ADDIS ABABA UNIVERSITY

COLLEGE OF NATURAL AND COMPUTITIONAL SCIENCES

DEPARTMENT OF ZOOLOGICAL SCIENCES

Ethnobotanical study of homegarden plants in Bibugn district, East Gojjam Zone Amhara region, Ethiopia.

A Thesis submitted to Department of zoological sciences in partial fulfillment of requirement for the degree of Master of Science in Biology.

By

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Advisor

Ermias Lulekal (Assocate Proffessor)

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This is to certify that the thesis prepared by Haymanot Ayalew, entitled: "Ethnobotanical study of homegarden plants in Bibugn district, East Gojjam Zone Amhara region, Ethiopia" and submitted in partial fulfillment of the requirements for the degree of Master of Science in Biology Program under Department of Zoological Sciences complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Ethnobotanical study of homegarden plants in Bibugn district, East Gojjam Zone Amhara region, Ethiopia.

By

Haymanot Ayalew Tarekegn, (Msc thesis).

June, 2024

Abstract

An ethnobotanical study was carried out in Bibugn district, East Gojjam Zone of Amhara region in Ethiopia, with the goal of conducting an ethnobotanical investigation on homegarden plant diversity, and their use value for local communities in relation to management practices. A stratified random sampling technique was employed to select seven Kebeles, and 366 households were selected proportionally by the Cochran formula. To collect homegarden plant data, 10 m x 10 m plots were laid in 42 representatives randomly selected homegardens and each homegarden's species and its total individuals were recorded. Ethnobotanical information was gathered by conducting homegarden observation, market survey, group discussions, and semi-structured interviews. In the data analysis, Microsoft Excel 2019 was used to compute frequency, density, simple preferences ranking, and direct matrix ranking. Furthermore, the Shannon-Weiner diversity index and Sorenson's index of similarity were computed to compute the diversity and similarity of homegarden plant species. The result indicated that 325 (88.79%) of the households were practicing home gardening activities. A total of 110 plant species were identified and documented, and distributed into 98 genera and 48 families. In terms of growth habits, the homegarden plants in the study area, 41 (37%) were herbs, 39 (36%) were shrubs, 23 (21%) were trees and 7 (6%) were climbers. Rhamnus prinoides had the highest frequency (92.86%), followed by Solanum tuberosum (80.95%) in the study area. Eucalyptus globulus had the highest density of the 110 plant species identified in the study area, followed by Rhamnus prinoides, and Solanum tuberosum. Diversity indices, with the highest value of (H'= 3.64) for Woina Dega, followed by Kolla. In the study area, there were approximately 14 major use reports of plants. 56 (18%) of the plants that occurred in the homegardens with multiple uses took the top position followed by 43 (14%) live fence plants and 41(13%) firewood plants among others. Therefore, it can be concluded that homegardens in the study area contain diverse types of plants and a lot of supply to the livelihood of the people.

Keywords: Bibugn districts, Ethnobotany, Homegarden, Species diversity, Use values.

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Lists of abbreviations

ASL	Above sea level
BDEPLAU	Bibugn district environment protection, land, administration and use office
BDFEO	Bibugn district finance and economy office
BDOA	Bibugn district office of Agriculture
CSA	Central statistic agency
FAO	Food and organization association
GPS	Global positioning system
GDP	Gross domestic products
HG	Homegarden
HH	Households
KM	Kilo meter
WHO	World health organization

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1. INTRODUCTION

1.1. Background of the study

The interaction between plants, people, and their way of life is the focus of ethnobotany, a relatively new scientific field that is a branch of ethnobiology and ethnosciences. Plants are essential to practically all life on earth and are of great value. They serve a wide range of purposes for humans, including ritual and religious purposes as well as medicine, food, shelter, clothing, and utensils (Solomon Tamrat, 2011). In addition to safeguarding areas of water catchments, they also recycle crucial nutrients for ecosystems, establishing soils, and preserving soil fertility. Additionally, through the process of evaporative transpiration, they enable and manage rainfall and maintain the ecological and climatic balance (Solomon Tamrat, 2011).

Homegardens are frequently defined as a piece of land with a definite boundary surrounding a homestead, being cultivated with a diverse mixture of perennial and annual plant species, arranged in a multilayered vertical structure, often in combination with raising livestock, and managed mainly by household members for subsistence production (Melese Mengitu and Daniel Fitamo, 2015). They are one of the most complicate and diverse agro-ecosystems worldwide and played an important role towards the development of early agriculture and domestication of crops and fruit trees, a still ongoing process (Mulugeta Kebebew, 2018). Millions of people in many developing countries do not have enough food to meet their daily requirements and a furthermore people are deficient in one or more micronutrients (FAO, 2004). Homegardens are generally multifunctional and play important roles in providing ecosystem services and numerous benefits for local residents' livelihoods (Galluzzi *et al*., 2010) as potential hotspots of agricultural biodiversity (Kumar and Nair, 2004:Galluzzi *et al*., 2010). In addition, Homegardens are important in the conservation of useful plant species since they contain very large numbers of species which are often absent or disappearing from

other production systems. Homegardens also provides a wide range of ecological benefits and services and a valuable set of products for the rural poor. The homegarden is closely related to the life of the owner (Galluzzi *et al*., 2010). Homegardens function as an important food source that supplies tubers, fruits, and vegetables for households (Galhena *et al*., 2013) and indicates the social status and economic level of a family. Moreover, homegardens with high plant diversity act as in situ conservation sites especially for local species. In the tropics, homegardens have high plant diversity but the threats to the preservation of plant diversity are quite alarming such as the need for land expansion due to population growth and transformation of plant composition due to changes in owner lifestyle (Wakhidah *et al*., 2020). Homegardens provide people with supplementary food, fuel and fodder. They are utilized in the cultivation of medicinal, spice, ornamental, and stimulant plants. Home gardens are common in Asia, Africa, and Central and South America's tropical and subtropical regions (Tefera Mekonen *et al*., 2015). The uses of homegardens vary, as some are used for subsistence agriculture and others for commercial production of food crops. Gardeners in rural areas typically grow fruits, vegetables, medicinal, spiritual, and ornamental plants. Worldwide, homegardens are a community's most adaptable and accessible land resources and important components in reducing vulnerability and ensuring food security. Year-round food production, reduced risks of production failure due to high species diversity, increased resource productivity over time, expansion of the amount and quality of labor applied in the farm, output flexibility, and alternative production are all characteristics of homegardens. Therefore, a homegarden can serve as an important source of both food and cash income for vulnerable households. Tropical homegardens may also harbour threatened plant species and serve as areas for experimentation and observation of recently acquired species (Maroyi, 2013). However, inventory and documentation of homegarden plant species and their ethnobotanical values in Ethiopia are few even though

there are some in southern and southwestern part of the country (Zemede Asfaw, 2004). Similar to other parts of the country, there is no sufficient scientific information or research previously conducts with regard to ethnobotanical study of homegardens in Bibugn district. Thus, the study was conducted with the aim of identifying the ethnobotanical study of homegarden plant diversity and their uses as well as to document indigenous knowledge for management of the homegarden plants in Bibugn District, East Gojjam Amhara region in Ethiopia.

1.2. Statement of the Problem

Eighty percent of the population of Ethiopia depends on agriculture for a living, and this sector accounts for between 42 and 45 percent of the nation's overall GDP. But recently, a variety of issues have put the production of agricultural goods in danger. Among them include soil erosion, soil fertility loss, severe soil moisture stress, organic matter and climate change. Malnutrition, financial instability, and loss of biodiversity are the overall effects of the aforementioned issues. These are the main issues causing human suffering that call for solutions. The use of Homegarden agroforestry, which may support more species than monoculture, is one way to solve the aforementioned issues (Girema Woldemichael *et al*., 2018).

Ethiopia has a diverse agroecology with many ethnic groups practicing different homegarden management cultures. Many plant species were conserved and used in the different cultures' across diverse homegardens in the country. However, as human population and land degradation has increased, the size and number of homegardens, as well as the species that grow in them, have decreased over time. Studies showed that problems such as genetic erosion, loss of indigenous knowledge of cropping patterns and management practices, human induced habit changes (change in land use), and drought had threatened homegardens and the agrobiodiversity in them (Dawit Daba and Gemedo Dalle, 2020). It is threatened by agricultural expansion, deforestation, and development activities, including rapid urban expansion. Urbanization is one of the most significant current issues in the vast reduction of plant diversity (Reta Regassa, 2016).

There is a lack of documentation on homegarden plant species diversity and conservation activities observed in Bibugn District, which is similar to most areas in Ethiopia. It is known that, the district has relatively better plant resources; the associated use value is expected to

be significant. The recent trend in plant use shows that the environment is facing problems of resource depletion and loss of indigenous knowledge like other areas of the country. As a result, concerned ethnobotanical research plays an important role in determining information on homegarden plants and their related use value, documentation and conservation homegardens plants. Now a day, some studies were done on some localities of Ethiopia. Nevertheless, no study was done to include an ethnobotanical study of homegarden plants diversity and their use value of the local communities of Bibugn District in the homegarden records and also to document important of indigenous knowledge for useful plants conservation and management practices in the district. As a result, the research focuses on the ethnobotanical study of homegarden plants species diversity and utility in Bibugn District.

1.3. Research questions

1. What are the ethnobotanical species diversity of homegardens in Bibugn district?
2. Which useful plant species are available at the homegardens of the Bibugn District?
3. What are the diversities and use values of homegarden plants in Bibugn district?
4. What are the factors influencing the species diversity of homegarden plants in the district?
5. How do the local communities conserve and manage the homegarden plants?

1.4. Objectives of the study

1.4.1. General Objective

- The general objective of this study was to conduct ethnobotanical investigation on the homegarden plant species of the Bibugn District.

1.4.2. Specific Objectives

The specific objectives of the study were:

- To determine the homegarden plant species diversity in Bibugn district.
- To assess diversity and the ethnobotanical use values of homegarden plants in study area.
- To identify factors that affecting the homegarden plants diversity in the study area.
- To determine homegarden plant conservation and management practices of the local people.
- To document the different uses of homegarden plants in the study area.

2. LITRATURE REIVEW

2.1. Definitions of Homegardens

Homegardens are species-rich agroforestry systems containing many cultivated and wild plants (Kumar and Nair, 2004). They have a distinctive vertical structure that plays a significant role in their capacity for production (Whitney *et al*., 2018). One of the most intricate and varied agro-ecosystems on the planet is the homegarden. Homegarden systems have been around for millennia in many tropical regions, where they were crucial in the early establishment of agriculture and the continuous domestication of crops and fruit trees (Kehlenbeck, 2007). Homegarden is locally known as yeguaro-ersha, Yeguaro Masa, and Yeatikilt Bota (in Amharic language), eddo, Hoddo, Boro, Mandubee in Afan Oromo (in Oromo language) (Biruk Kefale, 2020) and “Gattae” in Gedeo language (Melese Mengitu and Daniel Fitamo, 2015). Homegardens are often systems that are primarily man-made and that represent the ecological and cultural wisdom that have developed over time (Kumar & Nair, 2004). According to Galhena *et al*., (2013) Homegarden agroforestry is concerned with the cultivation of multipurpose and multi-storied trees and crops in conjunction with animal husbandry in the vicinity of a homestead. The term "homegarden" refers to an agroforestry approach that integrates physical, social, and economic activities on the property surrounding the home. Due to its connection to the production of food and other goods including firewood, fodder, medicinal plants, cash crops, and ornamentals, the maximum diversity of plant species found in homegardens plays a crucial socioeconomic and ecological significance (Arayaselassie Abebe, 2018). Homegardens are favorable for in situ conservation of plant genetic resources due to the high and sustained diversity of both cultivated and wild plant species (Kehlenbeck, 2007).

2.2. Characteristics of homegardens

Michell and Hanstad (2004) list the following five fundamental (necessary) qualities of a homegardens: they: 1) are close to the home 2) have a wide variety of vegetation 3) Production serves as a supplement to the family's primary sources of income and consumption 4) high rich in species diversity and 5) occupy a small space. A large body of research has been done and case studies have been done on the use of homegardens for food production, agroforestry, or a combination of the two (Gehlena *et al*., 2013). The year-round food production, lower production failure risks due to the high species diversity, growth of the number and quality of labor used in the farm, increased resource productivity through time, availability of output flexibility, and alternative production (Maroyi, 2013). The most noticeable features of almost all homegardens include a layered canopy, a harmonic mixing of species, and a specific location and function, but the main variations are found in the size, form, and intensity of cultivation, types of crops planted, and complexity of species diversity (Biruk Kefale, 2020). In general, there are three primary layers in every homegarden: a layer of herbaceous plants close to the ground, a layer of trees higher above, and a layer of intermediate plants in the middle. In most cases, the lowest layer can be divided into two sections, with the lowermost (less than 1 m height) being dominated by various vegetable and the second layer (1–3 m height) being composed of food plants such as cassava, banana, yam, and so on (Biruk Kefale, 2020).

2.3. Types of Homegardens

Ethiopian homegardens can be broadly divided into two groups (Tesfaye Abebe, 2005). Small-sized gardens fall under the first categories of homegardens, where fruits, vegetables, spices, and oil seeds are grown in addition to cereals and pulses that are grown in nearby fields. This kind of gardens is typical of the farming regions of the nation that rely on grain

crops, and it is also seen in urban areas. The other type of homegardens are those found in the south and southwest of the nation, and they are distinguished by a varied assortment of crop plants with ensete (*Ensete ventricosum*) serving as the main structure. When gardens are properly adapted, advocates of gardening point to studies showing that it can be a sustainable method for increasing earnings and food security (Reta Regassa, 2016).

Homegardens are ecological divided into two categories: tropical and temperate. Much of the literature focuses on homegarden on the tropical areas in central and South America. There is also substantial interest for homegardens in south and south East Asia and Africa. In contrast, there are only a few documented studies of homegardens from temperate regions and developed countries (Gehlena *et al*., 2013).

2.4. Design and size of homegardens

According to ecological, economical, and cultural factors, homegardens vary in size and construction (Pablo & Olga, 2004). The crops grown often rely on the demands of the individual owners and the amount of area that is available. There is no optimum or standard size for a homegarden. Depending on the socioeconomic and ecological factors, different geographical regions have diverse homegardens. According to (Tefera Mokonen *et al*., 2015), homegardens came in a variety of sizes and designs and were used as animal pens, plant nurseries, and homes for various plant species. The sizes of the sampled homegardens varied from 300 to 1200 meters. There were noticeable differences across household gardens in terms of size, species diversity, and species composition. More species composition richness was seen as homegaden sizes increased. Homegardens in Mizoram ranged in size from 0.10 to 0.60 hectares, which is comparable to the 0.10 to 0.50 hactare that is considered the typical size for homegardens worldwide. Large homegardens produce enough produce for both personal consumption and significant financial profits through the sale of additional items, and they are particularly productive in terms of plant diversity (Barbhuiya *et al*., 2011).

Homegardens are frequently built on marginal or unsuitable property due to its size, topography, or location for growing field crops or grazing. Every household's homegarden is a different size and is typically smaller than the amount of arable land owned by households (Gehlena *et al*., 2013). The homegarden area in Ethiopia, which comes in various shapes and sizes, includes the living house, animal houses, grain stores, drying places, and garden species plots. It is usually fenced and the fence is frequently reinforced by multipurpose live tree and shrub species. According to Biruk Kefale, (2020) report the common garden sizes range from about 500m^2 to more than 2,500 m^2 (a quarter of a hectare), but in extreme cases, gardens as small as 20m^2 and as large as 10,000m^2 have been recorded.

2.5. Function of homegarden plants

Benefits of homegardens vary depending on whether they are used for commercial food crop production or for subsistence farming (Maroyi, 2013). Farmers typically raise fruits, vegetables, herbs, spiritual and beautiful plants in their backyard gardens (Kumar & Nair, 2004: Maroyi, 2013). In the world, homegardens are crucial for providing food security and minimizing vulnerability since they are a community's most versatile and accessible land resource (Maroyi, 2013). As a result, a homegarden may be a significant source of both food and monetary income for vulnerable households (Kumar & Nair, 2004). In addition, family gardens serve as significant social and cultural hubs for the dissemination of agricultural knowledge (Galluzzi *et al*., 2010). As stated by Kumar& Nair (2004), homegarden production is mostly supplementary to staple food production and mainly focuses on vegetables, fruits and condiments. Nevertheless, the wide range of products from trees, shrubs and herbaceous plants cultivated in homegardens offers diversity to the diet for rural households and also serves as an important source of cash income through sale of surplus produce and cash crops (Maroyi, 2013).

Homegarden is a traditional land-use system which extensively practiced throughout the world. Homegardens are one of the most complex and diverse agro ecosystems worldwide (Biruk Kefale, 2020). The high diversity of species in homegarden have wide socioeconomic and agroecological roles including production of food and a wide range of other products su/ch as firewood, fodders, spices, medicinal plants and ornamentals avoidance of environmental deterioration of climate-related hazards commonly associated with monoculture production systems and income-generating sites. The diversity of plants in the homegarden associated with other organisms contribute to the formation and maintenance of soil structure and retention of moisture and nutrient levels and promote the recycling of nutrients, which reduces ecosystem vulnerability to climate change. Further, they represent an operational farm unit which integrates trees with field crops, poultry and/or fish having the basic objective of ensuring sustained availability of multiple products such as food, vegetables, fruits, fodder, fuel, timber, medicines and/or ornamentals (Chakravarty *et al*., 2018).

The compositions of crops grown in homegardens can be grouped based on function as food crops, medicinal, spices vegetables, ornamental, fruits, and fodder, building materials and fuel woods (Kumar and Nair, 2004: Biruk Kefale, 2020). Homegardens are known to play an important role in the socio-economic structure of rural subsistence communities and their diversified agricultural crops and trees fulfill many basic needs of local populations. The new contribution of the current study is the provision of information and reasons behind the households' decisions to plant or retain certain plant species (Kumar & Nair, 2004). Homegardens in Zvishavane district are major sources of food plants, ornamentals, medicinal plants and plants used for building purposes (Maroyi, 2013).

2.6. The nature of homegardens plant diversity

The diversity and variability of plants, animals, and microbes at the genetic, species, and ecosystem levels affecting the entire agroecosystem that is actively managed by farmers is referred to as agricultural biodiversity (agrobiodiversity). To maintain essential ecosystem functions, biological diversity, which is the variety and variability of animals, plants, and microbes at the genetic, species, and ecosystem levels, is required. Plant diversity contributes significantly to the providing of products and ecological services as part of biological diversity (Berhanu Awraris, 2020). Homegarden are rich in species diversity than that of a way from due to protected by fence and spreading of household wastes that served as manure for their growth (Endgedasew Andarge *et al.*, 2014). Plant species diversity in homegarden is decreasing from time to time because of changing of traditional subsistence agriculture into market oriented agriculture. The diversity and productivity of these homegardens are characterized the factors that affect the dynamics are identified as the implication of these change for agricultural sustainability. Homegarden agroforestry is believed to be more diverse due to combination of varieties of crops trees and livestocks (Euketu Linger *et al*., 2014).

The high diversity of species in homegardens, which combines crops, trees and animals having different uses and production cycles, is considered as an essential component of sustainable agriculture because of the wide socioeconomic and ecological roles it plays in these systems (Tesfaye Abebe, 2005). The high and maintained diversity of both cultivated and wild plant species makes homegardens suitable for *in situ* conservation of plant genetic resources (Kehlenbeck, 2007). Plant diversity is frequently used as a measure of health of biological system. It is damaged by deforestation, the agricultural expansion, and development activities including rapid urban expansion. Urbanization is one of the recent important issues in the enormous reduction of plant diversity. Recently the world urban

population (3.2 billion) greater that the number living in rural areas. People create rapid demands for food, settlements, jobs, waste management, and all basic needs for living. Dense settlements, traffic congestion, air and soil pollution, and waste dumps, reduce the space for plants, especially natural domestic plants (Reta Regassa, 2016).

