3. HG owners might allow the appearance, 4. The household might be newly settled or encroached in the area nearby the natural forest 5. Dispersal of seeds from natural forests by self mechanism or by others like wind, rain water, or by birds, small mammals, domestic animals and children brought for eating or through fecal. HGs' agrobiodiversity attracts a number of pollinator insects, bird species, and some small animal species like snake, frog, rats, and squirrel to collect their food and take shelter. Similar was reported elsewhere and Bangladesh, respectively [58; 60]. The HGs near the natural forest were documented with a large number of wild edible plants and can be taken as an opportunity to increase the diversity of HGs. However, dominating HG with weeds and wild species rather than intentionally managed types is strictly taboo. He/she has to ask (labor, seedlings, material, and other things) others/elders to help him/her to manage (avoid the dominated weed and planting multipurpose plants) in his/her HG otherwise having bare home is taboo and considered as thief (kayisuwa) or HG of migrated man (gangguwa/betiya). Because, they understand that multipurpose vascular plants in the HGs secure food, health and income, and make a conducive and attractive environment.

People of Dawuro know that the well-managed HG with diversified multi-purpose edible plants serve for both food security and as a source of micronutrients for the health of family members. The same was reported to rural households in Sri Lanka [18; 66]. They ask for multipurpose agrobiodiversity managed HG as criteria in case of marriage process; thinking that diversified HG is with secured life, prolonged life supplement.

Since it gives a viable solution for biodiversity conservation, the cultural practice and knowledge tied with management and utilization should be encouraged. In other words, ignoring the usable culture and indigenous knowledge of the community and managing a large number of invasive exotic species in homegardens might have long lasting negative effects [54].

Threats to vascular plants management in the HGs of the study area

Effect of the attitude of young generation on management of HGs in the study area The negative effect of the attitude of the new generation for continuation of traditional practice on managing HG may be 1. The new generation focuses on academics not interested in participating in agricultural activities including HGs 2. They search for other job opportunities 3. The generation follows the new lifestyle due to urbanization and imposed from abroad due to globalization. The good value of conservation and management practice and associated knowledge of vascular plants in the HGs derived from culture falls into threat. It needs the national wide intervention of incorporating into curriculum, awareness creation of all households and the young generation and continuous supporting and supervision of implementation by agricultural development agents for ensuring food security and other needs and healthy life of people.

Perception on the Effect of invasive exotic species on vascular plants of HGs in the study area

HG vascular plant diversity is currently threatened by the growth of invasive exotic species, population growth, monoculturing expansion for food security, market and agricultural led industrialization, and urbanization. The same was reported to Hawassa in Ethiopia [16]. People in the study area manage landraces in the HG for different purposes both vertically and horizontally thinking that they defend against pests, diseases and environmental changes indirectly apart from direct uses. This study result is similar to the report elsewhere [76]. Though the introduction of exotic species for different purposes increases the richness in the homegardens, it has the potential to be invasive or inhibit the others' growth under or nearby. Similar report of the study in the Assosa area of Ethiopia [72] supports this. Most of the inspected HGs were with some invasive exotic vascular plant species either in the homegardens or surrounding as live fence and wind break. Similar result was reported to Bule Hora District of West Guji Zone in southern Ethiopia [6]. The reasons might be 1. Their nature of multipurpose, especially timber production; similar to the present study, these species are also listed with 29 species as potential in timber production [17] 2. Due to lack of awareness, if the homegardens, live fences and farm fields were invaded by those species, the people tend to leave growing crops including staple ones like enset, wheat and maize, medicinal plants and other indigenous multipurpose plants. The consequences bring health problems, food insecurity and environmental change in near future unless intervention is taken in how to manage exotic invasive species. Those with their allelopathy chemicals had a negative effect on other plants' growth as well as on their productivity that grew under or nearby to them. Most of the respondents have awareness of or argue that some of invasive exotic species *E. camaldulensis*, *E. globules, C. lusitanica, G. robusta* and *A. indica* tree growth in the HGs diminishes the land size of the productive part of HG, management of plants with multiple uses, and the product of enset and other plants (reduction of crop yields) in the HGs. Similar was reported to Sebeta-Awas [43], Hawassa [16]. Amhara region [59], and Assosa area [72] in Ethiopia and in Kenya [74; 83]. Consequently, this aggravates food insecurity and ecological shift in the area by putting enset and other crops growth, production and productivity under question. There was lesson from many of the forestry activities in eucalypt forests in eastern Australia which were not ecologically sustainable and many components of the forest biodiversity are threatened, including various biological and ecological processes, many vertebrate and invertebrate fauna, and ecosystem diversity [67].

In present study, the negative effect of the above exotic invasive species on ecology of the area was claimed. Because those species naturally have frond leaves encouraging the lowland agroecology, adapt water stress and have the ability to grow in all agroecologies; hence, they became means for ecological change. Consequently climate change is expected due to their use of large amounts of moisture resources. There is indication that the lowland crops like teff and maize were recorded in highland homegardens of the study area. Apart from this there are farmers' claims on unproductivity of crops under or around those exotic invasive species, and on loss of some indigenous environmentally friendly species from the area. Furthermore, the live pharmacy, homestead that serves as a source of traditional medicine is losing its structure, diversity and system where the indigenous people of Dawuro practice their children on their culture, knowledge and skill [50].

