Homegarden plant diversity and their use category in Sinan district, East Gojjam Zone of Amhara region

Abebayehu Fenta Tamer

A Thesis Submitted to School of Graduate Studies of Addis Ababa University in Partial Fulfillment of the Requirements for the Degree of Master of Science in General Biology Program under Department of Zoological Sciences

GENERAL BIOLOGY PROGRAM UNDER DEPARTMENT OF ZOOLOGICAL SCIENCES

COLLEGE OF NATURAL SCIENCE

ADDIS ABABA UNIVERSITY

Addis Ababa, Ethiopia

August, 2016

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

Homegarden plant diversity and their use category in Sinan district, East Gojjam Zone of Amhara region

By

Abebayehu Fenta Tamer

This is to certify that the thesis prepared by Abebayehu Fenta, entitled: *Homegarden plant diversity and their use category in Sinan district, East Gojjam Zone of Amhara region* and submitted in partial fulfillment of the requirements for the Degree of Master of Science in General 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.

Signed by the Examining Committee:

Examiner _____ Signature_____ Date_____

Examiner _____ Signature_____ Date_____

Advisor _____ Signature_____ Date_____

Chairman _____ Signature_____ Date_____

ABSTRACT

Homegarden plant diversity and their use category in Sinan district, East Gojjam Zone, Amhara Region, Ethiopia

Abebayehu Fenta Tamer, MSc Thesis
Addis Ababa University, 2016

The homegarden is a small-scale traditional agricultural ecosystem and has played an important role in conservation and sustainable utilization of plant biodiversity. An ethnobotanical study was conducted in Sinan district, East gojjam Zone of Amhara region and investigated diversity of useful plants, their use category in the homegardens and the associated local management practices. A multistage sampling technique was employed to select three kebeles and 150 households. Ethnobotanic information were gathered by conducting observation, free-listing, group discussions, and semi-structured interview. Shannon-Weiner diversity index and Soreson`s index of similarity were used in the data anlysis and computed by using Microsoft Excel 2007. A total of 125 plant species were recorded and these are distributed in 51 families. *Asteraceae* stood first containing 15 (12 %) species, *Fabaceae* came in the second place with 11 (8. 8%) species, and *Poaceae*, *Rosaceae and Solanaceae* each in the third with 8 (6.4 %) species. *Rhamnus prinoides* came out as the dominant species being found in 76.67% HGs followed by *Vernonia urticifolia* 60.67% and *Ensete ventricosum* 57.33%. Diversity indices with the value of (H'= 3.38) highest for Gedamawit followed by Sinan mariyam (H'= 2.80) and Dangulie (H'= 2.62). Evenness index with the value (E = 0.73) highest for Gedamawit followed by Sinan mariyam (E =0.65) and Dangulie (E=0.63). There were about more than fifteen major use reports of plants in the study area. 60(48%) of plants that occurred in the homegardens with multiple uses took the top position followed by 45(36%) live fence plants and 43(34.4%) fodder plants among others. Therefore, it can be concluded that homegardens in the study area contain different types of plants and significantly contribute to the livelihood of the people.

Key words: Ethnobotany, local management practices, biodiversity, Sinan, East Gojjam Zone, Amhara Region.

Acknowledgements

First, I would like to express my deepest gratitude to my advisor, Dr. Bikilla Workineh, for his constructive guidance, encouragement and deep interest throughout the entire period of my study. My thanks are also due to the staffs of the high school and for my students in Sinan district, for helping me during data collection, analysis, and report writting.

I would like to thank very much the Agricultural Deparment chair person, development agents of the Wereda Adminstration and informants in the study site for facilitaing the research work, provision of necessary equipments and information during field work.

I would like to thank very much those individuals who helped me in the plant identification process particularly Gezahegen Ali, Molla Bellay, Getu Alemayehu and Hirut, and the staff members of the National Herbarium (ETH), Addis Ababa University for their cooperation in the herbarium work.