2.7. What is Ethnobotany?

Ethnobotany is a broad term referring to the study of direct interrelations between humans and plants (Martin, 1995; Endalew Amenu, 2007). It is taken as key science for studying the local people on the botanical aspects of conservation and development. Ethnobotany is part of human environmental science that defines the interface between people and plants, and provides clues needed for rural development based on sustainable yields from plants products (Kaigongi and Musila, 2015). An ethnobotanical research is extremely important for the developing country like Ethiopia, where local people are highly influenced by local plant resources for the lively hood. Ethnobotanists reported that modernization of the world is dominating the life style of traditional societies, which is result in massive cultural and environmental changes. Indigenous knowledge is vital for sustainable agrobiodiversity where the knowledge is lost at an incredible rate (Arayaselasie Abebe, 2018). From plants, humans can obtain food, pesticides, medicines, fuel, fodder, construction materials, tools, and derives aesthetic and spiritual fulfillments. As result, indigenous knowledge on plants appeared when humans started and learned how to use plants. Over centuries, indigenous people have developed their own locality specific knowledge on plant use, management and conservation. The complex knowledge, beliefs and practices generally known as indigenous knowledge (IK) or traditional knowledge develops and changes with time and space, with change of resources and culture (Endalew Amenu, 2007).

2.7.1. Indigenous knowledge

Indigenous knowledge refers to the accumulation of knowledge, rule, standards, skills, and mental sets, which are possessed by local people in a particular area (Quanash, 1998). The immediate and intimate dependency of local people on natural resources resulted in the accumulation of indigenous knowledge that helped people to adapt to and survive in the environments in which they live. It is local knowledge that is unique to a given culture or society and the base for agriculture, health care, food preparation, education, environmental conservation and a host of other activities. The complex knowledge, beliefs and practices generally known as indigenous knowledge develops and changes with time and space. Hence, such knowledge includes time-tested practice that developed in the process of interaction of humans with their environment (Endalew Amenu, 2007). Therefore; it is the result of many generations long year's experiences, careful observations and trial and error experiments (Endalew Amenu, 2007).

2.7.2. Conservation value of homegardens

Use of biological resources in a sustainable manner is referred to as conservation. Particularly in relation to biological resources, the idea of sustainability is now considered as the driving principle for economic and social progress (Endalew Amenu, 2007). Homegarden owners use various forms of plant management strategies in homegardening activities. On the basis of previous studies plant management in homegardens can be categorized into two main groups: cultivated or tolerated. Cultivated or planted species are managed and cared for by people during their entire life cycle. They are sown as seed, multiplied vegetative by means of stem, root or other cuttings, or transplanted from natural habitats. Tolerated plant species are those species that are deliberately spared during digging, weeding and land clearing activities for the benefits or usefulness they provide to households. Tolerated species are

maintained and protected in homegardens, and are also found growing naturally in the wild (Maroyi, 2013).

Farmers manage the trees inside the homegarden to reduce light competition by means of pruning. Farmers use the excrement of cattle and humans to keep the garden fertile and productive while they maintain sanitation (Habtamu Hailu and Zemede Asfaw, 2011). *Cordia africana, Erythrina brucei* and *Millettia ferruginea* are species that the farmers preferred to promote fertile soil. 98% of respondents produced plants with different use values mainly for home consumption to be harvested whenever they needed to use throughout the year. The prominent species that occurred in the South Nation Nationalities and People region home gardens was *Ensete ventricosum*, which provided food at a steady rate as an appropriate management system (Biruk Kefale, 2020).

2.7.3. **Applications of Ethnobotany to the study of homegardens**

Ethnobotany, as described by Martin (1995), is the study of how local people interact with their natural surroundings, including how they categorize, manage, and use the plants that are readily available to them. It examines how plants have been used in cultures and the complicated links between them utilized, handled, and view differently in many societies (Tesfaye Hailemariam *et al.,* 2009). Consequently, plants function reflects the biological and physical characteristics of the plants, biological needs, perceived human needs, and anthropogenic factors the distinct habitats that plants inhabit, as well as the genetically constrained response of plant to disruption by people. This implies that depending on the environment in which they live, their cultural background, their methods of subsistence, their level of development (economic, social, and political), the religions they practice, and other factors, there may be significant differences in how people perceive and hold beliefs about the values of various plants or parts used for various functional groups. Therefore, ethnobotany studies in countries like Ethiopia where agriculture is the backbone for

economic, social and political development and there is strong attachment and interactions between human and plants could have reasonable importance. Moreover, such studies at homegarden in which people intensively cultivates varieties of plants for different purpose under more cares of management than for field crops could help to document indigenous knowledge of important plants cultivation and management practices, their use purpose and parts used, preparation methods and how to use, and what challenges are there as well (Regessa Bekele, 2014).

2.8. Use Values of Homegarden Plants

Management and conservation of plants began with prehistoric human's endeavor of domesticating wild plants (Talemos Seta, 2007; Berhanu Awraris, 2020). Species found in homegardens were used for different purposes. Among species used for food there were cereals, legumes, root and tubers, fruit and nuts, oil crops, spices and vegetables. Some species used medicinally were identified. Other species were used for hedging, ornamental purposes and for shade. Germplasm found in homegardens come from different ecosystems depending on the utility of the species. Food crops come from four main sources: other home gardens, farms, the market, and research institutions (Watson and Eyzaguirre, 2002).

The usage of plants usually relate to peoples conceptualization of the importance of plants including their use for food, medicine, cosmetics, dyeing, textiles, for building tools, clothing and ritual (Talemos Seta, 2007; Berhanu Awraris, 2020).

2.8.1. Food values of homegarden plants

The main role of homegardens is for production of diversified food crops and so includes high species diversity when compared with monoculture production system in vast farm land (Regassa Bekele, 2014). Nutrition and food supply are major aspects of homegardens. Food crops are not only widely prevalent but they also provide a significant portion of the household nutritional requirement in many homegardens around the world. Along with the

nutritional benefits, homegardens provide potential food security to the householder. Since the diverse mixture of crops is harvested at different times, a constant supply of food in some form or the other is available from these homegardens, at all times of the year (Mohan, 2004). Homegarden production is mostly supplementary to staple food production and mainly focuses on vegetables, fruits and condiments. Nevertheless, the wide range of products from trees, shrubs and herbaceous plants cultivated in homegardens offers diversity to the diet for rural households and also serves as an important source of cash income through sale of surplus produce and cash crops (Maroyi, 2013).

2.8.2. Spice and medicinal plants in homegardens

A spice is a dried seed, fruit, root, bark or vegetative substance used in nutritionally insignificant quantities as a food additive for the purpose of flavoring, and sometimes as a preservative by killing or preventing the growth of harmful bacteria (Duns and Willems, 2013). Homegardens can be used to grow certain traditional herbs and spices (Mohan, 2004). Many of these substances are also used for other purposes, such as medicine, religious rituals, cosmetics, perfumery or eating as vegetables. For example, turmeric is also used as a preservative; licorice as a medicine; garlic as a vegetable and nutmeg as a recreational drug. The history of spices in Ethiopia is an ancient one and spices remain as basic food items of the Ethiopian people. Ethiopia is the homeland for many spices, for example Korarima, long pepper, black cumin, Bishops weed and coriander (Duns and Willems, 2013). On the other hand, Traditional medicine has been defined as the sum total of all knowledge and practices, whether explicable or not, used in the diagnosis, prevention and elimination of physical, mental or social imbalances and relying exclusively unpractical experience and observation handed down from generation to generation, whether verbally or in writing (WHO, 2008). Medicinal plants still serve as a source of healthcare in developing nations because of their availability, minimal side effects, effectiveness and low cost. Homegardens, especially in the

more rural areas, are reservoirs of species that can be used for many medical purposes (Mohan, 2004).

2.8.3. Furniture, construction, fire wood and fodder plants

Tree products, such as timber products, charcoal, firewood, and fodder constitute important safety nets and are part of income diversification strategies for many communities in developing countries facing increased climate variability and climate hazard risks. Next to food, firewood is the scarcest item in developing countries. More than one third of the world is dependent upon firewood to supply their energy needs and ninety percent of the people in the poorest countries depend upon it as their chief source of fuel (Biruk Kefale, 2020). Timber or value of wood products usually implies a significant amount of economic value. Many of the homegardens had a significant amount of timber and any timber that was used or sold in the year of study has been included in the financial worth of the garden (Mohan, 2004).

According to Akale Assamere *et al.*, (2019) a total of 10 (50%) fodder species were documented. *Cytisus proliferus, Buddleja polystachya* and *Hagenia abyssinica* were the most commonly grown bee and animal fodder plants in majority of homegardens. Some of the highly preferred species identified for building materials include*: Acacia mellifera, Dichrostachys cinerea, Bridelia micrantha, Dalbergia arbutifolia, Prunus africana,* and *Olea capensis* (Biruk Kefale, 2020).

2.8.4. Live fence and shade plants in homegardens

Garden fencing is an important management practice observed in the area to protect homegarden components. Forty five species of plants were used as live fence and 23 species of plants were used as shade in the homegardens of the study area (Abebayehu Fenta, 2016). Fence plants were the most common species in homegardens, where they serve as a barrier to keep fruits, vegetables, spices, and other items safe. This culture on the study site

keeps diverse plant species safe around their homes and gardens. The study found that the majority of the homegardens analyzed were encircled by a live fence. Live fence species constituted 112 plant species accounting for 47% of all the plant species documented, and 85.7% of the environmentally useful plants recorded. Plants recorded as live fence plants were *Justicia schimperiana*, *Eucalyptus globulus* and *Vernonia amygdalina* (Metsehet Yinebeb *et al*., 2022).

Most of them were trees and shrubs. Trees are being managed not only for their live fence purpose, but also for use when they are on site as shades for garden plants or for societal gatherings in addition to use as edible fruits and resting sites for farmers in the farm and at the gate of homes area (Abebayehu Fenta, 2016).

2.8.5. Cultural and ornamental plants in homegardens

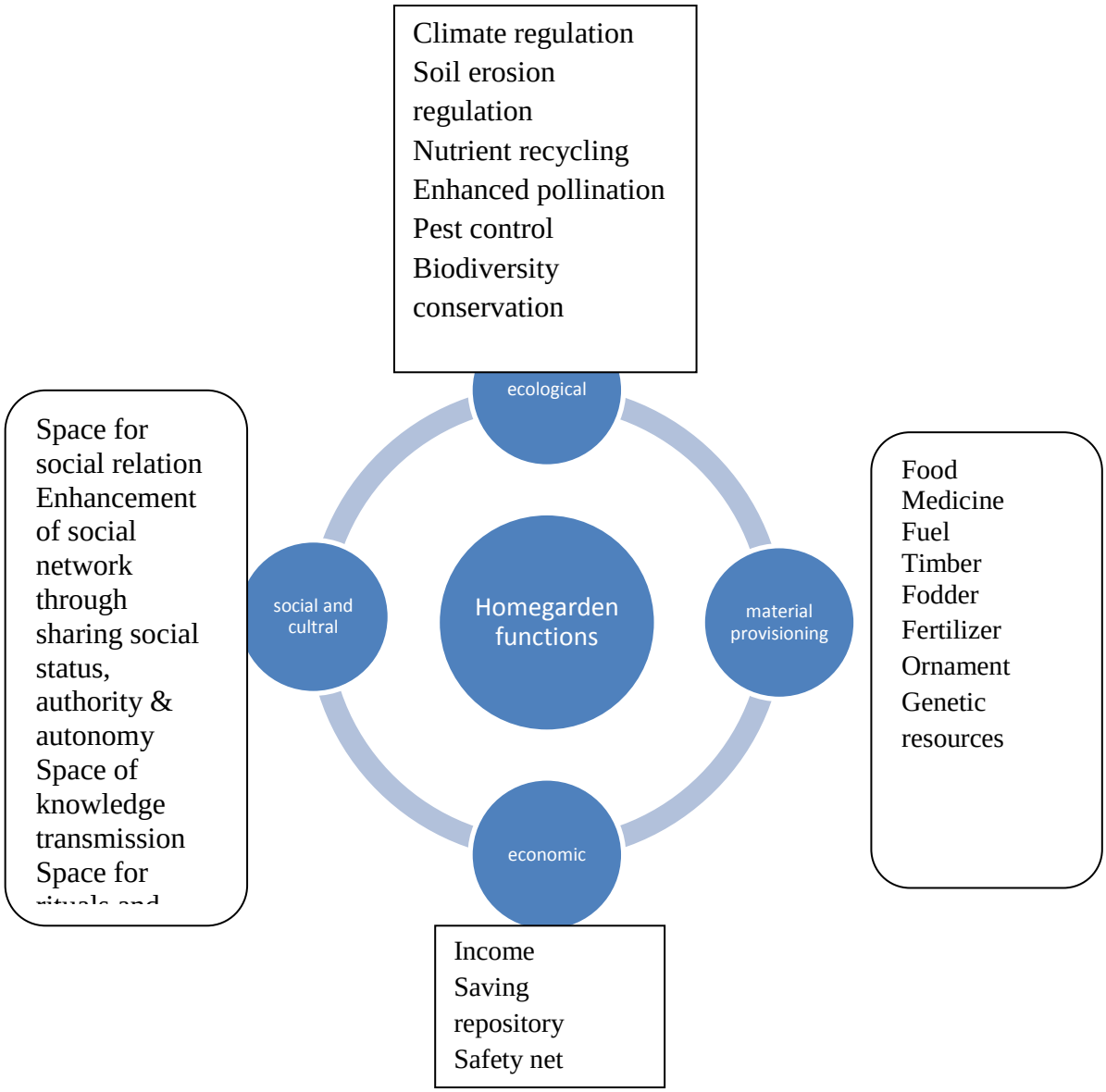
The homegarden is often a haven for the family members of rural communities to relax and gather together after a hard day's work. They are often local community meeting points. The gardens sometimes have a variety of flowers and other ornamental decorations. Some villages use these homegardens as a way to gain recognition for the village as a whole. The villagers are proud of the way their gardening contributes to the beauty of the village. In several tropical cultures, these ornamental flowers and some other selected plants are used for ritualistic and cultural. Some plant species in homegardens are believed to have a magical value, others are necessary for religious ceremonies, e.g., Hindu Balinese families need their homegardens as source and place for making sacrifices (Kehlenbeck, 2007).

2.8.6. The multipurpose homegardens plants

The basic function of homegardens is subsistence production, particularly in rural areas (Kumar & Nair, 2004). Because of the high plant species diversity existing in homegardens, a wide spectrum of multiple-use products can be generated with relatively low labour, cash, or other external inputs. Homegardens generally serve as a complement to staple crop fields by

producing mainly fruits, vegetables, spices, and many non-food products (Kumar & Nair, 2004). However, homegardens may also provide large portions of staple food, for example for poor families and in densely populated or heavily degraded areas without sufficient staple crop fields (Kehlenbeck, 2007).

Homegarden products, including those from animals reared in the gardens, have a relatively high nutritional value in terms of protein, minerals, and vitamins. Therefore, it is important for the nutritional security of the garden families. Therefore, the importance of homegardens for combating malnutrition and food insecurity has attracted increasing attention (Kumar & Nair, 2004).The second important function of homegardens is the generation of cash income, particularly in regions with good market access. Most of the income is said to be derived from perennials such as fruit and spice trees, cacao, and coffee, but in per-urban areas or tourist centers as well as in tropical highlands, also vegetables and/or ornamentals are frequently grown as cash crops. However, gardeners often do not cultivate certain crops exclusively for sale, but rather sell any marketable surplus of their subsistence crops. Thus, the portion of income from a homegarden may vary (Kehlenbeck, 2007). Multipurpose trees showed the highest and the most frequent occurrence. Useful species such as *Cordia africana, Moringa stenopetala, Melia azerdarch, Croton macrostachys,* and *Calpurea aurea* were showed the highest frequency. The most cultivated useful food plant species in the homegarden were *Enset ventricosum, Carica papaya, Persea americana, Coffee arabica, Musa paradisca, Mangifera indica* and *Zea mays (*Reta Regasa*, 2016).*



Source: Navarrete, 2021

Figure 1: Classification of homegarden plants function.

2.9. **Factors influencing species diversity of homegardens plants**

Species diversity and composition of homegardens is influenced by ecological, socio-economic and cultural factors (Tesfaye Abebe, 2005)). There are different factors that affect the diversity of homegarden plant species. Some of them are insufficient agricultural support from development agents, small sized gardens, and the shift from polycultural farming to few incomes generating food crops. In addition to these, other factors such as ecological, socioeconomic and cultural factors such as distance from urban markets, household size, environmental degradation and family tradition affect their diversity (Kumar and Nair, 2004)). Altitude and climate are important ecological factors that influence species diversity. Rainfall and temperature are the two important factors of climate that influence species diversity. Diversity of species increases with increased amount of rainfall and temperature. In this category, two major groups of variables can be distinguished; local (external) environment and household environment (household's resource levels). Among the local environment, commercialization and access to market, reliance on off-farm income, access to inputs and access to off-farm resources are believed to influence species diversity of farms. Commercialization and access to market often causes a decline in the diversity of species. Homegardens close to market towns, particularly in well-off households, tend to emphasize on high-value cash crops instead of staple foods. On the other hand, farmers tend to compensate their lack of access to markets and resources by producing as much of their consumption from home production as possible (Tesfaye Abebe, 2005). The composition of plant species in the homegardens of the study area is affected by different factors such as the availability of water, socio-economic conditions, homegarden size (Habtamu Hailu and Zemede Asfaw, 2011).

3. MATERIALS AND METHODS

3.1. Description of the study area

3.1.1. Location and topography

Bibugn district is located in the south western part of Amhara Regional State, and it is one of the 21 districts in the East Gojjam zone. The study area, Bibugn district, is located about 383 km north-west of Addis Ababa, 147 km south west of Bahir Dar, and 81 km north of Debre Markose. Bibugn district is bordered by Huletju Enesie and Dega Damot districts to the north, Machakel, Dembecha, and Sinan districts to the south; Huletju Enesie district to the east; and Dega Damot districts to the west. Bibugn district has 15 rural kebeles, and 4 kebeles in district are towns. The geographical location of the districts extends between 10^0 40’ 30" and 10^0 25’ 13" N latitude and 37^0 40'00" and 37^0 50’ 20" E longitude. The topography of the area consists of different land features: flat areas (29.2%), plateaus (69%) and steep slopes (1.8%).

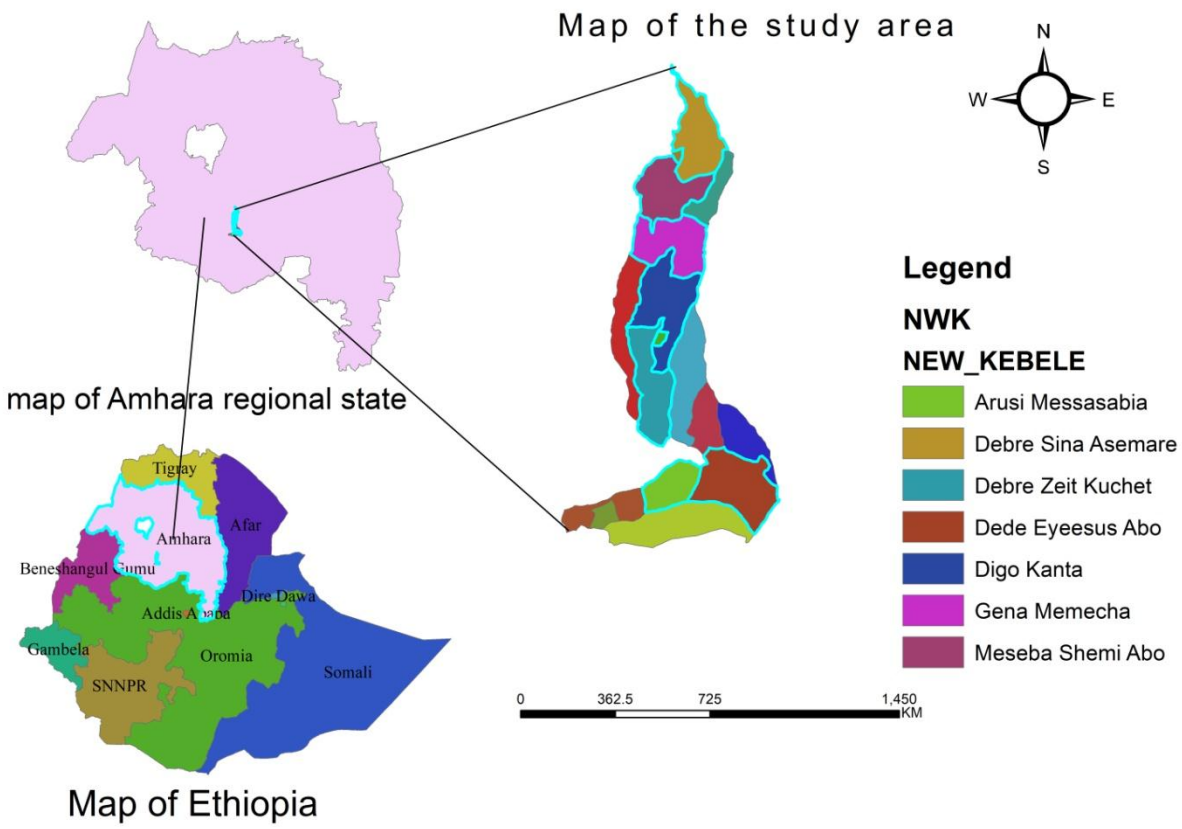


Figure 2: Map of the study area.

