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RESEARCH ARTICLE

MANAGEMENT OF PLANT BIODIVERSITY IN THE HOMEGARDEN AGROFORESTRY PRACTICES IN DEMBA GOFA DISTRICT OF SOUTH ETHIOPIA

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ABSTRACT

This study was premeditated to provide data on plant biodiversity, uses and management in homegarden agroforestry practices. Interview with owners, discussions with local people and site visits were applied to collect primary data. Secondary data were collected form online and documented sources. Species biodiversity data were calculated using Shannon- Wiener Index and vegetation data were analyzed using R-software of version R3.0.1 program. The result indicated that 106 plant species were collected from all sites. Out of the collected plant species, edible and medicinal plants accounted 76.7% and 58.0% respectively. *Cordia africana, Mangifera indicum*, *Persea americana* and *Moringa olefiera* had high species number and relative frequency. Some of these species were used as construction material while others used as source of income. Farmers have indigenous knowledge on management of plant biodiversity where farm size, water availability and socioeconomic differences hinder the plant biodiversity in homegarden agroforestry practices. It can be concluded that farm size, extension program, local knowledge in use and source of planting materials were must be considered to promote homegarden agroforestry technologies.

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INTRODUCTION

Homegarden agroforestry practices are land use practices involving deliberate management of multipurpose trees/shrubs in intimate association with perennial or annual agricultural plants and animals within the compounds of individual houses, the whole crop-tree- animal unit are intensively managed by family labor (Kunhamu, 2013; Ewuketu *et al*., 2014; Abay *et al*., 2019). Homegarden agroforestry practices are either subsistence or commercial production systems around houses that forms the principal means of livelihood for farming households (Gebrehiwot, 2013). In addition, homegarden agroforestry practices are receiving increasing attention owing to their perceived potential to mitigate environmental problems as well as conserving plants (both cultivated and semi- or non-cultivated) (Tefera *et al.*, 2019). An important feature of homegarden agroforestry practices is that they have multilayered structure. These multistoried structures have different functions where as practiced in many parts of the South and Southeast Ethiopia, which are characterized by both cereal-crops and perennial-crop based farming systems (Tesfaye, 2005). The management of plant biodiversity in homegarden agroforestry practices differs across sites depending on the ecological setting and socio-economic functions within different household economies (Reta, 2016; Tefera *et al*. 2019). However, a detailed data on plant biodiversity, management and uses of plants in the homegarden agroforestry practices is still missing in the study area. There is a wide knowledge gap about ethnobotanical data and information within different social settings. Furthermore, identification and documentation of plant biodiversity and useful plants have not yet been studied in the study area. Therefore, this study was designed to provide the basic data that enhance the management of plant biodiversity in the homegarden agroforestry practices with a particular emphasis on organizational structure, use diversity, management practices and determinant factors on plant biodiversity.

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MATERIALS AND METHODS

Description of the Study area: The study was conducted in Demba Gofa District, Gofa Zone of South Ethiopia.

Demba Gofa is situated with geographic positions of 8° 11' 21" to 8° 71' 84" N latitude and 42° 19' 35" to 43° 89' 86" E longitude also with elevation range of 1350 to 2600 m. a. s. l. The center of Demba Gofa, Sawla, is located at a distance of 284 km from Hawassa and 516 km from Addis Ababa (Figure 1). The land area coverage is 102,807 ha with 34 PAs. Currently, Demba Gofa has a total populations of 106,433 (F = 54,772) with total household of 23,972. The agroecology of the District is classified as highland (7.8%), midland (15.8%) and lowland (76.4%). The mean daily minimum and maximum temperature is 17.4 and 28.4°C while the mean annual temperature is 23°C and rainfall is 1300 mm. The rainfall is dispersed throughout the year in to two rainy seasons called *belg (*March-May) and *meher (*July-November) with small showers in February. April and October has the maximum rainfall (BoFED, 2019). Mixed farming is the principal source of livelihood economy in which teff, *(Eragrostis tef*), maize *(Zea mays)* and sweet potato ***(****Ipomoea batatas)* are the major animals reared.

Research Methods: Purposive sampling methods were used to select Peasant Associations (PAs). Households were selected based on similar presence of homegarden agroforestry practices in the study sites. Consequently, *Docha Dambala, Lote Gaila Chalbie, Zenga Awandie, Borda, Seziga* and *Uba Pizigo* PAs were selected. Totally, ninety (90) households were sampled (i.e. 15 from each site).

Data Collection Methods: Data collection methods were followed two procedures. First procedure was taking each home garden agro forestry practices as a sampling unit where every plant species was inventoried and the number of each species was counted. Local names of each plant species, uses and growth habits were also recorded. Likewise, the botanical names were identified by using tree identification manual and agro forestry data base. Secondly, the ethno botanical information was collected by guided garden tour and through structured questionnaire interviews on plant names, uses, management practices and growth habits were conducted with owners and informal discussions with indigenous local peoples.