I would like to thank my friends, Temesgen Adane, Wubdil Belay, Mahelet, Assemie, Anteneh Abebayehu, Belew Asrat, and Nigusu Welde Giyorgis who support me by providing GPS and moral encouragement.

I am also pleased to thank my wife Hululanchi Assassa, my child Nahome Abebayehu, my mother Sintayehu Tadesse, my sisters Aynadis and Banchamelack, and my brothers Mollalegn and Wubalem for the love and moral support they offered me throughout my work.

Table of Contents ..... **Page**

List of Figures

List of Tables

List of Abbreviations

CSA-Central Statistical Agency

DA- Development Agent

Da-Dangulie

Gd-Gedamawit

FAO – Food and Agricultural Organization

GPS- Global Positioning System

HG-Home garden

NGOs- Non-Governmental Organizations

Sm-Sinanmariyam

SWENRPO-Sinan Wereda Environmental and Natural Resource Protection Office

1. INTRODUCTION

1.1 Background and Justification

Homegardens are agro-ecosystems located close to the area that serves as a permanent or temporary residence (Vogl-Lukasser *et al*., 2002). Homegardens are defined in multiple ways highlighting various aspects based on the context or emphasis and objectives of the research (Hoogerbrugge and Fresco, 1993; Moreno-Calles *et al*., 2010). A large proportion of the cultivated plants and domestic animal species are maintained in homegardens, traditionally known by different vernacular names. The most common vernacular equivalents for the term homegarden are *yeguaro-ersha* (in Amharic language), *eddo* (in oromo language) (Zemede Asfaw, 2001) and *dhri-bet* (in tigregna language) (Gebremedhin Teklehaimanot and Mulubrhan Haile, 2007). The former term literally means the backyard farm while at the same time indicating the closeness of the cultivation plot to the house (Zemede Asfaw, 2001).

Although homegardens around the world vary considerably, they share some features. This is particularly true for tropical homegardens that evolved under the specific environmental conditions of the region through intensive household care. The unique nature of the homegarden system can be best expressed by describing three interrelated features: architecture, diversity, and sustainability (Feleke weldeyes, 2011). Ethiopian homegardens are unique in their architecture, crop mix and the key (dominant) species, which include a significant number of indigenous crop taxa and some that are truly endemic (eg. *Coffea arabica*, *Ensete ventricosum*, *Coccinia abyssinica*, *Brassica carinata, Plectranthus edulis* and many other lesser-known species). The presence of *enset* and other restricted-range crops makes Ethiopian home gardens unique and assures their reliance on indigenous crops and management practices (Zemede Asfaw, 2001).

Many studies provide descriptive evidence and analysis of homegardens in developing countries in Asia, Africa, and Latin America pinpoints their numerous benefits to communities and families (Galhena *et al*., 2013). They are the logical production system for crop plants that are eaten fresh, used on a daily basis, consumed only in small quantities, or that need specific attention such as vegetables, spices and medicinal plants.

Species such as minor fruit, root and tubers and others also fall into this category (Vogl-Lukasser, *et al*., 2002). The type of crops grown and the closeness of the garden to the house and kitchen assure that homegardens contribute significantly to food security, especially because they are an important source of micro-nutrients and vitamins, and therefore play a critical role in the nutritional balance of the human diet (Swaminathan, 1996). In addition, people that manage homegardens find in them multiple goods to satisfy their social, cultural and economic needs mainly medicines, ornamental and spiritual wellbeing, fodder, fuelwood and products that generate monetary incomes (FAO, 2004; Blancas *et al*., 2010). These benefits are presented and explained through the vast experiences on homegardens from developing nations around the world (Galhena *et al*., 2013).

Homegardens are also important for *in situ* conservation of a wide range of plant genetic resources (Engels, 2001). Since homegardens are spaces of resources, management techniques, and human cultural processes; these systems are considered as important reservoirs of bio-cultural heritage (Kumar and Nair, 2004). It is a place for the generation and maintenance of valuable biological diversity and its associated cultural heritage. This heritage is revealed in the depth of local peoples' indigenous knowledge, practices, and skills (Zemede Asfaw, 2001).