3.1.2. Climate

The altitude of the Bibugn district ranges from 1720 to 4060 meters above sea level. The highest peak is found in Ded Eyesus kebele in the Choke Mountain. In addition, Bibugn district is classified into four agro-ecological zones based on their altitudinal variation and climatic conditions. These are low lands (1720–1800 m.a.s.l.) at 4.46%, midlands (1800–2500 m.a.s.l.) at 48.06%, highlands (2500–3200 m.a.s.l.) 35.53%, and peaks (3200–4060 m.a.s.l.) 11.95%. These agro-ecological zones were also known by the people as kolla (tropical), woina dega (sub-tropical), dega (temperate), and würch (cool temperature), respectively. The annual temperature ranges from 9 to 240 °C, and the district receives 1200-1800 mm of rain per year.With regards to the rainfall in the region, the highest rainy season

in the region is during the summer season, from the middle of June to early September (Bibugn district office of Agriculture, 2022).

3.1.3. Soils and agriculture

The dominant soil types in Bibugn district, in their respective order, are brown soil (48.3%), red soil (42.8%), clay soil (3.5%), sandy soil (5.44%), and others (5.4%). The study area is characterized by a small-scale, mixed subsistence farming system, with livestock production as an integral part. Crop production is mainly rain-fed. In the study area, croplands are often planted with cereal crops such as maize (*Zea mays*), barley (*Hordeum vulgare*), wheat (*Triticum aestivum*), teff (*Eragrostis tef),* and, pulses such as beans (*Vicia faba*), peas (*Pisum sativum),* and potatoes *(Solanum tuberosum).* Subsistence agriculture is the mainstay of the livelihood of the population in Bibugn district. Farmers also cultivate vegetables and fruits, mainly in homegardens or wherever irrigation is possible. According to the Bibugn district Environmental and Natural Resource Protection Office (2022), there are 14 rivers and some of them used for irrigation purposes. It includes Abeya, Arefa, Babcha, Mammat, Gnbara, Tire wenz, Teyemo, kerkeha, Melman, Talak wenz, Mentan wenz, Zinbel, Gulla and Jiya Rivers.

3.1.4. Livelihood and sources of income

The main economic activities of local communities are mixed farming involving the cultivation of crops and animal rearing. The main crops include maize (*Zea mays*), teff (*Eragrostis tef*), wheat (*Triticum aestivum*), barley (*Hordeum vulgare*), potato *(Solanum tuberosum),* bean (*Vicia faba*), and pea (*Pisum sativum*) in combination with cattle, sheep, goats, and small traditional poultry rearing. To increase household income and food security, smallholder farmers grow different fruits and vegetables around their homes as an

agroforestry practice. These products serve for household consumption, for cash income, or both.

3.1.5. **Land use**

The total area of Bibugn districts is 39,129 hectars. According to the estimated data from BDEPLAU (2022), about 21,839 hectares of the land are cultivated; Bibugn district is occupied by different land uses such as grazing land (18.4%), forest land (15.5%), and the remaining is occupied by construction and unproductive land (Table 1).

Table 1: The land use of Bibugn district in 2022.

No	Type of land use	Area in hectare	Percent (%)
1	Cultivated land	21,839	55.8
2	Grazing land	71,99.7	18.4
3	Forest land	6,065	15.5
4	Construction/settlement	2,000	5.1
5	Others	2,025.3	5.2
6	Total	39,129	100

Source: Bibugn District Environment Protection, Land Administration and Use office (2022).

3.1.6. Population

Based on the 2007 national census conducted by the CSA, this district has a total population of 82,002, of whom 40,190 are men and 41,812 are women; 6,241 or 7.61% are urban inhabitants. Within an area of 399.79 square kilometers, Bibugn has a population density of 205.11, which is greater than the zone average of 153.8 persons per square kilometer. A total of 18,548 households were counted in this district, resulting in an average of 4.42 persons per household, and 17,959 housing units. The majority of the inhabitants practice Ethiopian Orthodox Christianity, with 99.13% reporting that as their religion.

3.2. Ethical Considerations

Special ethical considerations were taken based on the cultural views of the local communities in the study area. In view of these considerations, the approach to the informants was very systematic. By telling the truth and convincing each informant to strictly adhere to his or her culture, they were also informed that the objective of the research is not for commercial purposes but for academic ones. In so doing, the informants at the study site were well informed about the objective of the research before the start of data collection and /actual works.

3.3. Materials

Phone camera, GPS test, meter tape, note book, pen, cutting tools, plant press, plant specimen collection sheet (plastic) equipment and materials were used throughout data collection.

3.4. Data sources

Primary and secondary sources were used for data collection. Primary data were gathered through homegarden observation, market survey, semi-structured interview, and focus group discussion; secondary data were collected from websites, the internet, journals, a literature review, and Bibugn districts.

3.5. Methods

3.5.1. Sample sites identification and sample size determination

In order to gather all information about the study district, reconnaissance survey was conducted in Bibugn District in August 2022 to select study kebeles and conduct home garden surveys. Bibugn District was purposefully chosen from the districts of the East Gojjam Zone since it has a high potential of homegarden plants. Currently, Bibugn district

has 15 rural Kebeles, and all Kebeles have homegarden plants. First, stratified random sampling technique was employed. The study Kebeles were stratified into four agro-ecologies based on their altitudes and climatic conditions (Wurch, Dega, Woina Dega, and Kolla). From each agro-ecology i.e Wurch, Dega, Woina Dega, and Kolla and the four agro-ecology includes four Wurch, four Woina dega, four Dega, and two Kolla Kebles, respectively (BDAO, 2022).

Second, a proportional allocation technique was used to determine the number of sample Kebeles from each stratum. By using simple random sampling techniques, two Kebeles were chosen from Wurch, Woina Dega, and Dega agro-ecology, and one from the fourth, Kolla.

Third, kebeles found in the same agro-ecology were selected by simple random sampling from each stratum. Ded eyesus and Arusi representing Wurch agro-ecology (higher altitude above 3200 m.a.s.l.), Debre zeit and Digo Kanta representing Dega (medium altitude between 2500 and 3200 m.a.s.l.), Gena memecha and Meseba representing Woina Dega (altitude between 1800 and 2500 m.a.s.l.), and Debre sina representing Kolla (altitude between around 1720 and 1800 m.a.s.l.) were selected by simple random sampling technique for data collection (BDAO, 2022). The sampling sites from different climate zones were to capture possible variations in species diversity and the utility value of homegarden plants.

Fourth, a simple random sampling technique was employed to select sample households from each Kebele. A total number of households in seven sample kebeles was 7648 (BDAO, 2022), and the number of households selected as a sample size from seven Kebeles was also 366, making it a representative sample of the population. Cochran (1977); Metsehet Yinebeb *et al*., (2022) devised a formula to calculate a representative sample for proportions as where **no** is the sample size, **z** is the selected critical value of the normal distribution at 95% confidence level, **p** is the proportion of the target population estimated to have the desired

characteristics, which is 50% for this survey, **q**=1-p, and **e** is the level of precision with 5%, **p** = 0.5,

$$no=\frac{z2pq}{e2}$$

$$\textbf{no}= \frac{(1.96)^2*0.5*0.5}{(0.05)^2} =384$$

When the sample size exceeded 5% of the population size, a finite population correction formula was applied.

$$\textbf{n}=\frac{no}{(1+no-1/N)}$$

Where n = the adjusted sample size

no = the original required sample size and

$$\textbf{n}=\frac{384}{(1+\frac{384-1}{7648})} =366$$

N = population size.

The percent of sample size was computed by using: $\textbf{C}=\frac{n}{N}*100\%$, where **C** is the percent of sampled households, **n** is the number of selected sampled households, and **N** is the total population in seven sample kebeles. $\textbf{C}=\frac{366}{7648}*100$ =4.8%. A comparable sample size was determined in proportion to their household numbers among the seven Kebeles by using a simple proportion formula adapted from Cochran (1977), $\textbf{ni}=n\times\frac{Ni}{N}$ i=1, 2, 3..., **ni**=sample size of each Kebele, **Ni**=population size in each Kebele, **n**=total sample size, **N**=population size of seven Kebeles (Table 2). In each selected kebele, different numbers of households were visited and sampled, giving a total of 366 households by using simple random sampling to check for the presence or absence of homegardens, frequency of homegardens and assess their shapes and locations with respect to houses.

Table 2: Proportional distribution of sample households in seven Sample Kebeles.

Name of Kebeles	Sex	Total households	Proportionality	Sample size(n)	Sample size (%)
Debre Sina	M	739	739*0.048	36	9.84
	F	110	110*0.048	5	1.37
Meseba	M	709	709*0.048	34	9.29
	F	172	172*0.048	8	2.19
Gena memecha	M	930	930*0.048	45	12.29
	F	180	180*0.048	9	2.45
Debre zeit	M	1212	1212*0.048	58	15.85
	F	185	185*0.048	9	2.45
Digo Kanta	M	941	941*0.048	45	12.29
	F	157	157*0.048	6	1.64
Ded eyesus	M	1435	1435*0.048	69	18.85
	F	210	210*0.048	10	2.73
Arusi	M	580	580*0.048	28	7.65
	F	88	88*0.048	4	1.1
Total		7648		366	100

3.5.2. Ethnobotanical Data Collection and selection of key informants

Ethnobotanical data was collected between September and December 2022, mainly through homegarden observation, market surveys, focus group discussion and semi-structured interviews. All of the interviews were conducted using pre-prepared questions with 42 purposively selected homegardens owners (32 males and 10 females) from seven Kebeles (six from each kebele) between the ages of 25 and 70 for a detailed study to assess the richness, diversity of species and abundance of homegarden plants. The homegarden owners involved in the interviews were selected from survey of 366 households (from the seven sample kebeles, a different number of households were selected). The interviews and discussions were conducted in Amharic, later documented in English. The key informants were chosen based on the number of years they had lived in an area and the indigenous knowledge available for homegarden management. During interviews the 14 key informants

were selected from seven Kebeles (two from each kebele) include (10 males and 4 females) between the ages of 30-70 (Appendix 7).

3.5.3. Homegarden observation

Homegarden observation was done with selected key-informants and homegarden owners in each site during ethnobotanical data collection. The homegarden observations were assessed through field observation. During the observation, a plant inventory survey was performed using a structured format that included local names of plants, uses of plants, parts of the plant used as food, spices and medicine, and the habit of each plant. Field note was taken in local name of the homegarden plants including the use of plants and parts used. The survey was carried out with observations and plant identifications with local names (Appendix 5).

3.5.4. Semi-structured interview

Questions were used to collect local names of plants in homegardens, use categories, and the growth habits plant species in homegardens. The socioeconomic characteristics of informants like age, sex, marital status and educational background of the selected household of the homegarden owners were also recorded during interview. Informant responses were scored for the purposes of quantitative ethnobotanical data analysis (Appendix 5).

3.5.5. Focus group discussion

Four focus group discussions were held in four Kebeles chosen at random from each agroecology that contained the combination of key and general informants. Five participants were selected from one kebele in a total of 20 participants were selected from four agroecologies (Wurch, Dega, Woina Dega, and Kolla) i.e. one kebele was selected from each selected agroecology by simple random sampling techniques. Out of the total participants 4 were females. The discussions, explored their indigenous knowledge on homegarden

practices. This is an appropriate method for qualitative data collection in that it ensures the consistency of the responses given by the participants at a time as well as for quantitative data collection. The informants were those who were thought to be very knowledgeable by their community about their homegarden management practices and the conservation of homegarden plant species, and they were allowed to discuss what types of food crops they found in their homegardens, what roles their homegardens played in their daily lives. Researcher visited each key informant's garden to assess the consistency of their discussion with plant species from their homegardens. They were asked to mention the major factors that hinder the productivity of their homegardens.

3.5.6. **Market survey**

There are five market centers in the district: Woyin Wuha, Gena Memecha, Digo Tsion, Waber, and Korebta in the study sites. These surveys were conducted in three markets: Woyin Wuha, Digo Tsion, and Waber. Those sites were selected purposefully due to their large population coverage and accessibility. A market survey was conducted to record the variety and amount of food and other homegarden plant products produced and supplied to the local market. Plants with market value in Bibugn district were identified through market observation through interviewing producers, sellers, and buyers (Appendix 6).

3.5.7. **Sampling and data collection**

Plant specimens were collected by delimiting the plot size to 10m x 10m in 42 representative homegardens (i.e., one plot per garden), giving a total of 4200m^2 (0.42 ha) which lay randomly. The identity of plant species and the number of individuals per species were recorded in each plot. The plants inside the plot were counted and collected. Species richness was determined from the total number of species recorded in sample plots. In addition to these local names of plant species, use value, growth habits and geographical locations,

altitude were also recorded by asking homegarden owners and through observations of GPS test respectively. Plant specimens were collected, numbered, pressed, dried and identified using the published volumes of the Flora of Ethiopia and Eritrea and by comparing them with the authenticated specimens housed at the National Herbarium (ETH), Addis Ababa University (AAU). Additional references like Azene Bekele (2007) and other references were used to aid in the identification process.

3.6. Data analysis

Descriptive statistical methods were used to summarize, analyze, and interpret the data. The raw data from each household was entered into a Microsoft Excel 2019 using focus group discussions, market surveys, semi-structured interviews, homegarden observation, and field work. Then these data were transferred to various forms, such as tables, percentages, and charts with possible combinations. Descriptive statistics methods such as densities, frequencies, relative frequencies and relative density were used to analyze the data.

3.6.1. Frequency and relative frequency

Frequency is the number of times a species occurs within the sample plot. It is determined by calculating the percentage of plots or quadrats in a sample area on which a given species occurs. This method was applied to determine the frequency of homegardens in the study area using the frequency of plant species in the quadrats of homegardens.

$$\text{Frequency} = \frac{Number\ of\ \ quadrat\ \ in\ w\square ic\square\ \ a\ species\ occurs\ \ \ *100}{Total\ number\ of quadrats\ in\ t\square e\ \ sample}$$

Relative frequency (RF) is the number of occurrences of one species in a sample relative to the distribution of the total occurrences of all species (Martin, 1995).

$$\text{Relative frequency} = \frac{Frequency\ of\ a\ species\ in\ the\ sample}{Total\ \ frequency\ of\ all\ species\ in\ the\ sample} * 100$$

The frequency and relative frequency of all identified plant species were calculated. The highest frequency (occurrence) in 42 homegardens of the study area divided by the total frequency of all plant species in the sample and multiplied by 100.

3.6.2. Density and relative frequency

The density of a species is the number of individuals per unit area. It is closely related to abundance and more useful in estimating the importance of a species (Martin, 1995).

$$\text{Density} = \frac{total\ number\ of\ individuals\ of\ a\ species\ \ in\ all\ quadrats}{Total\ area\ of\ t\square e\ samples\ in\ (m\mathbf{2})}$$

Relative Density (RD) is the number of individuals of a species as a percentage of the total number of individuals of all species in that area (Martin, 1995).

$$\text{Relative density} = \frac{Density\ of\ a\ species}{Total\ density\ of\ all\ species} * 100$$

3.6.3. Shannon Weiner diversity index

Shannon Weiner diversity index is one of the most commonly used to species diversity indicators in plant communities, and it takes the value of zero when there is only one species in a community and a maximum value, when all species are present in equal abundance (Shannon and Wiener, 1949). Shannon indices are used to determine the richness and evenness of species present. Species diversity among homegardens was calculated using this formula.

$\mathbf{H'} = -\sum_{i=1}^{s}(\boldsymbol{pilnpi})$ where H' = the value of the Shannon-Weiner diversity index,

S = number of species in the community,

∑=sum of species

Pi, the proportion of individuals of the ith species expressed as a proportion of total cover,

ln = the natural logathrim to base e(log). The value **H'** ranges from 0 to 5, usually ranging from 1.5 to 3.5.

The larger value of **H**', the more diverse the species are within the site. Evenness **J'** is equal to the **H**' divided by maximum possible diversity i.e. J'= H' /H' max, where, **J**' is species evenness; **H**' is Shannon and Wiener diversity index and H" max is lnS where **S** is the number of species. The values for evenness range from 0 to 1. Equitability is near to Zero shows the site to be dominated by one species, while a value near 1.0 shows have an equal balance between all species.

3.6.4. Sorenson similarity among homegardens

Sorenson index of similarities were also used to compare the degree to which species composition of the samples/quadrats/ in the study area. This index method was applied mainly for comparing the similarity among different plant communities. This process was applied to determine for all homegardens in seven select sites of the study area.

$\mathbf{Ss=2a/2a+b+c}$ where ss=Sorenson similarity coefficient

a=number of species common to sample

b=number of species in sample 1

c=number of species in sample 2

The coefficient values ranges from 0 (complete dissimilarity) to 1 total similarity (kent and coker, 1992). This method was applied to calculate for all homegardens in seven selected sites of the study area.

3.6.5. Simple preference ranking

Preference ranking was one of the methods used to rank five to seven items and arrange those items based on a given criterion. Each rank was given an integer value, 1, 2, 3, 4, 5, and 6, with the most important item given the highest value, while assigned the smallest value to the least important (Martin, 1995). The preference ranking employed 14 key informants to rank the seven common medicinal garden plants chosen for their ability to heal a variety of ailments and their prevalence in the study sites.

3.6.6. Direct matrix ranking

Direct matrix ranking was conducted using the sample of 14 key informants on six multipurpose species as reported during the interview using the approach (Martin, 1995). To be ranked, the following seven attributes (medicinal, construction, furniture, live fence, shade, firewood, and fodder) were taken into account during the exercise. Based on information gathered from 14 selected key informants, six multipurpose tree species were selected in use categories and the informants were also asked to assign value to each attribute (5 = best, 4 = very good, 3 = good, 2 = less used, 1 = least used and 0 = not used). At the end, the result of key informants was summed up to create a matrix that represents the entire community.

4. RESULTS

4.1. Demographic and socioeconomic characteristics of informant

The general characteristics of informants in the research area was divided into three age groups: adult ages (25–45), middle ages (46–65), and elderly (greater than 66 age range). Out of the total 42 homegarden household owners interviewed, 19 (45.24%) were between the ages of 25 and 45, 15 (35.71%) were between the ages of 46 and 65, and 8 (19.05%) were beyond 66. It is clear that most of the informants were in the adult age category (45.24%). Similarly, 32 (76.19%) of the 42 participants in the study area were male, while 10 (23.81%) were female. The informants' educational level was as follows: 24 (57.14%) were illiterate, 11 (26.19%) could read and write, and 7 (16.67%) were in elementary and secondary school. In terms of marital status, 92% of all informants were married, while 8% were single (Appendix 7).

4.2. Local people classification of environmental components in the study area

The local people in the study area have their own scheme of classifying their environmental components, such as the classification system of landscape, vegetation, climatic, season and soils.