Data Analysis: The analytical methods used include preference and direct matrix rankings, paired comparisons where as species biodiversity analysis includes Shannon-Wiener Index (H'). Species richness and evenness were calculated (E =H'/H'max) for the most useful plant species (Shannon, and Wiener, 1949). The vegetation data was analyzed using R-software of version R3.0.1 and Ms-Excel 2010. The plant species were analyzed using the formula:-

$$\text{Frequency} = \frac{\text{Number of homegarden in which a species occurs}}{\text{Total number of sampled homegarden}}$$

$$\text{Relative Frequency} = \frac{\text{Frequency of individual species in the homegarden}}{\text{Total Frequency of all species in the sampled homegarden}} \times 100$$

$$\text{Density} = \frac{\text{Number of individual tree species in the sample}}{\text{Total area of the sample (m}^2\text{)}}$$

Evenness index = $\frac{H}{LogS}$, where H= Shannon Wiener biodiversity index; S = Total number of species

RESULT AND DISCUSSION

Organizational Structure of Homegardens: The present survey indicated that 95% of households have long experience with homegarden agroforestry practices (Photo 1). The compositions of homegarden agroforestry practices have complex vertical and horizontal structures with collection of multi-purpose trees, shrubs, annual and perennial crops. All respondents agreed that the biodiversity and compositions of homegarden agroforestry practices are under the management of household members. There are three patterns of arrangement of plants in homegardens, namely, close to house (61%), in mid-gardens (27%) and at margin (12%) of the farms. With regard to land allocation, the farm size allocated was ranged from 0.025ha to 2.5ha. Different studies in different sites revealed that the shape, size and composition of homegarden agroforestry practices are variable (Zemede, 2002; Talemos Seta, 2007). This varied shape and size of homegarden is due to land size and allocation of land to homegarden agroforestry practices. As to Okgibo (1990) and Tesfaye (2005), homegardens are multilayered where as decline in composition and biodiversity becomes compatible at edge. Similarly, the spatial arrangement of plants in the garden indicated that open and planted where ornamental plants, spices, vegetables, fruits and shade trees are placed on different spaces.

Plant Biodiversity: There are a total of 106 plant species were recorded from all samples where they belongs to 67 genera and 44 families. Accordingly, the ranks of each species are categorized as Fabaceae 7 (8.4%), Poaceae 6 (7.4%), Euphorbiaceae 5 (6.4%), Solanaceae 4 (5.7%), Rosaceae 4 (5.5%), Asteraceae 3 (4.6%) and Rutaceae 3 (3.7%). Moreover, the recorded plant species showed different relative frequencies ranging from 81.45% to 8%. With regard to contribution of each species, edible plants shared 43, medicinal plants 21 and fodder plants 15 species. The total number of *Cordia africana, Mangifera indcum, Persea americana, Moringa olefiera, Eucalyptus species were* 338, 310, 175,144, and 105 with relative frequency values of 0.00075, 0.00073, 0.00036, 0.00025 and 0.00023 respectively (Figure 2) below.

On the other hand, the Shannon Wiener diversity index showed the diversity indices of homegarden vegetations in *Borda, Seziga* and *Gaila Chalbie* were greater than 2.744 while *Borda* and *Seziga* PAs have the highest Shannon Wiener biodiversity index values (H'=3.166 and 3.125 respectively) but *Uba Pizigo* has the least value (H'= 2.015). Furthermore, the similar diversity indices calculated for *Borda* were 3.14, *Seziga* was 3.10, and *Uba Pizigo* was 3.04. The highest similarity index (0.9335) was observed in *Borda* and *Seziga* where the weakest were at *Uba Pizigo* and *Docha Dambala* (0.23). In line with present findings, studies carried out by Solomon (2011) at Gedeo indicated that less than 26 species where Mekonon (2014) at Holeta town reported 47 species.

Use Diversity of Plant Species in Homegardens: The tree species identified in all homegardens were used for a wide range of local and national purposes. The result of selected 18 key local peoples' direct matrix ranked with score of *Mangifera indicum (200), Moringa stenopetala (181), Eucalptus species (180)* and *Cordia africana (177).*