The ethnobotanical knowledge of farmers is an important resource for the development of sustainable agriculture and the conservation of genetic material. It is in this sense that indigenous knowledge is said to be at the hands of farmers and which is important for sustainable use of resources and sustainable development of livelihoods in particular and society in general (Mathewos Agize *et al*., 2013). For this study, Sinan is selected because homegardening is a long standing agricultural practice of the people of the area and there is no research conducted regarding the significance of homegarden plant diversity and local management in the area. Therefore, the study was conducted with the aim to identify the major plant species, to see their diversity and use categories as well as to document the local management for conservation and sustainable utilization of plants in the homegardens of Sinan district, East Gojjam Zone.

1.2 Statement of the problem

An important part of the genetic diversity of useful plants is conserved by farming communities. They have conserved and used agrobiodiversity for the survival of the humankind over time and space. Homegardens, like other similar gardens, serve diverse functions that range from satisfying household needs through biodiversity conservation to landscape stability (Feleke Weldeyes, 2011). The food security and sustainable utilization of homegardens depends on the extent of availability of diversity and its management practices in the ecosystems (Swaminathan, 1996; Pulami and Paudel, 2004). Homegarden plant diversity in the study area is closely linked to the livelihoods of many people and their economic development and it touches upon agricultural productivity and sustainability, human health and nutrition, indigenous knowledge, gender equality, water resources, aesthetic and cultural well-being of society. So lose of homegarden plant diversity will result in the loss of the benefits obtained from homegardens.

The problems encountered within homegardens are not determined and addressed by public or private-sector funded research in the district. According to Engels (2001), this situation will lead to a continued neglect of the homegardens, excluding them from national or regional conservation efforts, and requiring due attention and improvement. The present study of homegardens at Sinan district of East gojjam Zone in Amhara region of Ethiopia will contribute to a better understanding of home garden plant diversity, major plant use categories and the factors affecting plant diversity in home gardens. Moreover, such studies at homegardens in which people intensively cultivate plants for different purposes under more cares of management than for field crops could help to document indigenous knowledge of important plants cultivation and management practices.

1.3 Significance of the study

The study can provide valuable information about the status of homegarden plant diversity, their use categories and indigenous management practices. It can also serve as a source of information about factors that affect homegarden plants. Moreover, it can

offer baseline information for the local administration or other concerned agencies in the area to develop conservation strategy for homegarden plants as well as for planning integrated sustainable management of homegarden plants in Sinan district.

1.4 Objectives

1.4.1 General objective

The main objective of this study was to investigate the diversity of useful plants, thir use categories and the associated local management practices in the homegardens in Sinan district.

1.4.2 Specific objectives

- To show the local people resource classification system and types of homegarden in Sinan district.
- To describe the species diversity (richness and evenness) of homegarden plants in Sinan district.
- To identify the major use categories and habits of plants found in the homegardens.
- To document the local management practices and peoples knowledge in conservation of plant diversity in homegardens.
- To identify factors affecting homegarden plant diversity.

1.5 Research questions

- How do the people classify resources and what type of homegardens are there in the district?
- How diverse are the homegarden plants in Sinan district?
- What are the major use categories and habits of plants in sinan district?
- What traditional management practices and skills are there to conserve plant diversity in homegardens?
- What are the factors that influence the diversity of homegarden plants?

2. LITERATURE REVIEW

2.1 General description of homegardens

A homegarden refers to the traditional land use system around a homestead, where several species of plants are grown and maintained by the household members and their products are primarily intended for the family consumption. Several terms have been used to describe these garden production systems, such as "homestead garden, backyard garden, kitchen garden, agroforestry, mixed garden, garden culture, etc" (Mictchell and Hanstad, 2004). The term "homegarden" is preferred because it stresses the close relationship between the garden and the social group residing at home (Zemede Asfaw, 2001).