4.2.1. Landscape and vegetation classification by local people

The people of Bibugn Districts classify landscapes into four categories based on two main criteria: elevation and the purpose for which the land is used; namely, “meda”, “terara”, “wetageba” and “shelequo” and the vegetation can be classify based on growth habits and prupose into Zaf, kutquato, hareg and aremamo.

4.2.2. Climatic zone and season's classification by local people

In the Bibugn district recognizes four climatic zones based on climate condition and elevation: Wurch, Dega, Woina dega and Kolla agroecological zones. Ded Eyesus and Arusi which corresponds to Wurch, Debre zeit and Digo kanta corresponds to Dega, Gena memcha and Meseba which corresponds to Woina dega and Debre sina which represent to Kolla. In addition, seasons also classify by the local people in to four types based on doing agroeconomic activities. The first 'Bega' which is dry season consists from mid December to mid March. 2nd, 'Belg' which is small rainy season consists from mid March to May, 3rd 'Kiremt' which is main rainy season comprise from June to September and 4th, 'Mehere' which is mainly sunny season comprise from October to December.

4.2.3. Soil classification by local People

The local people classify soil based on soil characteristics such as color of the soil and fertility of the land. There are four soil types have been identified by local people:-

Walka Afer: This soil category refers to black soil and with better fertility and production in contrast to other soil types. The people use this soil to grow crops like *Eragrostis tef, Allium sativum, Pisum sativum,* and *Hordeum vulgare*.

Key Afer: This kind of soil is red soil type which is less fertile in comparison to the black soil. But, it can enable to grow crops of various types by applying fertilizer. The people use this soil to grow crops like, *Triticum aestivum* and *Zea mays*.

Nech Afer: This category of soil is white soil which is not suitable for crop production.

Teterama Afer: this category of soils is the mix of both small stone and different types of soil which are suited for crop production, for instance. *Guizotia abyssinica, Zea mays* and *Eragrostis tef*.

4.3. Position of homegardens in the study area

The location of homegardens varied in type and size in the study area in relation to their house, but the most dominant type was the back-yard garden (34.43%), followed by the side-yard garden (22.95%), and the front-yard garden (17.49%), respectively. A study of 366 households in seven kebeles in the study area found that 325 (88.79%) engaged in home gardening activities, while the remaining (11.21%) did not. Table 3 shows the practices and frequency of homegardens in the seven study sites. Ded Eysus had the highest frequency (70), and Arusi had the lowest (28).

Table 3: Homegardens practice surveyed in the study area.

Sites(kebeles)	No of house served	Houses with homegardens	Front yard gardens	Back yard garden	Side yard gardens	Front and side yard gardens	Back and side yard gardens	Round yard gardens
Debre Sina	41	36	7	11	9	4	5	-
Meseba	42	37	11	17	9	-	-	-
Gena memecha	54	48	8	20	11	6	3	-
Debre zeit	67	60	15	18	16	1	10	-
Digo Kanta	51	46	11	15	13	2	5	-
Ded eyesus	79	70	10	32	17	4	7	-
Arusi	32	28	2	13	9	-	4	-
Total	366	325	64	126	84	17	34	-
Percent (%)		88.79%	17.49%	34.43%	22.95%	4.64%	9.28%	0

4.4. Design and size of homegardens

The sizes of the 42 observed homegardens ranged from the smallest 250 m^2 to the largest 2500 m^2, with an average size of about 1305 m^2. As homegaden sizes increased, so did species richness. Homegardens of the Bibugn District have different shapes; some are circular, rectangular, square, or irregular shape. Visual assessment of the vertical and horizontal structure of the majority (88%) of gardens in the study area indicated that they were multilayered structures comprised of various plant growth types such as trees, shrubs, herbs and climbers. Plant species in the study area were found to be stratified into five separate horizontal strata and three vertical strata. The first layers of horizontal strata were either free space and shade plants like *Acacia abyssinica*, *Acacia decurrens*, and *Azadirachta indica*. The second layer consisted of medicinal plants, the third of various types of vegetables, and the fourth were various types of shrubs, herbs, and trees that had nutritional value. The fifth layer, a live fence, was used to keep out different herbivores that could harm the home gardens. The study area's residential gardens were divided into higher, middle, and lower vertical strata. Long trees including *Acacia abyssinica, Cordia africana, Hagenia abyssinica, Cupressus lusitanica, Croton macrostachyus, Juniperus procera, Eucalyptus camaldulensis*, and *Eucalyptus globulus*, as well as fruit trees like *Persea americana*, and *Mangifera indica* make up the majority of the upper layer. The medium stratum of the vegetation in a home garden was shrubs like *Enset ventricosum, Rhamnus prinoides, Coffea arabica*, and *Catha edulis*. The lower stratum was herbs like *Beta vulgaris, Brassica carinata, Brassica oleracea, Daucus carota, Ocimum basilicum, Coriandrum sativum, Ruta chalepensis, Allium sativum*, and small ornamental plant species.

4.5. Plant taxonomic diversity and growth habits in Bibugn Districts

In this study, 110 plant species were documented and recorded in the 42 homegarden surveyed, which were divided into 98 genera, 48 families, and different use values (Appendix 1). In terms of growth habits, the identified and documented homegarden plants in the study area were as follows: 41 (37%) were herbs, 39 (36%) were shrubs, 23 (21%) were trees and 7 (6%) were climbers. Because of their nutritional and economic value, homegardeners had planted herbs and shrubs in study area.

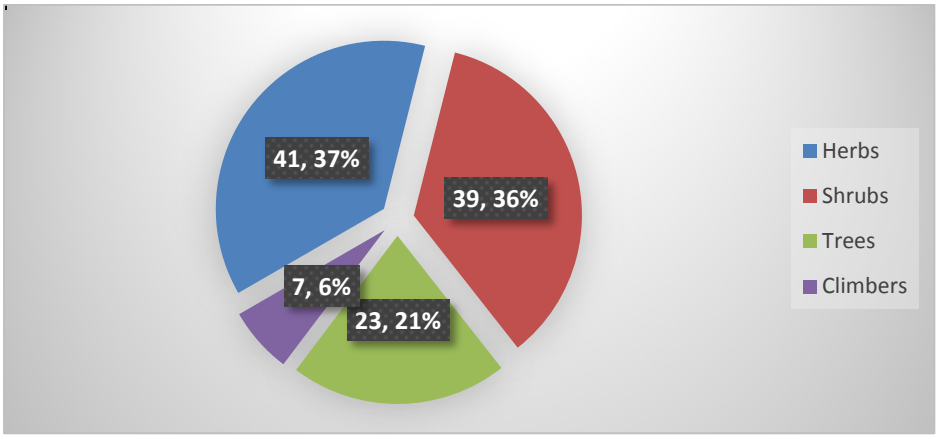


Figure 3: Growth habits of homegarden plant species in study area.

The most dominant family, with 13 species was the *Fabaceae*, followed by the *Poaceae* with 12 species, and the third *Asteraceae* with 9 species, *Rosaceae* with 6 species, *Lamiaceae* and *Solonaceae* with 5 species each, *Rutaceae*, *Euphorbiaceae*, *Cucurbitaceae*, and *Myrtaceae* each with 3 species, *Acanthaceae*, *Alliaceae*, *Apiaceae*, *Celastraceae*, *Musaceae*, *Brassicaceae*, *Boraginaceae*, *Rubiaceae*, *Cupressaceae*, and *Moraceae* 2 species each. On the other hand, the remaining families consist of a single species (Appendix 2)**.**

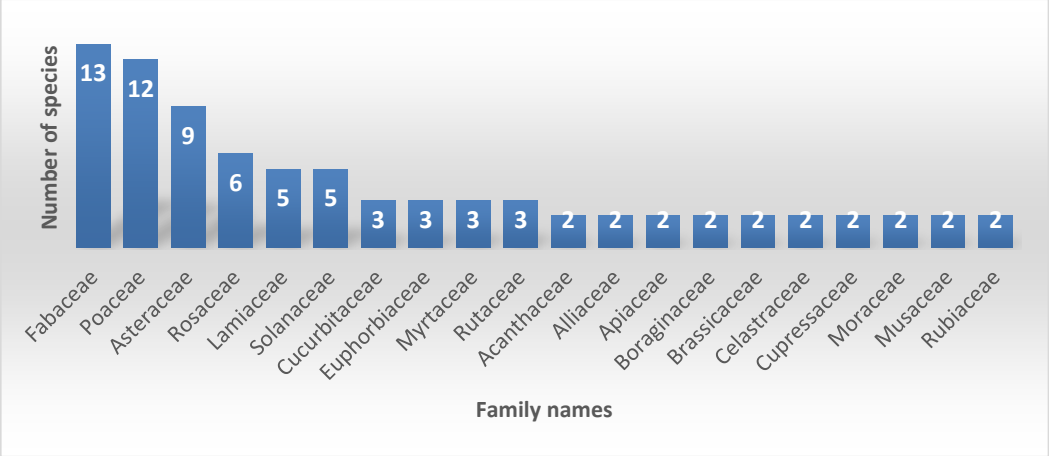


Figure 4: The frequency of families that contains more than or equal to two species in Bibugn District.

4.5.1. Species richness, Diversity, Evenness, and Similarities in the Study Area

The highest number of species recorded per homegarden was 46 in Meseba, and the lowest number of species was 6 in Arusi homegardens, with an average of 25 species. On the other hand, the highest species number per kebele was recorded to be 71 in Meseba, while the smallest number of species recorded was 37 in Ded Eyesus kebele.

Table 4: Richness, Shannon's index, and evenness of plant species in the study area.

Study sites	Species richness	Shannon's index	Evenness
Debre sina	52	3.45	0.86
Gena memcha	62	3.59	0.86
Meseba	71	3.64	0.87
Digo Kanta	50	3.34	0.85
Debre zeit	43	3.15	0.83
Arusi	40	2.89	0.78
Ded eyesus	37	2.75	0.73

Table 4 displays the Shannon-Wiener diversity indices as well as the species evenness of the seven sampling sites. The species richness per sample site varied from 71 to 37 species, while the species diversity indices ranged from 2.75 to 3.64. The Meseba sample site had the most species (71), followed by the Gena memecha sampling site (62) species. Ded Eyesus and Arusi had the fewest species richness 37 and 40, respectively. The evenness of species ranged from 0.73 to 0.87. The evenness indices showed that the species in Meseba (J' = 0.87) were more abundant and equally distributed as compared to Ded Eysus (J' =0.73). The least species richness and evenness were identified from Ded eyesus sample site that indicates the area was dominated by few species.

The Sorenson similarity index was calculated among the seven sample sites, and the values ranged from 0.19 to 0.81 (Table 5). Meseba and Gena memcha homegardens had the highest similarity coefficient of 0.81 (81%) where as Debre sina and Arusi homegardens had the lowest similarity coefficient 0.19 (19%).

Table 5: Sorenson's Index of similarity of overall species in seven study sites.

Study kebeles	Ded Eyesus	Arusi	Debre zeit	Digo Kanta	Gena memecha	Meseba	Debre sina
Ded Eyesus	1						
Arusi	0.79	1					
Debre zeit	0.60	0.56	1				
Digo Kanta	0.57	0.62	0.76	1			
Gena memcha	0.32	0.34	0.49	0.64	1		
Meseba	0.26	0.29	0.42	0.48	0.81	1	
Debre sina	0.20	0.19	0.25	0.31	0.64	0.72	1

4.5.2. Frequency and relative frequency of Homegarden Plant Species

From the total number of plant species identified in the study area, *Rhamnus prinoides* had the highest frequency and relative frequency (92.86%), followed by *Solanum tuberosum* (80.95%), and *Eucalyptus globulus* (71.43%) were the second and third respectively. *Zehneria scabra* was the least frequent species, accounting for only (2.38%) of the total (Appendix 3).

Table 6: Top 10 homegarden species in terms of frequency and relative frequency in 42 home gardens in the study area.

No	Botanical name	Local name	No of quadrats' a species occur	Frequency	Relative frequency
1	*Allium sativum* L.	Nech shinkurt	29	69.05	2.47
2	*Brassica carinata* A. Br.	Yehabesha gomen	26	61.90	2.22
3	*Cupressus lusitanica* Mill.	Yeferngi tid	27	64.29	2.30
4	*Ensete ventricosum* (Welw.) Cheesman.	Enste	26	61.90	2.22
5	*Eucalyptus globulus* Labill.	Nech bahir zaf	30	71.43	2.56
6	*Hordeum vulgare* L.	Gebis	23	54.76	1.96
7	*Rhamnus prinoides* L. Herit.	Gesho	39	92.86	3.33
8	*Ruta chalepensis* L.	Tena adam	25	59.52	2.13
9	*Solanum tuberosum* L.	Dinch	34	80.95	2.90
10	*Zea mays* L.	Bekolo	22	52.38	1.88

4.5.3. Density and relative density of Homegarden plant species

People in the study area grow a variety of plant species in their homegardens, which serve for variety of tasks. As a result, *Eucalyptus globulus* had the highest density of the 110 plant species identified in the study area, followed by *Rhamnus prinoides*, *Solanum tuberosum,* and *Cupressus lusitanica,* which had the highest density and relative density when compared to

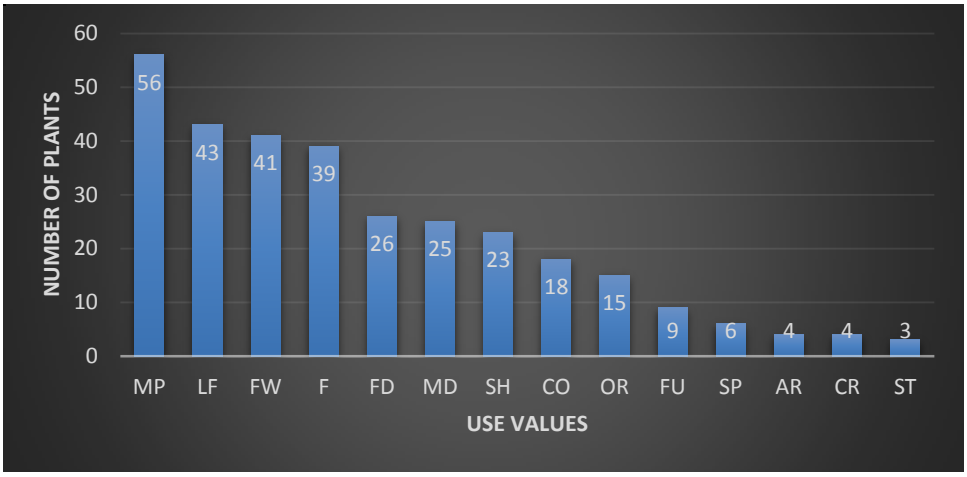
the other species. This shows that *Eucalyptus globulus* was the most common abundant plant species in homegardens in district (Appendix 3).

Table 7: Top 10 homegarden species in terms of density and relative density in 42 homegardens in study area.

No	Botanical names	Growth form	No of individual quadrats' a species occur	Density	Relative density
1	*Allium sativum* L.	H	205	0.049	2.596
2	*Cupressus lusitanica* Mill.	T	293	0.070	3.711
3	*Eucalyptus globulus* Labill.	T	525	0.125	6.649
4	*Hordeum vulgare* L.	H	225	0.054	2.850
5	*Juniperus procera* Hochst.	T	196	0.047	2.482
6	*Rhamnus prinoides* L. Herit.	S	462	0.110	5.851
7	*Ruta chalepensis* L.	H	225	0.054	2.850
8	*Solanum tuberosum* L.	H	383	0.091	4.851
9	*Triticum aestivum* L.	H	276	0.066	3.495
10	*Zea mays* L.	H	265	0.063	3.356

4.6. Main Use Categories of Bibugn District Homegarden Plant Species

For this study, 14 major plant use categories were identified and recorded based on the farmers' interview and group discussions. Plants with multifunctional use categories accounted for 56 (18%) of the 110 plant species reported in the study sites, followed by live fence 43 (14%), firewood plants 41 (13%), food plants 39 (13%), fodder or forage plants 26 (8%), medicinal plants 25 (8%), shade plants 23 (7%), construction plants 18 (6%), ornamentals plants 15 (5%), furniture or timber plants 8 (3%), spices 6 (2%), aromatic 4 (1%), cultural and religious 4 (1%), and stimulant 3 (1%).



Represented as **MP=** multipurpose, **LF**= live fence, **F**= food, **FW**= firewood and charcoal, **FD**=fodder**, MD**= medicinal, **SH** =shade, **CO**=construction, **OR**= ornamentals, **Fu**= furniture, **Sp**=spices, **CR**= Cultural and religions, **AR**=aromatic plants and **ST**= stimulants.

Figure 5: Multipurpose use value of homegarden plant species in Bibugn District.

4.6.1. Multi-use homegarden plants in study area

According to informants and group discussions, 56 (18%) of the 110 plant species collected in the study area had multipurpose use values. In such circumstances, direct matrix ranking analysis was utilized to find plants with high social preference based on their diverse use values. As a result, six multifunctional tree species were chosen for the study area, and 14 key informants were asked to assess the plant species reported in the area for each use category (i.e., construction, furniture, medicinal, living fence, shade, firewood, and forage) for each attribute of the species compared, and the resulting scores were summed and used to compare the use values of the plants. The result of direct matrix ranking showed that, *Eucalyptus globulus* had the highest use value, followed by *Cupressus lusitanica*, *Croton macrostachyus* and *Cordina affricana* comprised the second, third, and fourth ranks, respectively, and *Hagenia abyssinica* had the lowest use value from six multipurpose tree plants that were selected by key informants. The results showed that multipurpose tree plants that were more used for firewood followed by construction and live fence.

Table 8: Direct matrix ranking values of six multipurpose plant species based on their seven use categories.

	Scientific name	*Acacia abyssinica*	*Croton macrostachyus*	*Cupressus lusitanic*	*Cordia affricana*	*Eucalyptus globulus*	*Hagenia abyssinica*	Total	Rank
Use values	Construction	45	50	65	64	70	15	309	2
	Furniture	0	61	56	60	56	10	243	5
	Medicine	0	41	0	0	68	65	174	6
	Fire wood	62	32	62	60	70	42	328	1
	Shade	65	44	51	27	54	32	273	4
	Live fence	50	51	54	36	46	40	277	3
	Forage	23	19	14	0	0	36	92	7
	Total score	245	298	302	247	364	240		
	Rank	5	3	2	4	1	6		

4.6.2. **Homegardens plant species provide food in study area**

Out of the total 39 (13%) species of the valuable plant flora in the homegardens of Bibugn District were food plants. These plants grouped under 36 genera and 21 families. Fruits account for 14 (36%) of food plants, vegetables 7(18%), pulses and cereals 6 (15%) each, oils 2 (5%), sugars 2 (5%), and spices 2 (5%). From this finding of the study, fruits had a large number of species followed by vegetables and pulses compared to the rest of the food plant species, and sugar and spice were represented by two species. *Poaceae* had the highest number of species of food plants with 7 species, followed by *Fabaceae* with 6 species, *Rosaceae* and *Solanaceae* 3 species each, *Asteraceae, Brassicaceae,* and *Rutaceae* 2 species each, and the remaining families contained one species. *Solanum tuberosum, Hordeum vulgare, Triticum aestivum,* and *Brassica carinata* were frequently occurred in all agroecology from the responses of informants and field observation (Appendix 3). In Woina Dega and Kolla agroecology, the most common fruits were *Musa x paradisiaca*, *Persea americana, Citrus sinensis, Mangifera indica*, and *Citrus aurantifolia*, where as *Prunus persica* and *Malus sylvestris* were among the fruit species that were frequently seen in the

study's homegardens in Dega agroecology. Common vegetables cultivated in study area pointed out by informants include *Brassica carinata, Solanum tuberosum, Capsicum annuum, Brassica oleracea, Beta vulgaris,* and *Daucus carota*.

4.6.3. Medicinal plants in the homegardens in study area

In this study, 25 (8%) medicinal plant species were identified. The medicinal plants were categorized into 25 genera and 22 families based on taxonomic hierarchy. It was found that *Asteraceae* and *Rutaceae* were the most widely distributed plant family among medicinal plant species 2 species each, and the remaining containing one species in the study area. The habits of medicinal plants comprised with 11 (44%) shrubs, 9 (36%) herbs, 4 (16%) trees, and 1 (4%) was climber (Appendix 4).