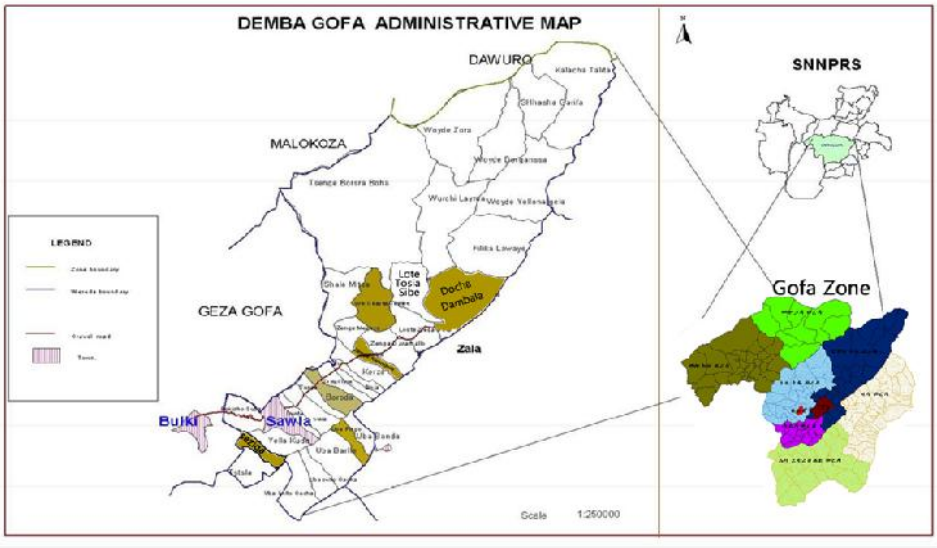

Figure 1. Map showing the location of Demba Goffa District and the research sites (BoFED, 2019)

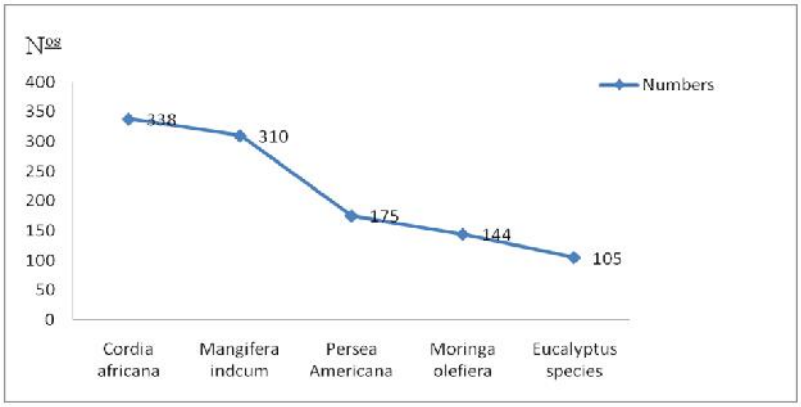

Figure 2. Some of Tree Species with high number of Plant diversity

Photo 1. Different features and organizational structures of homegardens in the study PAs

The major uses of *Eucalyptus species* and *Cordia africana* were source of construction materials where as *Mangifera indicum and Moringa stenopetala were* income generation. Besides, cultivated food crops were the major components of homegarden agroforestry. Among other plant species, 43 plant species were used as food plants (fruits, vegetable, spices, root crops and tubers) while 21 plant species have medicinal values.

The composition of species varies with climate, edaphic and socioeconomic factors. The biodiversity maintained is a type of *insitu* conservation of plant genetic resources (Das and Das, 2005).

Management Practices: In the study sites, different plant management practices were exercised by farmers which help them to grow high biodiversity of plant species.

Out of total tree species identified in the present study, the maximum number of plant species per homegarden is 33 while the minimum is 4. The farm owners have accumulated indigenous knowledge on management of plants, for example, the fertility of the soils was maintained by using house refuses (43%), manures (36%) and crop residues (15%). On the other hand, they focused on income generating (fruits and vegetables), construction and shade provisioning plant species.

In the same way, farmers in the study sites also gave high attention in selection and expansion of fast growing, easy access to planting materials and highly demandable species. These highly demandable species selection and expansion leads to change in homegarden composition and biodiversity. Similar studies conducted by Tesfaye (2005) from Sidama homegardens and Belachew, W., *et al*. (2003) reported that farmers' indigenous plant management practices helped them to maintain plant biodiversity.

Factors that Affect Plant Diversity: Although farmers plant trees, maintain biodiversity and manage them for a wide range of uses, there is a decline in plant biodiversity. As to respondents, farm size (22%), water availability (18%), agricultural support system (17%), management system (15%), socio-economic condition (12%), biological determinants (9%) and lack of awareness (5%) are the main hindering factors encountered in managing plant biodiversity in homegarden agroforestry practices.

Among many studies carried out, the results of FAO (2015) and Rahman et al. (2017) and Tefera J., *et al*. (2019) revealed that differences in climate, edaphic and socioeconomic factors brought change in composition and biological diversity of plants.

Conclusions and Recommendations

Conclusion

The results of the present study confirmed that management of plant biodiversity in homegardens revealed that homegardens are rich in plant biodiversity. However, this biodiversity is inconsistent among study sites due to climate, soil, input supply and socioeconomic factor. Differences in management of plants in homegarden also brought irregularity in plant biodiversity.

Recommendations

To ensure sustainable compositions of plant biodiversity, promoting indigenous multipurpose plant species, creating awareness about wise use of species, management skills, and linking with current extension programs are important. The government, non-government and private sectors should promote plant biodiversity management in homegardens in the form of modern agroforestry technologies.

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