Although the homegarden has been used rather loosely to describe diverse practices from growing vegetables behind houses to complex multi-storied systems, the word is used here to refer to land-use practices involving deliberate management of multipurpose trees and shrubs in intimate association with annual and perennial agricultural crops and, invariably, livestock, within the compounds of individual houses, the whole crop-tree-animal unit being intensively managed by family labor (Millat-e-Mustafa, 1997). It can therefore be seen that the homegardens display many agroforestry concepts: the intimate mix of diversified agricultural crops and multipurpose trees fulfills most of the fundamental needs of the local populations and their multistoried configuration and high species diversity avoid the environmental deterioration commonly associated with mono-cultural production systems. Moreover, they have been producing sustained yields for centuries in a most efficient way. Thus homegardens are economically efficient, ecologically sound and biologically sustainable agroforestry systems (Fernandes and Nair, 1986).

Ecosystem services that homegardens provide to the larger agricultural systems and the health and well-being of the household are often noted. The homegardens provide, protect and enrich environments for varieties that may be susceptible to biotic and abiotic stress in fields (Agbogidi, 2013). They are valued for different reasons, for instance: one

can distinguish an intrinsic value related to its aesthetic value, religious value, etc.; an ecosystem value as mentioned before; and a value in its contribution to livelihoods. Closely related to these different types of value is the fact that genetic diversity managed by people has a close and direct linkage with the cultural diversity. Therefore, while purposefully conserving one aspect of diversity, it is impossible to avoid considering the others (Kumar and Nair, 2004). Sthapit *et al*., (2004) summarized the main features of homegardens with their explanation in table form (Table 1).

Table 1: The main features of homegardens

Feature	Explanation
Function	• Subsistence of household needs, • Easy access to fresh harvests for home cooking. • Site for introduction, experimentation and domestication; and multipurpose.
Size	• Variable in size and design as determined by choice of species (crops Vs trees), and often linked with large agroecosystem.
Diversity	• Species richness and home for unique species and varieties.
Composition	• Consist of crops, vegetables and fruits, forestry, fodder fuel wood and others; • Both traditional cultivars and hybrid present, and multilayer canopy structure.
Value	• Food security, food quality and dietary diversity and health; • Cultural, religious and spiritual and Aesthetic value. • Ecosystem health and support; and Conservation of unique and rare species.
Ecosystem services	• Habits for pollinators and associated biodiversity; • Support nutrient recycling, water and soil retention; Carbon sequestration and regulation of local hydrological cycles.

Source: Sthapit *et al*., (2004).

2.2 Types of homegarden

Homegardens worldwide are integrated into family life. They may be divided broadly into **traditional gardens**, resulting from a long history of adaptation of plants to local needs and conditions, and **model gardens**, often developed with external support, ideas and imported technologies. In urban areas and isolated rural areas, a traditional **kitchen garden** may be inexpensively established - a small plot from which vegetables and garnishes are taken each day to improve meals. It can be watered with the waste water from dish washing and bathing. Depending on local environmental sensitivity and available recycling technologies such as composting and biogas production, nutrients can be utilized from kitchen and human wastes. Requiring a little more space and capital invested, traditional **mixed gardens** integrating poultry, other livestock and fish ponds provide productive opportunities for waste transformation and nutrient recycling. **Agroforestry gardens** maximize use of scarce land by cultivating crops in multiple layers:-trees, vines, and under storey and root crops (FAO, 2004).

Homegardens are found in most regions of the tropics and subtropics, but a majority of them are in the low land humid tropics (Fernandes and Nair, 1986). Different types of homegardens generally observed in various parts of the world. This homegarden typology is derived from the terms people locally use to refer to the homegardens and the related structures, and is largely based on the location (in relation to the house) and composition of these gardens (Shrestha *et al*., 2001).There are many types of traditional homegardens, varying in their layouts and types of species grown, and associated with different geographical areas or ethnic groups (Abdoellah *et al.*, 2006; Hamilton and Hamilton, 2006).