4.6.4. Preference ranking

Preference ranking performed by fourteen key informants for seven selected medicinal plant species (Table 9) showed that *Allium sativum* was the most chosen, followed by *Zehneria scabra*, *Rumex nervosus*, and *Ruta chalepensis* respectively, in the second, third, and fourth ranks.

Table 9: Simple Preference ranking for seven medicinal plants on the degree of curing several illnesses and their prevalence in study area (1-6): 6- most valuable, 1- least valuable for species.

Scientific name	Key informants (K)														Total Score	Rank
	K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	K_9	K_{10}	K_{11}	K_{12}	K_{13}	K_{14}		
Ruta chalepensis	5	3	4	6	2	4	6	4	3	5	6	2	3	5	58	4
Rumex nervosus	2	5	4	6	2	3	5	6	5	4	4	3	6	5	60	3
Zehneria scabra	5	5	6	4	5	6	5	6	3	5	6	4	5	6	71	2
Ocimum lamifolium	4	3	3	5	3	6	3	1	3	5	4	6	4	4	54	5
Hagenia abyssinica.	3	3	4	3	2	5	3	6	2	1	3	5	2	4	46	7
Allium sativum	5	6	5	5	6	4	5	6	5	6	5	6	6	5	75	1
Eucalyptus globulus	4	5	6	5	2	1	1	3	3	3	5	6	4	3	51	6

4.6.5. Construction and furniture plants in homegarden of the study area

The importance of plants documented for construction and furniture contributed in the order of 18 and 8 out of the total 110 species, respectively. The recorded 18 plant species that were used for construction purposes were taxonomically classified into 15 genera and 12 families (Appendix 1). Among these, *Fabaceae* and *Myrtaceae* were the most dominant plant species represented with 3 species followed by *Poaceae* and *Cupressaceae* with 2 species each and the remaining 8 families each with 1 species (Appendix 1). The identified 8 homegarden plant species reported for furniture were categorized into 8 genera and 6 families, whereby *Myrtaceae* and *Cupressaceae* were the most dominant plant species with 2 species each and the remaining 4 families each with 1 species (Appendix 1).

The principal plant species utilized for construction building and furniture preparation, according to the respondents and personal observation in the homegarden, were *Eucalyptus globulus, Cupressus lusitanica, Juniperus procera, Acacia decurrens, Croton macrostachyus, Eucalyptus camaldulensis* and *Cordia africana*.

4.6.6. Firewood plants in homegarden the study area

The energy sources were gathered from various plant life forms, such as climbers, herbs, shrubs, and trees. In addition, total number of 41 (13%) plant species categorized into 36 genera and 24 families (Appendix 1). Among these families, *Fabaceae* was the most dominant with 6 species followed by *Asteraceae* and *Roseaceae* each with 4 species, *Euphorbiaceae* and *Myrtaceae* each with 3 species, *Poaceae* and *Cupressaceae* each with 2 species while the remaining contain one species. Habit wise distributions of firewood plants in the study area were 17(42%) trees, 22 (54%) shrubs, 1(2%) herb and 1(2%) was climber.

4.6.7. Aromatic and spices plants in the homegarden of the study area

Out of a total of 110 species, four (1%) plant species were used as aromatics by the community and six (2%) plant species were used as spices taxonomically categorized to 6 genera and 5 families. Family wise distribution shows that *Lamiaceae* was the most dominant with 2 species and the remaining 4 families contain one species. According to the informants, *Ruta chalepensis*, locally known as "Tenadam," was one of the predominant spice plants grown in the homegarden of four agroecologies.

Table 10: Lists of spices plants growing in Bibugn District homegardens, their parts used and methods of preparation.

No	Botanical names	Local name	Part used	Method of preparation
1	*Allium sativum* L.	Nech shinkurt	Bulbs	Bulb is chopped and mixed during cooking of food.
2	*Capsicum annuum* L.	Yehabesha karia	Dry pods and seeds	Dry pod and seed can be chopped and added to "wot" or vegetable cooking.
3	*Coriandrum sativum* L.	Denbilal	seeds	The seed is added in boiled water to drink.
4	*Ocimum bacilicum* L.	Besobila	Leaves with flowers	Leaf is dried, chopped and mixed to prepare "wot".
5	*Rosmarinus officinalis* L.	Segametbesha	Leaves	Leaves are added to roasting meat and berbere processing.
6	*Ruta chalepensis* L.	Tena adam	Top of young leaves and seed	Leaf is added to buna and berbere processing.

4.6.8. **Ornamental plants in the homegarden in the Bibugn district**

The decorative plant use category included 15 (5%) species of plants that were identified and documented. These plants were taxonomically divided into 15 genera and 12 families, with *Asteraceae, Cupressaceae*, and *Fabaceae* 2 species each, and *Apocynaceae, Boraginaceae, Meliaceae, Melianthaceae, Bignoniaceae, Musaceae, Poaceae, Proteaceae*, and *Rosaceae* 1 species each. In terms of growth habits of ornamental plants 7(47%) trees, 6(40%) shrubs and 2(13%) herbs. As mentioned by the informants, ornamental trees and shrubs were most widely distributed, such as *Azadirachta indica, Jacaranda mimosifolia, Cupressus lusitanica, Grevillea robusta, Rosa x richardii*, and *Acacia* sp.

4.6.9. Homegarden fodder or forage plant species the study area

A total of 26 (8%) fodder or forage species were identified in the current study. These plants were grouped under 25 genera and 17 families, with *Fabaceae* and *Poaceae* as the most dominant plant species represented with 4 species each followed by *Asteraceae* with 3 species, *Boraginaceae* with 2 species and the remaining 13 families each with 1 species

(Appendix 1). In terms of growth forms, nine (35%) of the species grew were shrubs, while eight (31%) were herbs, six (23%) trees, and three (11%) climbers. As reported by informants, the most important fodder plants were *Cajanus cajan*, *Dombeya torrida*, *Cynodon dactylon*, and *Snowdenia polystachya* (Appendix 1).

4.6.10. Homegardens contain cultural and religious plants in study area

A total of four (1%) cultural and religious plant species were recorded and identified in the study area (Appendix 1). The most important ones reported by the informants and in the group discussion were *Cymbopogon citratus* (which was commonly used for celebration of a religious holiday, locally known as "kbir bale"), *Artemisia absinthium, Otostegia integrifolia* and *Ficus vasta*.

4.6.11. The stimulant plants in district homegardens

Catha edulis, Rhamnus prinoides, and *Coffea arabica* were the stimulant plants in the study area. *Catha edulis* and *Coffea arabica* were found to be common in the homegardens of Woina Dega and Kolla agroclimatic zones; this was confirmed by observations done in the homegardens in Meseba, Gena memcha, and Debre sina. On the other hand, *Rhamnus prinoides* was the most common in all agroclimatic zones. People in the Bibugn district used to make a locally known alcohol drink known as "tella", “tej” and high-value cash crops in their homegardens, according to informants and group discussion.

Table 11: Lists of stimulant plants growing in study area.

No	Botanical name	Local name	Part used
1	*Catha edulis* (Vahl.)Forssk. ex Endl.	Chat	Young leaves
2	*Coffea arabica* L.	Buna	Seeds
3	*Rhamnus prinoides* L. Herit.	Gesho	Leaves and stems

4.6.12. Live fence and Shade plants in the homegarden in the district

Out of the 110 plant species recorded in the district, 43 (14%) were live fences, belonging to 38 genera and 29 families. Among these families, *Fabaceae* was the most dominant with 6 species followed by *Asteraceae* with 4 species, *Euphorbiaceae* and *Rosaceae* each with 3 species, *Cupressaceae* and *Myrtaceae* with 2 species each. In terms of growth habits, shrubs were dominant 25 species (56.8%) followed by trees 16 (36.3%), climbers 3 (6.8%). Shade plants identified in Bibugn homegardens were 23 (7%) in number. The shade plants were grouped into 17 genera and 14 families. Habit-wise distribution of shade plants indicated 19 (82.6%) trees, 3 (13.9%) shrubs, and 1 (4.3%) herb. As mentioned by informants during group discussion, some of the common live fence and shade plants were *Eucalyptus globulus, Cupressus lusitanica, Dombeya torrida, Grevillea robusta, Acacia abyssinica* and other common live fence and shade plants.

4.7. Factors influencing species diversity homegarden plant in Bibugn District

According to informants, the main three variables influencing the species diversity and species richness of homegardens in the study area include the size of the homegarden, a lack of access to water, disease and pests. As mentioned by the informants during the interview, the first main constraint in cultivating homegarden plants in the study area was the size of homegardens (80.95%). The second main constraint was a lack of access to water (73.81%). According to the informants, the third major constraints were disease and pests on some homegarden species (57.14%), which were factors that limit the variety of homegarden species. The main factors that influence species diversity of homegarden plant along with their frequency, percent, and rank are presented in (Table 12).

Table 12: The factors that influence the species diversity of homegarden in study area.

No	Main Constraints	Frequency	Percent of informants	Rank
1	Homegarden size	34	80.95%	1
2	Lack of available water	31	73.81%	2
3	Disease and pests	24	57.14%	3
4	Lack of sufficient seed(seedling)	15	35.71%	4
5	Lack of awareness	11	26.19%	5
6	Altitude and climate conditions	9	21.42%	6
7	Lack of agricultural support(advice)	7	16.66%	7

4.8. Marketed homegarden plants on Bibugn district

A survey conducted in three different markets revealed that fruits such as *Citrus aurantifolia*, *Mangifera indica*, *Musa x paradisica*, *Citrus sinensis*, *Malus sylvestris*, *Persea americana*, *Prunus persica*, vegetables such as *Solanum tuberosum*, *Beta vulgaris*, *Lycopersicon esculentum*, *Brassica oleracea*, *Daucus carota*, spices such as *Allium sativum*, *Capsicum annuum*, and *Ruta chalepensis*, sugars like *Saccharum officinarum*, cereals like *Hordeum vulgare*, *Zea mays*, *Eragrostis tef*, *Triticum aestivum*, *Elusine coracana*, pulses such as *Lathyrus sativus*, *Lupinus albus*, *Cicer arietinum*, *Vicia faba*, *Pisum sativium*, stimulants like *Coffea arabica*, *Rhamnus prinoides*,construction, furniture, ornamental as well as medicinal were dominant homegarden products in the area commonly sold in markets. Throughout the market survey and discussions with informants, it was noted that most of these products were sold by women, men and children.

Figure 6: Sample photographs showing the market survey (by Haymanot, 2023).

4.9. Indigenous knowledge and homegarden management in Bibugn District

In the study area, the terms "yeguaro ersha," "Tegane, Yeguaro Masa," and "Yeatikilt Bota" refer to a homegarden. The informants emphasized that indigenous knowledge was acquired through oral transmission from one generation to the next. Ethnobotanical indigenous knowledge was related to the homegarden plants that are maintained by both men and women in the gardens in the study area. As a result, there was a division of labor that was significant since enough labor was made available to carry out the activities related to the homegarden. The informants generally agreed that the communities in the Bibugn district commonly depend on homegarden species for food supply, animal feed, traditional medicine, live fencing, firewood, timber production, house building, money creation, and other functions. Even while both men and women participate in the management of homegardens, women were more active throughout the activities of cultivation, harvesting, adding cow dung and marketing. People in the study area manage their gardens in a variety of ways, including weeding, watering during the dry season, fencing, digging, creating erosion canals (tracing), utilizing animal manure, and cutting down plants' leaves for producing organic composts.

In the study area, there are a variety of plant species management practices managed by family members with the goal of maintaining soil fertility and protecting crops from various factors such as wildlife, disease, and pests. Family members were found to share their responsibilities. Women help with the planting, watering, fertilizing, weeding, harvesting, and selling of plants, vegetables, fruits, cereals, and spices. Men were frequently involved in farming, digging, and finding quality seeds for cash crops. Local people in the study area maintain and manage their homegardens through a variety of activities. Crop rotations were the first management practices observed in the study area. Cereals like *Zea mays* and *Triticum aestivum, Hordeum vulgare, Lupinus albus, Solanum tuberosum, Eragrostis tef, Pisum sativum,* and *Vica faba* were rotated. These legumes improve soil fertility by increasing soil nitrogen content. Intercropping systems were the second management practices observed in the study area. They were successful in selecting crops that were co-adapted and provide several benefits. Most of the time, maize (*Zea mays)* intercropped with *Brassica carinata, Solanum tuberosum, Vica faba,* and *Helianthus annuus*. Because of this, they are able to meet various household needs, collect a large amount of products, and solve the problem of farm land scarcity. Crop protection was one of the management practices in the study area. So that farmers can protect their plants from pests such as domestic animals, wild animals, and birds. These barriers were protected by using fences, keeping farms during sowing, using rope to defend birds, building terraces, and other methods. They also used herbicides and pesticides.

House garbage (kitchen wastes, livestock wastes, and ashes) were combined with agricultural leftovers, weeds, and ashes from the homegarden to create organic fertilizer (composts) and manures, especially in Wurch and Dega agroecology, while in Woina Dega and Kolla agroecology, inorganic fertilizers (artificial fertilizers) were used to maintain soil fertility.

5. DISCUSSION, CONCLUSIONS AND RECOMMEDATIONS

5.1. DISCUSSION

5.1.1. Demographic and Socio-economic Characteristics of Respondents

Population structures, sex, and age of the respondents are the most important indicators of the demographic characteristics of the respondents. Accordingly, of the 42 homegarden household owners interviewed, most of the respondents were in the adult age category (45.24%). The majority of the respondents (76.19%) involved in the study were male. Similar results were reported by Birhanu Getie (2021) in Getta Districts in that the socio demographic characteristics of the respondents suggest that the majority of homegardeners were aged between 20 and 40, followed by those between 41 and 65 and above 66 years of age, and that the majority of homegardeners were males.

As stated by Kehlenbeck (2007) concerning socio-economic conditions, a sustainable agricultural system should be able to maintain its productive capacity by continuously yielding adequate amounts of diverse and valuable crops suitable for meeting both the subsistence and cash needs of the farmer's household. Homegardening activities were best practiced by older people and those with some educational background in order to fulfill their food security needs, maintain balanced diets, and generate income by planting trees, shrubs, and herbs. Besides, a sustainable system should enhance social and gender equity, traditional knowledge, and cultural integrity (Kehlenbeck, 2007). Similarly, the marital status and sex of respondents indicated that most of the gardening work was performed by married and male individuals. On the other hand, level of education had significant effect on productivity of households in the study area. The findings obtained were similar to that of (Berhanu Awraris, 2020) and (Mekonnen Amberber, 2011).

5.1.2. Local people classification of environmental components in the study area

The local people in the study area have their own scheme of classifying their environmental components, such as the classification system of landscape, soils, climatic, vegetation, and season. Similar results reported by different researcher in different area of Ethiopia like (Haimanot Reta, 2010：Eskedar Abebe, 2011: Abebayehu Fenta, 2016).

5.1.3. Frequency of Homegarden characteristics in study area

325 (88.79%) of the 366 households surveyed in seven kebeles in the Bibugn district had homegardens where they grew various types of plants to fulfill various household needs such as food, traditional medicine, firewood, building house, and income generation. This finding was consistent with the findings of Regassa Bekele (2014), who discovered that the majority (90%) of households in Bishoftu Town care for homegardens, and Mekonen Amberber (2011) in Holeta Town, who discovered that 85.5% of households practice homegardening.

Homegardens come in a variety of designs and patterns, but they all share the same fundamental elements. The Homegarden typically comprises a residence surrounded by uncultivated and planted areas. The position of homegardens in Bibugn district was dominated by the back-yard (34.43%), followed by the side yard (22.95%), and the front yard (17.49%). Most of (34.43%) the studied homegardens in the Bibugn district have backyard locations. The reason for this could be that the front yard was left as a free space for children to play, run different social ceremonies, and some were used as resting places in Kolla and Woina Dega Kebeles, as well as to protect their vegetables from physical damage and human interference, and that the back yard plant is not harmed by free movement of animals and is suitable for animal waste access. This finding was consistent with the findings of Girma Woldemichael *et al*., (2018) in Misha Woreda, Hadiya Zone South Ethiopia and

Arayaselassie Abebe (2018) in Eastern Hararghe, Kombolcha Town, Oromia Regional State, Ethiopia, who reported that different types of homegardens exist in Ethiopia, including back yard, side yard, front yard, and back-side gardens. The findings of this study disagree with Regassa Bekele (2014) findings in the homegardens of Bishoftu Town, Oromia National Regional State, Ethiopia. In that in his study area out of the total 270 homegardens inspected, 115 (43%), 109 (40%), 32 (12%), and 14 (5%) were front, mixed, side, and back types of gardens, respectively. This is may be due to the difference in land availability and different region.

5.1.4. **Design and size of homegardens**

According to Tefera Mokonen *et al*., (2015), homegardens had different sizes and shapes, and served as animal houses, green stores and land for growing different plant species. The sizes of homegardens sampled range from 300 m^2 to 1200 m^2. Distinct variation in sizes, diversity, and composition of species was observed among homegardens. With increasing sizes of homegaden, more richness of species composition was observed, and as stated in the Biruk Kefale (2020) the common garden sizes range from about 500 m^2 to more than 2,500 m^2 (a quarter of a hectare), but in extreme cases, gardens as small as 20m^2 and as large as 10,000 m^2 have been recorded in Ethiopia. In the study area, the sizes of the 42 observed homegardens ranged from the smallest 250 m^2 to the largest 2500 m^2, with the average size of about 1305 m^2. The design and pattern of homegarden varied from garden to garden but they still have some similarities in their basic features. A visual assessment of the vertical and horizontal structure of the majority of gardens in the study area indicated that they were multilayered structures comprised of various plant growth types such as trees, shrubs, herbs, and climbers. Plant species in the study area were found to be stratified into five separate horizontal strata and three vertical strata. This result agreed with Regassa Bekele (2014) in that homegarden in Bishoftu Town a typical structure of plant arrangement in Bishoftu

homegardens comes in six distinctive horizontal and three vertical patches and Girma Woldemichael *et al*., (2018) who reported that homegardens of the Misha Woreda were structured into upper, middle and lower vertical strata.

5.1.5. Plant taxonomic diversity and Growth habits of plants in study area

In this study, 110 plant species were documented and recorded in 42 homegarden surveyed, which were divided into 98 genera, 48 families, and different use values. This result agreed with Mekonen Amberber (2011), in which a total of 112 plant species were identified and documented. In that in his study area plant species were classified into 93 genera and 43 families and Regassa Bekele (2014) reported a total of 115 plant species classified under 94 genera, 51 families and 15 use groups in Bishoftu Town.

Regarding to plant growth habits were observed in the study area, which included (6%) were climbers, (37%) were herbs, (36%) were shrubs, and (21%) were trees distributed in 48 different families (Appendix 1). The dominant family observed in the study area was *Fabaceae*, and most of the plants observed in the study area were herbaceous in their growth habits. The findings obtained were similar to those of Reta Regassa (2016), who reported that herbs (44.57%) were the most numerous species in the homegardens studied, followed by shrubs (27.13%), trees (24.8%), and climbers 16(6.2%) and Metsehet Yinebeb *et al*., (2022) in their study of Cultural Use of Homegarden Plants in Gozamen Districts reported that among the 238 plant species, 15 (6.3%) were climbers, 93 (39%) were herbs, 69 (29%) were shrubs, and 61 (25.6%) were trees and also Birhanu Getie (2021) in Getta Districts reported that shrubs were the most numerous species, followed by herbs. Family wise distribution shows that *Fabaceae* was the most dominant family with 13 species. The dominance of *Fabaceae* was reported from other homegarden studies in Ethiopia (Mekonnen Amberber,

2011; Tefera Mekonnen, 2010; Solomon Tamrat, 2011). This may indicate that home gardeners frequently cultivate *Fabaceae* for food security purposes.