The effect of distance of urbanization and settlement on management of vascular plant diversity in the HGs

Urbanization and settlement infrastructure is thought to be done at distant places from natural forest. There is an effect of natural forest on diversity of vascular plants which was contributed to the high diversity in the study area. The diversity of vascular plants decreases as we go far away from natural forest, as we approach urban areas. Therefore, the distance from urban areas has positive association with the diversity of vascular plants in the HGs of the study area (Fig. 4). The same was reported to Shan communities in Thailand [76], to the Nuba Mountains of Sudan [81], and to the Eastern Himalayan region of Mizoram, Northeast India [57]. This is because 1. The

size of HG is diminished because of activities to sustain the blooming population in the process of settlement or urbanization 2. The fertility of soil which is important for plant growth becomes diminished due to the absence of natural forest nearby the urban area 3. Market oriented and those plants not found in the market, and spices and ornamental plants need small surface area were grown in the HG.

In another faucet, traditional knowledge (information on the type of plant, its uses and role) and local culture have developed in association with local resources over time [82]. The more the people living near urban areas, the more threat to his/her traditional practice and the associated knowledge will occur. The practice, management associated with community knowledge, culture and lifestyle tied with HG management diminish or will be lost with. This is because; the generation is more eager and aggravates the new lifestyle, not the traditional practice derived from culture. In addition to this, the growth of ornamental and the multi-use exotic plant species in the HGs was encouraged to show urban and the changed life style, modernity. They, elders' claim that the negative effect of urbanization and resettlements for the continuation of their traditional practice of managing HG and others is considered as remote activity and enforces the knowledgeable persons to leave their traditional diversifying practice and managing knowledge. This study result agrees with the report to western Kenya [79] and Jimma in Ethiopia [78]. This is because; the lifestyle changes the pattern, composition and management system of HG.

Conclusion

HG in the study area is practiced for millennia by applying planned complex spatial and temporal structure for the sustainability of people's livelihoods. By periodically boosting their richness and abundance in the research area, the cultural practices made the HGs reservoirs and more diversity in vascular species. In the studied area, HG is a significant enset and agrobiodiversity-based agricultural system that sustainably produces food, medicine, and other products. Enset, avocado, mango and coffee are the top important vascular plants in the study area. In order to address the present problems pertaining to food, health, the environment, and the economy, encouraging HG systems is crucial. The culture of diversification of HG plants and food source diversification on the dining table needs encouragement and scaling up to other areas, and especially to area where HGs were yet not practiced and attention was not given. However, awareness raising efforts to fill the knowledge gap among the new generation managing HGs and general attitude even to the extent of incorporating into the school curricula is needed. The scientific plantation design on the growth and management of invasive exotic plant species in the HGs must be taken; the monoculture in the HGs is too; failure to do so would result in nutritional issues, food insecurity, and other ecological and health issues. In addition, since enset plantations are the foundation of farmers' and HGs' livelihoods, scientific assistance in the advancement and expansion of indigenous knowledge and practices, as well as in preventing diseases and other management and utilization barriers, should be prioritized. Focus should be placed on management strategy, ongoing support, and follow-up for home gardens and live fences in order to sustain the biodiversity present, traditional home garden management, and related community knowledge and skills, as well as ecology.

Definitions of terms

Vascular plants are plants that use specialized tissue for transporting water and food to different areas in the plant, be able to stand and grow tall to trees, shrub, flowers, grasses, and vines.

Homegarden is a fixed plot of land comprising multipurpose plants harvestable at different times to meet diverse people's requirements, garden/yard around home.

Abbreviations

HGs	Homegardens
VPs	Vascular plants
TMPs	Traditional medicinal plants
H'	α-Diversity
NFs	Natural forests

Supplementary Information

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Additional file 1.

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Author contributions
Mathewos Agize conceived and designed the study; collected and identified specimens; fed data, analyzed and interpreted the information; wrote the draft and final manuscript. Zemede Asfaw helped to frame and improve the design of the study, supervised the research work and finally reviewed and edited the draft and final manuscript and was a major contributor in writing the manuscript, Sileshi Nemomissa helped to frame and design the study, supervised the research work, helped in identification of specimens and finally reviewed the draft manuscript, and Tizazu Gebre helped to frame and improve the design of the study, supervised the research work closely, helped to draft manuscript and finally reviewed the manuscript. All authors read and approved submission of the final revised version of the manuscript to the selected journal.

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Availability of data and materials
No datasets were generated or analyzed during the current study.

Declarations

Ethics approval and consent to participate
The researcher explained the aim and nature of the study to the participants to create informed decisions on whether or not to participate in the study. Anonymity was always ensured not to put research participants in a situation to make them free from any danger or harmful position as a result of their participation in the project. Any communication with the concerned bodies was accomplished after voluntary agreement without harming and threatening the private or institutional wellbeing. This was confirmed by taking supportive letters from Arba Minch University to the study area, Dawuro Zone administration; then, from Dawuro Zone administration to the target districts, then finally, from each district to kebeles. Each kebele then assigned a field guide to join the data gathering activities. All references obtained from different sources were cited properly and therefore the respondents' information kept confidential. Additionally, participant agreement was obtained to be allowed to publish the information collected during the course of this research.

Consent for publication
"Not applicable". There is no third party data. It is our original research data, all concerned individual authors have agreed to the publication of the outcome of this study as stated above under ethical consideration and authors' contribution.

Competing interests
The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as potential conflicts of interest. "The authors declare that they have no competing interests".

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