5.1.6. Species richness, Diversity, Evenness and Similarities of the seven kebeles of Study area

The species richness of Woina Dega and Kolla kebeles of study area was found to be higher than that of Dega and Wurch kebeles. Meseba, Gena memcha, and Deber sina Kebeles were found to have a species richness value of 71, 62, and 52, respectively, from the Woina Dega and Kolla kebeles. High species diversity in Meseba and Gena memecha could be attributed to the presence of optimum environmental factors such as temperature, altitude, climate, slope, land availability, adequate nutrients, soil types, close to each other and moisture. Digo Kanta and Debre zeit kebeles from the Dega agroecology had species richness values of 50 and 43, respectively. The highest value of Shannon diversity indice indicated that the site had more diverse plant species compared with other sites. Ded eyesus and Arusi kebeles were found to have species richness values of 37 and 40 respectively from the Wurch area. The number of species decreased with increasing altitude, with similar results reported in homegardens of Misha district, Hadyia zone (Girema Woldemichael *et al*., 2018) and similar results reported in homegardens of Sululta district Oromia region by Berhanu Awraris (2022) who reported that low-land areas had higher species richness than mid-land and high-land areas. In this study, the highest values of Shannon-Wiener diversity indices in Woina dega, followed by kolla, dega and Wurch respectively. This result lined with Metsehet Yinebeb *et al*., (2022) who reported that the Woina dega agroclimatic zone had higher species diversity than Kolla and Dega in Gozamin district, East Gojjam, Amhara region. The evenness of species in the study area ranged from 0.73 to 0.87. The least species richness and evenness were identified from Ded eyesus sample site that indicates the area was dominated by few species. This due to environmental conditions and the area households could be

cultivated some plants like *Triticum aestivum*, *Hordeum vulgare*, *Solanum tuberosum*, and *Eucalyptus globulus* and so on. This result lined with Kaya *et al*., (2002), have reported high evenness values of 0.71 to 0.91 for the forest gardens of Central Maluku, Indonesia. There was strong dissimilarity in the distribution of species among different agroecology sample locations but similarity distribution of species among the same agroecology sample locations. This is because of different agroecology, altitude, climate, and homegarden size. These indicated that homegarden plant species in the same agroecology had the highest degree of similarity among them, while plant species found in different agroecology had more dissimilarity.

5.1.7. Frequency and density of homegarden plants in study area

In the 42 homegardens in the study area, *Rhamnus prinoides* (92.85%), *Solanum tuberosum* (80.95%), *Eucalyptus globulus* (71.45%), *Allium sativum* (69.05%), and *Cupressus lusitanica* (64.28) were the five most frequently observed homegarden plant species. *Rhamnus prinoides* was used to make the local alcoholic beverage "Tella", “Tej” and was reported as a highly profitable plant in all agroecology. Similar to this, the majority (80.95%) of homegardens in the study area have *Solanum tuberosum.* Hence it was a common staple diet in the Bibugn District. *Eucalyptus globulus* was the most abundant planted tree across homegardens of Bibugn. This could be due to their importance or the numerous ethnobotanical applications. For instance, Eucalyptus trees were frequently planted by homegardeners for use as source of income, medicine, shade, live fences, firewood, furniture, and construction. This result agreed with that of Berhanu Awraris (2020) who studied homegardens of Sululta Districts. Similar to this, Density can be defined as the number of individual plants per unit area, and it is a pivotal parameter in plant management and conservation action. *Eucalyptus globulus* was shown to had the highest density and relative

density of the 110 plant species identified in the study area, followed by *Rhamnus prinoides, Solanum tuberosum,* and *Cupressus lusitanica* which had the highest density and relative density in the second, third, and fourth ranks respectively, when compared to the other species. *Cupressus lusitanica* had the highest density and relative density of tree plants in Sebata town done by Habtamu Hailu and Zemede Asfaw, (2011).

5.1.8. Preference ranking and direct matrix ranking

Simple preference ranking for seven medicinal plants based on the degree of curing several illnesses and frequently encountered medicinal plant species' utility in the study area. *Allium sativum* appears to be the most popular, followed by *Zehneria scabra, Rumex nervosus,* and *Ruta chalepensis*, respectively, in the second, third, and fourth ranks (Table 9). This is consistent with the findings of Abebayehu Fenta (2016), who discovered that Sinan ditrict *Allium sativum* is the most preferred, followed by *Vernonia amygdalina*. Direct matrix ranking was performed by fourteen key informants for six selected multipurpose plant species. Similarly, *Eucalyptus globulus* came out on top in a direct matrix ranking of six multipurpose plant species based on seven major use categories, followed by *Cupressus lusitanica, Croton macrostachyus, Cordia affricana,* and *Acacia abyssinica* which came in second, third, fourth, and fifth, respectively (Table 8). Habtamu Hailu (2008) reported similar results in Sabata Town, Oromia national regional state, Ethiopian, *Eucalyptus globulus* ranking first with a total score of 240 (19.05%), and Tefera Mekonen (2010) in Sebeta-Hawas District's diverse ethnobotanical uses.

5.1.9. Main Use Categories of Bibugn District Homegarden Plant Species

According to Zemede Asfaw (2001), plant species are commonly utilized for multiple purposes apart from their single value. Similarly, the study area's homegardens supplied a

variety of services to the local farmers produced a variety of plant species to meet their daily subsistence needs. Food requirements, treatment of ailments on a daily basis, feeding their domestic animals, firewood collection, income creation activities, furniture making, construction, cultural and religious beliefs, as well as live fence and shade services, were among the services given. In this study, homegardens supplied a variety of services to the local farmers produce a variety of plant species. There were 56 (18%) plants with multifunctional use categories among the 110 plant species reported in the homegarden sample at study sites, followed by live fence 43 (14%), firewood 41 (13%), food 39 (13%), fodder or forage 26 (8%), medicinal 25 (8%), and shade 23 (7%); construction 18 (6%); ornamental 15 (5%); furniture or timber 8 (3%); spices 6 (2%); aromatics 4 (1%); cultural and religious 4 (1%) and stimulant 3 (1%). Similar findings reported by Abebayehu Fenta (2016) in the homegardens of Sinan Districts found that 60 (48%) plants that occurred in the home gardens with multiple uses took the top position of the plant categories, followed by 45 (36%) live fence plants, and Birhanu Getie (2021) in the homegardens of Getta District, Gurage Zone, Southern Regional State of Ethiopia, multipurpose species took the top position, followed by food plant species.

Out of the 110 plant species identified and documented in homegarden sample at study sites, 39 (13%) plant species in the homegardens of Bibugn District were food plants. Fruits account for 14 (36%) of food plants, vegetables 7 (18%), pulses 6 (15%), cereals 6 (15%), oils 2 (5 %), sugars 2 (5%), and spices 2 (5%). This finding indicated that, fruits had a large number of species followed by vegetables and pulses compared to the rest of the food plant species. Vegetables and spices were grown as cash crops and sold to neighboring districts to generate income. As recognized during group discussion and the informants' response of homegarden owner use vegetables and fruit for sell as means of income generating and using food. This result agreed with Regassa Bekele (2014) findings in the homegardens of Bishoftu

Town, who reported that the majority of these food and nutrition plants were fruits and vegetables which were cultivated throughout the year and directly used as household food and nutrition sources on daily basis.

The local people in the study area partially rely on medicinal plants grown in their own gardens to day-to-day health care needs and livestock diseases. Out of the 110 plant species documented and recorded, 25 (8%) medicinal plant species were identified in this investigation, with 11 (44%) shrubs, 9 (36%) herbs, 4 (16%) trees, and 1 (4%) climber. In addition to their medical potential, some of them have significant nutritional value, which qualifies them as nutraceutical plants. A total of 22 medicinal plants were identified from homegardens managed by farmers in a similar finding report by Dawit Daba and Gemedo Dalle (2020). These medicinal plants were used to treat both human and domestic animal ailments. Herbs were the most common (77.3%) medicinal plants followed by shrubs (18.2%). Similarly, Local people in the study area generally employed trees for furniture preparation and building. In the study area, most (99%) of the local people were discovered to be energy-dependent on firewood to generate fuel (energy) for diverse functions, including cooking. The dependence of people on the firewood and charcoal was the lack of alternative power to use. For this reason, they used different plant species to obtain energy. Most of the ornamental plants are found in the side yards and front yards of houses. Particularly near the house. However, some are planted either in back yard or far home in front yard. Most of the time, the ornamental plants grown near the house are herbs, shrubs and trees with beautiful flowers. The spices were either used for household purposes or some were used as income generating means. Cultural and religious plants were used for exercising different cultural, spiritual, and religious ceremonies. As reported by informants during group discussion these plants were used during holly days, festivities and cultural ceremonies to decorate their house and gave pleasure for the family. Three stimulant plant species were documented in the study

area, despite the fact that they were not plentiful. A diverse plant species with various ethnobotanical uses were also identified and documented in the Bibugn District, which include firewood 41 (13%), shade 23 (7%), fodder or forage 26 (8%), construction 18 (6%), ornamental 15 (5%), furniture or timber 8 (3%), spices 6 (2%), aromatic 4 (1%), cultural and religion 4 (1%) and stimulant 3 (1%). This result lined with Abebayehu Fenta (2016) in the homegarden of Sinan Districts.

5.1.10. Factors influencing species diversity homegarden plant in Bibugn District

According to the informants or homegarden owners there are many factors that hinder the species diversity and the productivity of homegarden species. As the informants identified was the size of homegarden. Due to rapid population growth, homegarden sizes reduced as ranged from 250-450 m^2 in Wurch and Dega agroecology, while homegarden sizes ranged from 600-2500 m^2 in Woina Dega and Kolla agroecology. The second main constraint was a lack of access to water. According to the informants, homegardens in the study area are mostly rain fed, and homegarden plants variety diminishes significantly during the dry season owing to a shortage of water. To meet the requirement for water, transporting, fetching and irrigating the homegarden has become a time-consuming. Some informants have water-accessible homegardens where they can grow and harvest garden produce all year due to the presence of water for irrigation purpose. Disease and pests were the third top major factors facing the communities. This result agreed with Gebremedhin Chameno, (2020) reported that 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%) as the main hindering factors encountered in managing plant biodiversity in homegarden agroforestry practices in Demba Gofa District of South Ethiopia. Temesgen Fikre, (2019) also reported that the factors that limit the contribution of homegarden

agroforestry in household livelihoods. Among them land shortage, crop competition, limited capital were the top three factors. More /less similar results were reported by Tefera Mekonen *et al*., (2015) from Sebeta-Awas districts in that lack of access water, size of homegarden, and the occurence of pest and weeds were the top three factors affecting homegarden species diversity. In the study area, due to rapid population growth, homegarden sizes reduced as ranged from 250-450 m^2 in Wurch and Dega agroecology. This result agreed with Girma Woldemichael *et al*., (2018), who reported that homegard.en size is decreasing with increasing population number and decreasing with landholding size.

5.1.11. Bibugn districts marketed homegarden plants

According to a market survey conducted in three different markets revealed that fruits, vegetables, spices, medicinal plant, sugar, cereals, stimulants, construction, furniture and ornamental plants were dominant homegarden products in the area commonly sold in markets. Similar results stated by Solomon Tamerat (2011), the marketable products from homegardens are either in fresh (vegetable, fruits and medicinal plants) or deried (seeds of some crops) forms and Regassa Bekele (2014) the market survey result showed that homegarden products like fruits, vegetables, spices, root and tubers, and others came from other market. As stated by the traders and consumers in market survey suggestions, the diversity of plant species in markets varies with seasons. For instance, cereals and vegetables dominated from October to January. Fruits dominated markets in February and May. This result agreed with Mekonnen Amberber (2011) who reported that the abundance and diversity of plant species in markets vary with seasons.

5.1.12. Indigenous knowledge and homegarden management in Bibugn District

Homegardens are recognized as a significant, self-sustaining agroecosystems that serves both agricultural production needs and farm conservation needs Arayeselassie Abebe, (2018). Homegardens that are properly managed in a traditional manner have a significant chance of preserving biodiversity, reducing food insecurity, and maintaining ecosystem services. A homegarden is a plot of land surrounding a farmer's home from which they obtain their daily supply of fruits, vegetables, fodder, medicinal herbs, and culturally significant plants. According to (80%) homegarden owners, constant production of plants for household purposes, maintains the ecological system, and makes the garden sustainable. Many different species and genetic varieties can be found in homegardens, which were crucial for the in-situ preservation of plant genetic resources as well as a source of food, firewood, medicinal plants, building materials, and generate income. In the homegardens of the study area, homegardens serve as a site for in situ conservation, has a variety of plants, including wild and domesticated. Similar result reported by Watoson and Eyzaguirre, (2002) that homegardens do play a role for in situ protection and conservation of plant species. According to Mohan (2004) all members of the house participate in the day to day working of the homegardens to varying degrees. Both male and female members of the household participate in both the labor and in the economic decision making processes. Similarly, in the study area, there were a variety of plant species management practices managed by family members, with the goal of maintaining soil fertility and protecting crops from various factors such as wildlife, disease, and pests. Family members were found to share their responsibilities. Women help with the planting, watering, fertilizing, weeding, harvesting, and selling of plants, vegetables, fruits, cereals, and spices. Similar result stated by Dawit Daba and Gemedo Dalle, (2020) states that women were active participants in the management of homegardens including planting, weeding, and watering. Local people in the

study area maintain and manage their homegardens through a variety of activities such as crop rotations, intercropping systems, and crop protection. This result agreed with Mulugeta Kebebew, (2018) in Arba Minch Town, Southern Ethiopia, who noted that management practices like intercropping were observed among people of the area. In study area, House garbage was combined with agricultural leftovers, weeds, and ashes from the homegarden to create organic fertilizer and manures were used to maintain soil fertility. The findings obtained were similar to that of Mohan, (2004) in that organic waste material from the household and animal manure, are often the only sources of nutrients added to the homegardens.

5.2. CONCLUSIONS

Ethnobotanical studies of homegardens are generally multifunctional and play a vital role in supporting households in many diverse ways, including the provision of food, firewood, building materials, medicinal plants, live fencing, foraging for livestock, and income for sustaining the livelihood of local people. In a survey of plant species diversity in 42 home gardens, a total of 110 plant species within 14 functional groups were recorded. The highest Shannon diversity indice in the study area was H' = 3.64, and the lowest was H' = 2.75. The species richness per sample site varied from 37 to 71 species, while the species diversity indices ranged from 2.75 to 3.64. Homegarden plant species in the same agroecology had the highest degree of similarity among them, while plant species found in different agroecology had more dissimilarity.

The result of the current study provide evidence that homegarden plants continue to play an significant role in maintaining food security, environmental and biodiversity conservation. The study shows that plant species in the homegardens as gradually replaced by certain income generating plants rather than cultivating varieties of plants. That is in a majority of homegardens of Bibugn District the varieties of indigenous plant species replaced by exotic ones for instance by Eucalyptus trees as one of the income generating plant.

As a final point, the study area's homegardens are the basic livelihood of the local people like food requirements, treatment of ailments on a daily basis, feeding their domestic animals, firewood collection, income creation activities, furniture making, construction, cultural and religious beliefs, as well as live fence and shade service. Thus, the study shows that the size of the homegarden, a lack of access to water, disease and pests, lack of sufficient seed (seedling), lack of awareness, and altitude and climate conditions were major factors

influencing species diversity and richness homegarden plants in Bibugn District. Local people in the study area maintain and manage their homegardens through a variety of activities such as intercropping, crop rotation, making compost, manure, and crop protection. The current study results documented ethnobotanical study of homegarden plant diversity, use categories and community manages to grow a wide range of plant species in their homegarden.

5.3. RECOMMENDATIONS

Based on the study results, the following recommendations were suggested:

- Gardeners should be encouraged by Bibugn District office to use their indigenous knowledge for mantain soil fertility and productivity management practices.
- Traditional land management and conservation mechanisms for improving soil fertility should be encouraged by the District agricultural office to promote homegarden productivity.
- The kebele administrative staff Bibugn District agricultural office awareness creation for the local people and training on the sustainable utilization and conservation of homegarden plants is critical.
- Encourage homegardening for plant biodiversity conservation and management. As a result, the district should raise awareness and promote the use of local and indigenous varieties for long-term sustainability.
- Even if Bibugn is potential area in homegarden plant diversities, there are several constraints that affect its diversities. Consequently, extension service providers should take up homegarden plant as essential and diverse commodity giving priority to enhance productivity by providing area specific fertilizers.
- Using of compost, irrigation and manure application were low in the study area. As a result, agricultural development agents and district experts of agriculture office should support farmers by providing continuous trainings, supervisions, providing enhancing the diversities of homegarden plants and introducing different irrigation water use efficiency mechanisms so as to manage and conserve the homegarden plant species.
- Eventhough Eucalyptus species had multiples use categories for the local people; this plant is one of verage of declining homegarden plant species diversity and soil

fertility, as a result, the local government and NGO advisable to encourage farmers to replace their homegardens in native species like *Hagenia abyssinica, Ficus vasta, Erica arborea, Hypericum revolutum* and *Zehneria scabra.*

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Appendix 1: Scientific Name, Family, Local Name, Growth form, use value, geographic location, altitude, and Collection No. of each Homegarden plants species in study area.

No	Scientific names	Family	Local name	Growth form	Use value	Geographical location		Altitude	Collection
						Latitude	Longitude		
1	*Acacia abyssinica* Hochst. ex Benth.	Fabaceae	Girar	T	Sh, fd ,lf ,Co , fw	10870615	37735491	2754	HA46
2	*Acacia decurrens* Willd.	*Fabaceae*	Yeferenj grar	*T*	Lf,Fw,fu,Co, Sh	10777924	37746156	3326	HA02
3	*Acacia abyssinica* Hochst. ex Benth	Fabaceae	Cheba	T	Sh, fw, lf	11010988	37751758	2223	HA07
4	*Acacia* SP.	Fabaceae	Sesa	T	Lf,Fw,Co,Fd,Sh,Or	10848453	37731913	2771	HA25
5	*Acanthus* SP.	Acanthaceae	Kosheshila	H	Sh ,fd	10753454	37771981	3563	HA18
6	*Allium cepa* L.	Alliaceae	Key shinkurt	H	F	10850473	37729719	2797	HA34
7	*Allium sativum* L.	Alliaceae	Nech shinkurt	H	Md , SP	10850473	37729719	2797	HA33
8	*Artemisia absinthium* L.	*Asteraceae*	Ereyan	H	Ar ,Cr,md	10851516	37728612	2803	HA21
9	*Arundinaria alpina* K. Schum.	Poaceae	Kerkeha	S	Fu,Fw,fd,Co	10734113	37786592	3542	HA72
10	*Arundo donax* L.	Poaceae	Shenbeko	S	LF, Fw, fd,co	10996809	37747451	2241	HA79
11	*Azadirachta indica* A.Juss.	Meliac-eae	Neem	T	Or, sh,Md	11065101	37774192	1797	HA98

12	*Bersama abyssinica* Fresen.	Melianthaceae	Azamra	S	Or	10997754	37746904	2214	HA67
13	*Beta vulgaris* L	*Chenopodiaceae*	Key sir	H	F	10923644	37757890	2512	HA103
14	*Brassica carinata* A. Br.	Brassicaceae	Yehabesha gomen	H	F	10850473	37729717	2797	HA51
15	*Brassica oleracea* L.	*Brassicaceae*	Tikil gomen	H	F	109271100	37757760	2489	HA35
16	*Brucea antidysenterica* J. F. Mill.	Simaroubaceae	Abalo	S	Md	11063408	37772401	1814	HA104
17	*Buddleja polystachya* Fresen.	Longaniaceae	Anfer	S	Lf ,Fw, Co	10767796	37751230	3435	HA32
18	*Cajanus cajan (*L.*)* Millsp.	*Fabaceae*	Meno	S	Fd,LF,Sh,Fw,or	10848453	37731913	2771	HA23
19	*Capparis tomentosa* Lam.	Capparidaceae	Gumero	S	Md .lf, fw	11062068	37771867	1815	HA62
20	*Capsicum annuum* L.	Solanaceae	Yehabesha karia	H	F ,sp	10840719	37735084	2868	HA49
21	*Carissa spinarum* L.	Apocynaceae	Agam	S	Lf, fw, or,f	10996774	37746764	2237	HA65
22	*Catha edulis* (Vahl.)Forssk. ex Endl.	Celastraceae	Chat	S	St , md	10998696	37748427	2237	HA92
23	*Cicer arietinum* L.	Fabaceae	Shimebera	H	F	11059917	37771313	1831	HA93
24	*Citrus aurantifolia (*Christm.) Swingle	Rutaceae	Lomi	S	F ,md	11065068	37774175	1798	HA88
25	*Citrus sinensis (*L,) osb	Rutaceae	Birtukan	S	F	10997889	37747538	2247	HA57
26	*Clematis hirsuta* Perro & Guill	Ranunculaceae	Anzo hareg	C	Fd	10869307	37735481	2766	HA14
27	*Coffea arabica* L.	Rubiaceae	Buna	S	St	11064076	37772969	1813	HA91
28	*Cordia affricana*	Boraginaceae	Wanza	T	Lf,Fw,Co,Sh,Fu,f,or,fd	11063426	37772407	1814	HA60

	Lam.								
29	*Coriandrum sativum* L.	Apiaceae	Denbilal	H	Sp, Md	10851516	37728612	2802	HA30
30	*Croton macrostachyus* Del.	Euphorbiaceae	Bisana	T	Lf,Fw,Co,Md,Sh, fu	11020683	37752872	2225	HA69
31	*Cucurbita pepo* L.	Cucurbitaceae	Duba	C	F	11060368	37771371	1829	HA87
32	*Cupressus lusitanica* Mill.	Cupressaceae	Yeferngi tid	T	Lf,Sh,Co,fw,or ,fu	10807650	37734808	3150	HA107
33	*Cymbopogon citratus (*DC.) Stapf	Poaceae	Tej sar	H	Ar,Or,Fd,md , Cr	10851516	37728612	2802	HA58
34	*Cynodon dactylon* (L.)pers	Poaceae	Serdo sar	H	Fd	10725385	37800496	3500	HA105
35	*Cynoglossum coeruleum (*Hochst A.Rich*)*	Boraginaceae	Shingug	H	Md .fd	10725709	37800250	3501	HA106
36	*Cyperus digitatus* Roxb.	Cyperaceae	Gerameta	H	Fd	10998875	37748703	2238	HA17
37	*Daucus carota* L.	*Apiaceae*	Carot	H	F	10931501	37757008	2482	HA43
38	*Discopodium penninervium* Hochst.	Solanaceae	Aluma	S	Lf, Fw	10731223	37792502	3497	HA13
39	*Dodonaea angustifolia* L.f.	Sapindaceae	Kitkita	S	Fw, lf, md	11065112	37774252	1795	HA45
40	*Dombeya torrida* (J.F.Gmel.)P.Bamps	Sterculiaceae	Wulkefa	T	Co,FW,LF,fd , sh	10738403	37781544	3645	HA36
41	*Elusine coracana (*L.*)*Gaertn.	Poaceae	Dagusa	H	F	11010406	37751013	2214	HA64
42	*Ensete ventricosum (*Welw.)Cheesman.	Musaceae	Enste	S	Md, Or	10842067	37735901	2839	HA38
43	*Eragrostis tef.*L.	*Poaceae*	Key teff	H	F	10868373	37735849	2773	HA48
44	*Eragrostis tef* .L.	Poaceae	Nechi teff	H	F	10999161	37747916	2211	HA66

45	*Erica arborea* L.	Ericaceae	Asta	S	Fw ,lf ,fd,Co	10730296	37793529	3487	HA109
46	*Erythrina brucei* .Schweinf.	Fabaceae	Korch	T	Lf, Sh, Fw	10850319	37730286	2807	HA03
47	*Eucalyptus camaldulensis* Dehnh.	Myrtaceae	Key bahir zaf	T	Fw,Lf,Co,Sh ,fu	10996722	37747127	2236	HA05
48	*Eucalyptus globulus* Labill.	Myrtaceae	Nech bahir zaf	T	Co,LF,Sh,Md,Fu,fw	10851517	37728611	2805	HA28
49	*Euphorbia tirucalli* L.	Euphorbiaceae	Kincheb	S	Lf ,fw	11058474	37771432	1850	HA110
50	*Euryops pinifolius* A. Rich.	Asteraceae	Gemmie	H	Fw	10755253	37766020	3510	HA12
51	*Ficus sur* Forssk	Moraceae	Sholla	T	Fw, F, Sh, lf, Fw	11062832	37772112	1813	HA86
52	*Ficus vasta* Fossk.	Moraceae	Wareka	T	Sh,Cr	11063418	37772406	1814	HA96
53	*Glycine wightii (*Wight & Am) Verde.	Fabaceae	Ayet harg	C	Fd	10871325	37734228	2748	HA15
54	*Grevillea robusta* R. Br.	Proteaceae	Gravlia	T	Co,Sh,Or,fu,fd	10851516	37728612	2802	HA31
55	*Guizotia schimperi* Sch. Bip. ex Walp.	Asteraceae	Adey abeba	H	Or ,fd	10762400	37758825	3466	HA108
56	*Guizotia abyssinica(*L.f.)Cass	Asteraceae	Nug	H	F	11065058	37774093	1792	HA71
57	*Hagenia abyssinica (*Bruce) J.F.Gmelin.	*Rosaceae*	Koso	T	LF, Sh, FW, Md	10748099	37776092	3610	HA29
58	*Helianthus annuus* L.	*Asteraceae*	Suff	H	F	11063522	37773944	1804	HA77
59	*Hordeum vulgare* L	*Poaceae*	Gebis	H	F	10722977	37801616	3499	HA43
60	*Hypericum revolutum* Vahl	Hypericaceae	Amija	S	Fw ,lf,Fd	10734717	37790613	3499	HA01

61	*Jacaranda mimosifolia* D.Don.	Bignoniaceae	Temenja zaf	T	Co ,fw,or	10934512	37749652	2397	HA90
62	*Juniperus procera* Hochst.	*Cupressaceae*	Yehabesha tid	T	LF,Co,Sh,FW,Or,Fu	10724453	37801241	3488	HA84
63	Justicia schimperiana (Hochst. ex Nees) T Anders.	Acanthaceae	Smiza	S	Lf, Fw	10850415	37729924	2797	HA20
64	*Kniphofia* SP.	Asphodelaceae	Ashangidiy	H	F ,fd	10736185	37784124	3582	HA26
65	*Lagenaria siceraria (*Molina) Stand.	Cucurbitaceae	Qill	C	Lf	11060426	37771361	1824	HA89
66	*Lathyrus sativus* L.	Fabaceae	Gouya	H	F	11058849	37771466	1843	HA95
67	*Leonotis ocymifolia* (Burm. f.) Iwarsson	Lamiaceae	Fers zing	S	Lf,fd	10734982	37789869	3511	HA94
68	*Lippia adoensis* Hochst. ex Walp.	Verbenaceae	Kessiy	S	Lf .md ,fw	10998975	37748756	2236	HA16
69	*Lobelia rhynchopetalum* Hemsl.	Lobeliaceae	Jebera	S	Md	10736528	37783038	3601	HA100
70	*Lupinus albus* L.	Fabaceae	Gebito	H	F	10850772	37728516	2801	HA22
71	*Lycopersicon esculentum* Mill	Solanaceae	Timatim	H	F	11010406	37751013	2214	HA81
72	*Malus sylvestris* Miller.	*Rosaceae*	Apple	S	F	10819530	37732511	3041	HA80
73	*Malva parviflora* Hojer	Malvaceae	Lut	H	Md ,fd	10729182	37796371	3485	HA102
74	*Mangifera indica* L.	Anacardaceae	Mango	T	F	10997326	37747236	2289	HA56
75	*Maytenus arbutifolia (*Hochst. exA. Rich.)Wilczek.	Celastraceae	Atat	S	Fw ,lf, fd	10896741	37740849	2250	HA68

76	*Musa x paradisiaca* L.	Musaceae	Muz	H	F	11051784	37769209	1968	HA83
77	*Myrica salicifolia* Hochst. ex A. Rich	Myricaceae	Shinet	S	Fw ,lf ,fu	10003011	37750884	2227	HA73
78	*Ocimum bacilicum* L.	Lamiaceae	Besobila	H	Sp	10851516	37728612	2802	HA42
79	*Ocimum lamifolium* Hochst. ex Benth.	Lamiaceae	Damakese	H	Md	10845652	37738298	2824	HA59
80	*Olea europea subsp cuspidate (*Wall. ex. DC.) Gifferri.	Oleaceae	Woyera	T	Co,Lf,Sh,Fd, Ar	11061888	37771355	1829	HA47
81	*Opuntia ficus-indica (*L.) Miller	Cactaceae	Bels	S	Lf ,F	110664818	37773818	1808	HA63
82	*Otostegia integrifolia* Benth.	*Lamiaceae*	Tunjet	S	Ar,fw , Cr	10851516	37728612	2802	HA08
83	*Pentas schimperiana* (A. Rich.) Vatke	Rubiaceae	Wuyenagift	S	Fw ,lf	10727634	37797585	3486	HA101
84	*Persea americana* Mill.	Lauraceae	Avocado	T	F , lf ,sh	109996709	37747112	2251	HA61
85	*Phaseolus lanatus* L.	Fabaceae	Adenguare	C	F	10998322	37748353	2239	HA97
86	*Phytolacca dodecandra* L'herit.	Phytolaccaceae	Endod	S	Md, Lf	10374880	37790234	3519	HA37
87	*Pisum sativium* L.	*Fabaceae*	Ater	H	F	10850772	37728516	2801	HA41
88	*Prunus persica* (L.) Batsch	Rosaceae	Koke	T	F ,fw	10923644	37757890	2512	HA99
89	*Rhamnus prinoides* L. Herit.	Rhamnaceae	Gesho	S	St	10735016	37784228	3577	HA53
90	*Ricinus communis* L.	Euphorbiaceae	Chakema	S	Lf , Fw, Md	10850772	37729719	2797	HA24
91	*Rosa abyssinica*	*Rosaceae*	Kega	S	F,lf,fw	10737858	37781971	3633	HA39

	lindley.								
92	*Rosa x richardii* Rehder.	Rosaceae	Tsigerda ababa	S	Or	10735136	37789253	3529	HA74
93	*Rosmarinus officinalis* L.	Lamiaceae	Segametbesha	H	Sp	10836313	37734674	2915	HA50
94	*Rubus steudneri* Schweinf.	Rosaceae	Injori	C	Lf ,fw	10727100	37798865	3486	HA78
95	*Rumex nervosus* vahal.	Polgonaceae	Anbacho	S	Md	11000408	37749717	2225	HA76
96	*Ruta chalepensis L.*	Rutaceae	Tena adam	H	Md , sp	10725512	37799198	3452	HA102
97	*Saccharum officinarum* L.	Poaceae	Shinkora ageda	H	F	11065058	37774093	1799	HA85
98	*Senecio myriocephalus* Sch. Bip. ex A. Rich.	Asteraceae	Sinbut	S	Fw ,lf,fd	10734899	37790300	3513	HA02
99	*Snowdenia polystachya* (Fresen.) Pilg.	Poaceae	Muja sar	H	Fd	10764061	37754061	3476	HA10
100	*Solanecio gigas* (Vatke) C. Jeffery	Asteraceae	Boz	S	Lf	10727088	37797948	3470	HA40
101	*Solanum marginatum* L.f	Solanaceae	Imboy	S	Lf	10734880	37790234	3519	HA11
102	*Solanum tuberosum L.*	*Solanaceae*	Dinch	H	F	10725385	37800496	3500	HA70
103	*Syzygium guineense* (Willd.) DC.	Myrtaceae	Dokema	T	Co .fw, fu ,F	11010406	37751013	2214	HA82
104	*Triticum aestivum* L.	Poaceae	Sendie	H	F	10850772	37728516	2801	HA27
105	*Urtica simensis* steudel.	Urticaceae	Sama	H	F, Md	10850473	37729719	2797	HA55
106	*Vernonia*	Asteraceae	Grawa	S	Fd,Lf,Sh,Md, fw,Or	10997603	37747359	2245	HA75

	amygdalina Del.								
107	*Vernonia* spp.	Asteraceae	Gengerta	S	Lf,Sh,Fw	10850319	37730286	2807	HA19
108	*Vicia faba* L.	*Fabaceae*	Bakila	H	F	10850319	37730286	2807	HA54
109	*Zea mays* L.	*Poaceae*	Bekolo	H	F	10850472	37729717	2790	HA52
110	*Zehneria scabra (*Linn.f.) Sond.	Cucurbitaceae	Herg ressa	C	Md ,Fd	10850319	37730286	2806	HA06

Growth form: T=tree, **S**= shrub, **H**=herbs, **C**= Climbers.
Use values: F= food, **Fu**= furniture, **Fw**= fire wood and charcoal, **Co**=construction, **Md**= medicinal, **Sp**=spices, **St**= Stimulant, **Or**= ornamentals **Ar**=aromatic plants, **Fd**=fodder, **LF**= live fence, **Sh** =shade, CR=cultural and religion and **MP=** multiple use.

Appendix 2: Families with number of species identified in the study area.

No	Name of family	No of species	No	Name of family	No of species
1	Fabaceae	13	25	Cactaceae	1
2	Poaceae	12	26	Capparidacee	1
3	Asteraceae	9	27	Chenopodiaceae	1
4	Rosaceae	6	28	Cyperaceae	1
5	Lamiaceae	5	29	Ericaceae	1
6	Solanaceae	5	30	Hypericaceae	1
7	Cucurbitaceae	3	31	Lauraceae	1
8	Euphorbiaceae	3	32	Lobeliaceae	1
9	Myrtaceae	3	33	Longaniaceae	1
10	Rutaceae	3	34	Malvaceae	1
11	Acanthaceae	2	35	Meliaceae	1
12	Alliaceae	2	36	Melianthaceae	1
13	Apiaceae	2	37	Myricaceae	1
14	Boraginaceae	2	38	Oleaceae	1
15	Brassicaceae	2	39	Phytolaccaceae	1
16	Celastraceae	2	40	Polgonaceae	1
17	Cupressaceae	2	41	Proteaceae	1
18	Moraceae	2	42	Ranunculaceae	1
19	Musaceae	2	43	Rhamnaceae	1
20	Rubiaceae	2	44	Sapindaceae	1
21	Anacardaceae	1	45	Simaroubaceae	1
22	Apocynaceae	1	46	Sterculiaceae	1
23	Asphodelaceae	1	47	Urticaceae	1
24	Bignoniaceae	1	48	Verbenaceae	1

Appendix 3: the frequency, relative frequency, density and relative density of HG plant in the study area.

No	Botanical name	Local names	No of quadrats a species occur	Frequency	Relative frequency	No of individual quadrats' a species occur	Density	Relative density
1	*Acacia abyssinica* Hochst. ex Benth.	Girar	15	35.71	1.28	70	0.017	0.887
2	*Acacia abyssinica* Hochst. ex Benth.	Cheba	6	14.29	0.51	16	0.004	0.203
3	*Acacia decurrens* Willd.	Yeferenj grar	2	4.76	0.17	22	0.005	0.279
4	*Acacia* sp.	Sesa	5	11.90	0.43	29	0.007	0.367
5	*Acanthus* sp.	Kosheshila	9	21.43	0.77	30	0.007	0.380
6	*Allium cepa* L.	Key shinkurt	16	38.10	1.37	127	0.030	1.608
7	*Allium sativum* L.	Nech shinkurt	29	69.05	2.47	205	0.049	2.596
8	*Artemisia absinthium* L.	Ereyan	7	16.67	0.60	11	0.003	0.139
9	*Arundinaria alpina* K. Schum.	Kerkeha	14	33.33	1.19	95	0.023	1.203
10	*Arundo donax* L.	Shenbeko	6	14.29	0.51	35	0.008	0.443
11	*Azadirachta indicia* A.Juss	Neem	9	21.43	0.77	43	0.010	0.545
12	*Bersama abyssinica* Fresen	Azamra	6	14.29	0.51	12	0.003	0.152
13	*Beta vulgaris* L	Key sir	10	23.81	0.85	57	0.014	0.722
14	*Brassica carinata* A. Br.	Yehabesha gomen	26	61.90	2.22	90	0.021	1.140
15	*Brassica oleracea* L.	Tikil gomen	11	26.19	0.94	65	0.015	0.823
16	*Brucea antidysenterica* J. F. Mill.	Abalo	5	11.90	0.43	16	0.004	0.203
17	*Buddleja polystachya* Fresen.	Anfer	11	26.19	0.94	39	0.009	0.494
18	*Cajanus cajan (*L.) Millsp.	Meno	17	40.48	1.45	78	0.019	0.988

19	*Capparis tomentosa* Lam.	Gumero	6	14.29	0.51	18	0.004	0.228
20	*Capsicum annuum* L.	Yehabesha karia	11	26.19	0.94	96	0.023	1.216
21	*Carissa spinarum* L.	Agam	9	21.43	0.77	28	0.007	0.355
22	*Catha edulis (*Vahl.)Forssk. ex Endl.	Chat	6	14.29	0.51	36	0.009	0.456
23	*Cicer arietinum* L.	Shimebera	10	23.81	0.85	90	0.021	1.140
24	*Citrus aurantifolia (*Christm.) Swingle	Lomi	8	19.05	0.68	67	0.016	0.849
25	*Citrus sinensis (*L,) osb	Birtukan	9	21.43	0.77	49	0.012	0.621
26	*Clematis hirsuta* Perro & Guill	Anzo hareg	8	19.05	0.68	25	0.006	0.317
27	*Coffea arabica L.*	Buna	5	11.90	0.43	65	0.015	0.823
28	*Cordia affricana* Lam.	Wanza	11	26.19	0.94	32	0.008	0.405
29	*Coriandrum sativum* L.	Denbilal	9	21.43	0.77	64	0.015	0.811
30	*Croton macrostachyus* Del.	Bisana	13	30.95	1.11	58	0.014	0.735
31	*Cucurbita pepo* L.	Duba	6	14.29	0.51	41	0.010	0.519
32	*Cupressus lusitanica* Mill.	Yefernji tid	27	64.29	2.30	293	0.070	3.711
33	*Cymbopogon citratus (*DC.) Stapf	Tej sar	3	7.14	0.26	18	0.004	0.228
34	*Cynodon dactylon (*L.)pers	Serdo sar	13	30.95	1.11	27	0.006	0.342
35	*Cynoglossum coeruleum (*Hochst A.Rich)	Shingug	18	42.86	1.54	45	0.011	0.570
36	*Cyperus digitatus* Roxb.	Gerameta	3	7.14	0.26	13	0.003	0.165
37	*Daucus carota* L.	Carot	11	26.19	0.94	73	0.017	0.925
38	*Discopodium penninervium* Hochst.	Aluma	16	38.10	1.37	108	0.026	1.368
39	*Dodonaea angustifolia* L.f.	Kitkita	3	7.14	0.26	12	0.003	0.152
40	*Dombeya torrida (*J.F.Gmel.) P.Bamps.	Wulkefa	18	42.86	1.54	96	0.023	1.216
41	*Elusine coracana (*L.)Gaertn.	Dagusa	7	16.67	0.60	91	0.022	1.152
42	*Ensete ventricosum (*Welw.) Cheesman.	Enste	26	61.90	2.22	84	0.020	1.064
43	*Eragrostis tef*.L.	Nechi teff	12	28.57	1.02	131	0.031	1.659

44	*Eragrostis teff.*L.	Key teff	5	11.90	0.43	88	0.021	1.114
45	*Erica arborea* L.	Asta	5	11.90	0.43	11	0.003	0.139
46	*Erythrina brucei* .Schweinf.	Korch	12	28.57	1.02	23	0.005	0.291
47	*Eucalyptus camaldulensis* Dehnh.	Key bahir zaf	15	35.71	1.28	147	0.035	1.862
48	*Eucalyptus globulus* Labill.	Nech bahir zaf	30	71.43	2.56	525	0.125	6.649
49	*Euphorbia tirucalli* L.	Kincheb	4	9.52	0.34	43	0.010	0.545
50	*Euryops pinifolius* A. Rich.	Gemmie	3	7.14	0.26	11	0.003	0.139
51	*Ficus sur* Forssk	Sholla	10	23.81	0.85	29	0.007	0.367
52	*Ficus vasta* Fossk.	Wareka	5	11.90	0.43	12	0.003	0.152
53	*Glycine wightii (*Wight & Am) Verde.	Ayet harg	5	11.90	0.43	10	0.002	0.127
54	*Grevillea robusta* R.Br.	Gravlia	5	11.90	0.43	17	0.004	0.215
55	*Guizotia schimperi* Sch. Bip. ex Walp.	Adey abeba	17	40.48	1.45	36	0.009	0.456
56	*Guizotia abyssinica (*L.f.) Cass	Nug	3	7.14	0.26	17	0.004	0.215
57	*Hagenia abyssinica (*Bruce)J.F.Gmelin.	Koso	14	33.33	1.19	72	0.017	0.912
58	*Helianthus annuus* L.	Suff	10	23.81	0.85	53	0.013	0.671
59	*Hordeum vulgare* L	Gebis	23	54.76	1.96	225	0.054	2.850
60	*Hypericum revolutum* Vahl	Amija	4	9.52	0.34	11	0.003	0.139
61	*Jacaranda mimosifolia* D.Don.	Temenja zaf	4	9.52	0.34	15	0.004	0.190
62	*Juniperus procera* Hochst.	Yehabesh a tid	18	42.86	1.54	196	0.047	2.482
63	*Justicia schimperiana(*Hochst. ex Nees) T Anders.	Semiza	17	40.48	1.45	190	0.045	2.406
64	*Kniphofia* spp.	Ashangidi y	7	16.67	0.60	21	0.005	0.266
65	*Lagenaria siceraria (*Molina) Stand.	Qill	6	14.29	0.51	24	0.006	0.304
66	*Lathyrus sativus* L.	Gouya	8	19.05	0.68	67	0.016	0.849
67	*Leonotis ocymifolia*	Fers zing	9	21.43	0.77	62	0.015	0.785
68	*Lippia adoensis* Hochst.ex Walp.	Kessiy	3	7.14	0.26	14	0.003	0.177
69	*Lobelia rhynchopetalum* Hemsl.	Jebera	3	7.14	0.26	11	0.003	0.139
70	*Lupinus albus* L.	Gebito	12	28.57	1.02	113	0.027	1.431
71	*Lycopersicon*	Timatim	7	16.67	0.60	68	0.016	0.861

	esculentum Mill							
72	*Malus sylvestris* Miller.	Apple	15	35.71	1.28	62	0.015	0.785
73	*Malva parviflora* Hojer	Lut	6	14.29	0.51	19	0.005	0.241
74	*Mangifera indica* L.	Mango	11	26.19	0.94	66	0.016	0.836
75	*Maytenus arbutifolia (*Hochst. exA. Rich.) Wilczek.	Atat	8	19.05	0.68	22	0.005	0.279
76	*Musa x paradisiaca* L.	Muz	5	11.90	0.43	36	0.009	0.456
77	*Myrica salicifolia* Hochst. ex A. Rich	Shinet	5	11.90	0.43	14	0.003	0.177
78	*Ocimum bacilicum* L.	Besobila	6	14.29	0.51	50	0.012	0.633
79	*Ocimum lamifolium* Hochst. ex Benth.	Damakese	7	16.67	0.60	23	0.005	0.291
80	*Olea europea subsp cuspidate (*Wall. ex. DC.) Gifferri.	Woyera	12	28.57	1.02	60	0.014	0.760
81	*Opuntia ficus-indica (*L.) Miller	Bels	6	14.29	0.51	16	0.004	0.203
82	*Otostegia integrifolia* benth.	Tunjet	5	11.90	0.43	14	0.003	0.177
83	*Pentas schimperiana* (A. Rich.) Vatke	Wuyenagi ft	6	14.29	0.51	25	0.006	0.317
84	*Persea americana* Mill.	Avocado	8	19.05	0.68	79	0.019	1.001
85	*Phaseolus lanatus* L.	Adenguar e	2	4.76	0.17	7	0.002	0.089
86	*Phytolacca dodecandra* L'Herit.	Endod	6	14.29	0.51	37	0.009	0.469
87	*Pisum sativium* L.	Ater	15	35.71	1.28	129	0.031	1.634
88	*Prunus persica* (L.) Batsch	Koke	3	7.14	0.26	18	0.004	0.228
89	*Rhamnus prinoides* L. Herit.	Gesho	39	92.86	3.33	462	0.110	5.851
90	*Ricinus communis* L.	Chakema	11	26.19	0.94	48	0.011	0.608
91	*Rosa abyssinica* lindley.	Kega	16	38.10	1.37	61	0.015	0.773
92	*Rosa x richardii* Rehder.	Tsigerda ababa	11	26.19	0.94	36	0.009	0.456
93	*Rosmarinus officinalis* L.	Segametb esha	2	4.76	0.17	6	0.001	0.076
94	*Rubus steudneri* Schweinf.	Injori	11	26.19	0.94	29	0.007	0.367
95	*Rumex nervosus* vahal.	Anbacho	9	21.43	0.77	57	0.014	0.722
96	*Ruta chalepensis* L.	Tena adam	25	59.52	2.13	225	0.054	2.850

97	*Saccharum officinarum* L.	Shinkora ageda	6	14.29	0.51	40	0.010	0.507
98	*Senecio myriocephalus* Sch. Bip. ex A. Rich.	Sinbut	10	23.81	0.85	64	0.015	0.811
99	*Snowdenia polystachya (*Fresen) pilg.	Muja sar	8	19.05	0.68	68	0.016	0.861
100	*Solanecio gigas (*Vatke) C. Jeffery	Boz	20	47.62	1.71	65	0.015	0.823
101	*Solanum marginatum* L.f	Imboy	5	11.90	0.43	20	0.005	0.253
102	*Solanum tuberosum* L.	Dinch	34	80.95	2.90	383	0.091	4.851
103	*Syzygium guineense* (Willd.) DC.	Dokema	6	14.29	0.51	25	0.006	0.317
104	*Triticum aestivum* L.	Sendie	21	50.00	1.79	276	0.066	3.495
105	*Urtica simensis* steudel	Sama	13	30.95	1.11	28	0.007	0.355
106	*Vernonia amygdalina* Del.	Grawa	5	11.90	0.43	30	0.007	0.380
107	*Vernonia* spp.	Gengerta	20	47.62	1.71	99	0.024	1.254
108	*Vicia faba* L	Bakila	15	35.71	1.28	114	0.027	1.444
109	*Zea mays* L.	Bekolo	22	52.38	1.88	265	0.063	3.356
110	*Zehneria scabra (*linn.f.) sondll.	Herg ressa	1	2.38	0.09	8	0.002	0.101
	Total	2790.48					1.880	

Appendix 4: Medicinal plant species in study area with health problems, part used, and method of preparation as well as their use.

No	Botanical name	local names	Health problems	Part used	Method of preparation and use
1	*Allium sativum* L.	Nech shinkurt	Common cold	Bulb	Chewing bud or smelling typically
			Headache	Blub	Chewing bud or smelling typically
			Abdominal pain	Blub	Bulb of *Allium sativum* and seed of seed of *Lepidium sativum* are pounded together and eaten with injera.
			Malaria	Blub	Bulb of allium and rhizome of *Ginger* are pounded and eaten with honey.
2	*Artemisia absinthium* L.	Erayan	Evil-eye	Leaves	The leaves are used to be protected against the evil eye added with *Allium*.
			Syphilis	Whole parts	The whole parts is crushed, mixed with little water and drunk it.
3	*Azadirachta indica* .A.Juss	Neem	Toothache	Leaf	The leaf is hold by the infected teeth during the feeling of ache.
4	*Brucea antidysenterica* J. F. Mill.	Abalo	Wound	Leaves	The leaf is pounded, squeezed and then creamed affected part until recovery
5	*Capparis tomentosa* Lam.	Gumero	Epidemic	Bark	the bark is crushed and placed on the red hot charcoal and is used to fumigate smokes
			Intestinal worm	Root	Root is dried and powdered, mixed with water. Three spoon is given per a day for three days
6	*Catha edulis (*Vahl.)Forssk. ex Endl.	Chat	Gonorrhea	Leaf	Red color leaf is cooked, stayed for one night and taken for 2 - 3 days in the morning by adding small amount of sugar.
7	*Citrus aurantifolia (*Christm.)Swingle	Lomi	Athletes' foot	Fruit	The fruit of citrus is squeezed and creamed on affected for continues days.
8	*Coriandrum*	Dinb	Common	Seeds	The seed is boiled with *Allium sativum*

	sativum L.	elal	cold, cough		and drink it.
9	*Croton macrostachyus* Del.	Bisana	Ascariasis	Bark	The bark is crushed, powdered , mixed with *cicer arietinum* powdered, water and backed than eaten before any food for 3 days
			Wound	Bark	Bark is dried and powdered, added to wound.
10	*Cymbopogon citratus (*DC.) Stapf	Tejsar	Abdominal pain	Root	The root is chewed to treat pain of abdominal.
			Evil-spirit	Root	The leaves is used to protect from the evil spirit
11	*Cynoglossum coeruleum (*Hochst A.Rich)	Shingug	Febrile illness	Leaf	Squeezed leaves with water are put on cap and drink it.
12.	*Ensete ventricosum (*Welw.)Cheesman	Gunaguna	bone injuries, lack of energy	Corm	The corm or pseudo stem is chopped, fermented and mixed with butter.
13	*Eucalyptus globulus* Labill.	Nechbahirzaf	Fibril illness and bronchitis	Leaf	The leaf is chopped and boiled with water and in hale repeatedly the vapor, while boiling steam bath is taken by human in closed door and window
14	*Hagenia abyssinica(*Bruce) J.F.Gmelin.	Kosso	Tape worm	Seeds	The seed is crushed, powdered, mixed with milk, boiled and drink for 5 days
15	*Lippia adoensis* Hochst.ex Walp.	Kessie	Fibril illness	Leaf	Steaming the leaf by inserting it in boiled water and also drink.
16	*Lobelia rhynchopetalum* Hemsl.	Jebera	Evil-eye	Bark and root	The bark and root is crushed, mixed little water and sniffed at the sickness time
17	*Malva parviflora* Hojer L.	Lut	Wound and ring worms (“kukucha”)	Root	The root of Malva is pounded, squeezed and creamed on affected part.
18	*Ocimum lamifolium* Hochst. ex Benth.	Damakessie	Febrile illness	Leaf	The fresh leaf is squeezed and added in tea or coffee and drunk.
19	*Phytolacca dodecandra* L’Herit.	Endod	Rabies	Leaf	The leaf is pounded mixed with Coffee and drunk a tea cup every morning for evening until recovery.
			Abortion	Leaf	The leaf is squeezed and drunk the

					juice
20	*Ricinus communis* L.	Chakema	Febrile illness	Leaf	The leaf is mixed with leaf of anbacho is pounded, squeezed and added through nose
21	*Rumex nervosus* vahal.	Anbacho	Snake bite	Leaf	The leaf is chewing and swallowing the solution during time bite.
			Wound	Leaf	The leaf is pounded, squeezed and then creamed on wounded part.
			Eye disease	Leaf	The leaf is pounded, squeezed and added drops through eye.
22	*Ruta chalepensis* L.	Tena adam	Evil eye	Seed	The seed is mixed with allium sativum and mixed with hyena liver are finely crushed together and sniffed at the sickness time.
			Stomachache	Leaf	The leaf is Squeezed and drunk the juice during ache.
23	*Urtica simensis* steudel	Sama	Gastritis	Leaf	The fresh leaf of is collected and roasted like “wot” and eaten by injera.
24	*Vernonia amygdalina* Del.	Grawa	Herpes	Leaf	The leaf is pounded, powdered and applied on affected area
			Athletes foot	Leaf	The leaf is crushed, squeezed and creamed on affected part for continuous days.
25	*Zehneria scabra (*linn.f.) sondll.	Hargressa	Stomach problem	Leaf	The leaf is pounded, powdered mixed with honey than eaten.
			Hermorrhoids	Stem	The stem is heated or warmed by charcoal and the warmed step put on the affected part until recovery.
			Febrile illness	Leaf	The leaf is boiled and then taken up the heat

Appendix 5: Check list of semi-structured interview questions for data collection.

I. General Information

Name of respondent…..... Sex….....

Date of interview….....Kebele….....Age….....Educational Status….....

Marital status…..... Religion----------

1.For how long have you lived in the area? Since birth

A. For the last 20 years

B. For the last 10 years

C. For less than 10 years

II. Ethnobotanical information.

1. Mention the traditional way of classifying vegetations, seasons, climate and landscapes in your area.
2. List the soil types of your locality.
3. What is the sizes land of your homegardens?
4. What is the name of homegardens in your locality**?**
5. Excuse me, List the name of plant in your homegardens with their local name.
6. Excuse me, tell the name of multipurpose plant species in your garden and rank top six of them?
7. Excuse me; List all food plants growing in your homegardens?
8. Excuse me; List all medicinal plants growing in your homegardens, which parts are used and application method.
9. Which types of plant/crops in your homegardens are more important? Rank them accordingly.
10. Elucidate the fruit crops, vegetable crops, spices, shade trees, live fences, aromatics ,medicinal plants, ornamentals, or others growing in your homegardens.
11. List fodder plants growing in your homegardens?
12. How do you manage the soil fertility of your homegarden?
    A. Commercial fertilizer
    B. By adding manures
    C. Compost
    D. If other, please specify.....
13. For what purpose do you use your homegarden productions?
14. What are the conservation practices that you implement to manage your homegarden?
15. Which family member participates in gardening practice?
    A. Husband
    B. Wife
    C. Children
    D. Specify if any.....

List of plant species collected in Bibugn District, local name, forms (habits) and use value of their parts.

No	Collection number	Local names	Growth Habits	Use values	Preliminary identification
1					
2					
3					
4					
5					
6					

Appendix 6: Question For market survey.

1. Are these plant products cultivated/wild?
2. Mention the most commonly homegardens plants you sell in the market?
3. What are the use categories of homegardens plants you sell/buy?
4. Accessibility per year: A. Jan. - April ii B. May- August iii C. Sept. - Dec.

Appendix 7: List of Informants background in the Study Area.

No	Name	Sex	Age	Educational background	Marital status	Kebele	Religion	Occupation
1	Yeshareg Bizualem	M	37	Illiterate	Married	Debre zeit	Orthodox	Farmer
2	Asdenek Embiale	M	60	Illiterate	Married	Debre zeit	Orthodox	Farmer
3	Tsehay Aleminew	M	68	Illiterate	Married	Debre zeit	Orthodox	Farmer
4	Yalemteg Lingerew	M	36	Illiterate	Married	Debre zeit	Orthodox	Farmer
5	Sewmehon Wassie *	F	31	1-10	Married	Debre zeit	Orthodox	Farmer
6	Sinetsehay Maru*	F	40	Illiterate	Married	Debre zeit	Orthodox	Farmer
7	Yegerie Admie	M	42	Illiterate	Married	Digo Kanta	Orthodox	Farmer
8	Asamen Wale	F	55	Illiterate	Married	Digo Kanta	Orthodox	Farmer
9	Aseratu Alemeneh	M	60	Basic	Married	Digo Kanta	Orthodox	Farmer

10	Neges Aseratu *	M	30	1-10	Married	Digo Kanta	Orthodox	Farmer
11	Yayeh alemu	M	35	Illiterate	Married	Digo Kanta	Orthodox	Farmer
12	Kassa Ademie *	M	69	Illiterate	Married	Digo Kanta	Orthodox	Farmer
13	Dejene sewagegn*	M	42	Ill	Married	Meseba	Orthodox	Farmer
14	Asmare fenta	M	70	Basic	Married	Meseba	Orthodox	Farmer
15	Habitamu Getie	M	45	Illiterate	Married	Meseba	Orthodox	Farmer
16	Bawuke fentie	M	33	1-10	Married	Meseba	Orthodox	Farmer
17	Mosit nigat*	F	50	1-10	Single	Meseba	Orthodox	Farmer
18	Melekam gebeyehu	F	69	Illiterate	Married	Meseba	Orthodox	Farmer
19	Defaru wendalew*	M	37	Basic	Married	Debre sina	Orthodox	Farmer
20	Tassie tameru	M	48	Basic	Married	Debre sina	Orthodox	Farmer
21	Megebaru alebachew	M	46	Basic	Married	Debre sina	Orthodox	Farmer
22	Abere wubie*	M	68	Basic	Married	Debre sina	Orthodox	Farmer
23	Senkie gebeyehu	F	70	Illiterate	Married	Debre sina	Orthodox	Farmer
24	Yezihalem gebeyehu	M	50	Basic	Married	Debre sina	Orthodox	Farmer
25	Mintamer Yimer*	F	48	Illiterate	Married	Ded eyesus	Orthodox	Farmer
26	Biyayih Bassie	M	26	1-10	Married	Ded eyesus	Orthodox	Farmer
27	Yilkal Ayalew	M	40	Illiterate	Married	Ded eyesus	Orthodox	Farmer
28	Kumie Mengist*	M	45	Illiterate	Married	Ded eyesus	Orthodox	Farmer

29	Endalew Tsega	M	43	Illiterate	Married	Ded eyesus	Orthodox	Farmer
30	Fentie Yigzaw	M	32	Basic	Married	Ded eyesus	Orthodox	Farmer
31	Ager Endawoke *	F	42	Basic	Married	Arusi	Orthodox	Farmer
32	Binalf Azmeraw	M	53	Illiterate	Married	Arusi	Orthodox	Farmer

33	Gojjam Fentie	M	35	1-10	Married	Arusi	Orthodox	Farmer
34	SimegnewTegibaru*	M	62	Basic	Married	Arusi	Orthodox	Farmer
35	Shiferaw Dagne	M	47	Basic	Married	Arusi	Orthodox	Farmer
36	Enyew Abitew	M	67	Illiterate	Single	Arusi	Orthodox	Farmer
37	Yetayesh Aderaw	F	61	Illiterate	Married	Gena memcha	Orthodox	Farmer
38	Mamar Binalf	M	25	1-10	Married	Gena memcha	Orthodox	Farmer
39	Keralem Chanie	F	52	Illiterate	Married	Gena memcha	Orthodox	Farmer
40	Aleka Meseret*	M	60	Illiterate	Married	Gena memcha	Orthodox	Farmer
41	Gesese Debasu	M	65	Illiterate	Married	Gena memcha	Orthodox	Farmer
42	Molla Lashitie*	M	66	Illiterate	Single	Gena memcha	Orthodox	Farmer

* Key informants.

The first image shows that plant species found in the Wurch agroclimte and the second image also revealed that homegarden plant that found in the dega agroclimate.

Photo by Haymanot. A, 2023).

(Photo by Haymanot. A, 2023)

The third and fourth images shows that plant species found in the Woina dega agroclimte and the fifth image also revealed that homegarden plant that found in the dega agroclimate.

Figure 7: Representative Homegardens sample in different agroecology in 2023.

Figure 8: Samples of photographs that represent key informants and focus group discussion in 2023.

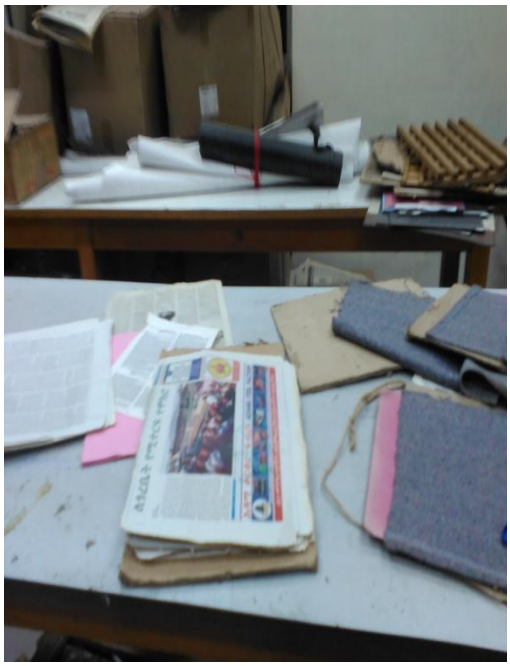

Figure 9: Sample of photographs that showing the field work and Herbarium activity of researcher in 2023.