According to Shrestha *et al*., (2001), fenced area around house, is the most common type of homegarden in Nepal. These homegardens are maintained around the homestead and are generally fenced to keep livestock away from the area. In Ethiopia, the homegarden area, which has variable shapes and sizes, includes the living house, animal houses, grain stores, drying places, and plots of garden species. It is usually fenced and the fence is frequently reinforced by multipurpose live tree and shrub species. Common garden sizes

range from about 500m^2 to more than 2,500m^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. Larger gardens, approaching the upper limit, are more frequent in households where the homegarden is the only cultivated land available. When crop composition is considered, the gardens are typically of the mixed type (Zemede Asfaw, 2001).

Common locations for gardens in Ethiopia, in relation to the house are back yards, front yards, side yards and those that almost encircle the house. In many rural villages where homegardening is well developed, the space in front of the house is with a clean green meadow as a family resting and socializing place. In some areas, fences confine gardens while in others they merge with crop fields and may be fenced together (Zemede Asfaw, 2001).

2.3 Homegardens in the maintenance of biological diversity

2.3.1 Biodiversity conservation and development in homegardens

Homegardens are micro-environments containing high levels of species and genetic diversity within larger farming systems. These gardens are not only important sources of food, fodder, fuel, medicines, spices, construction materials and income in many countries around the world, but are also important for *in situ* conservation of a wide range of plant genetic resources (Engels, 2001). Homegardens are dynamic systems; their structure, composition and species and cultivar diversity are influenced by changes in the socio-economic circumstances and cultural values of the households that maintain these gardens. The conservation of agrobiodiversity is inseparable from the sustainable use of plant genetic resources in agriculture. This agro-biodiversity conservation is both a goal and a means to secure the livelihoods and well-being of farming communities in poorer regions of the developing world. Homegardens are clear examples of diversity rich production systems that serve both a development and a conservation function (Agbogidi, 2013).

2.3.2 Conservation value of homegardens

Homegardens, one of the oldest forms of managed land-use systems, are considered to be the richest in species diversity per unit area. Several landraces and cultivars, and rare and endangered species have been preserved in the homegardens. Homegardens as an ecosystem contain multiple levels of diversity, including cultural, genetic and agronomic diversity (Zemede Asfaw, 2001; Kumar and Nair, 2004).

There are various ways that homegardens contribute to biodiversity conservation at the ecosystem, species and genetic levels. At the ecosystem level, the homegarden provides a complex micro-environment that links more complex natural ecosystems with agricultural systems. Homegardens are often the focal point of a household's social interactions within the family and with visitors (Casas *et al*., 2008). One of the important functions that homegardens perform is to keep knowledge of varieties and uses of diversity alive from generation to generation. In homegardens children and visitors can learn from the family experts on different types of diversity and its uses. These can be nutritional, commercial, aesthetic and spiritual. In several countries and ecosystems, the homegarden was where germplasm from the wild was brought under cultivation. This complex ecosystem close to the house where plants can closely be observed and managed makes it a convenient site for traditional plant experimentation and domestication. Some homegarden species that exists both in cultivated and uncultivated forms are also income earners (Agbogidi, 2013). According to Agbogidi (2013), importance of homegardens as conservation unit include:-

- Homegardens contain the highest population of some under-utilized fruit species they are also conservation sites for these species.
- Homegardens are *in situ* conservation sites for indigenous varieties of some crops.
- Homegardens are sites for the domestication of wild varieties of some species.
- Homegardens are trial sites for new variety of some crops and hence can be considered as entry point for new varieties of crops into our agricultural system.

2.4 Plant diversity in the homegardens

Biodiversity is the totality of genes, species and ecosystems of a region. Biological diversity is the variety and variability of animals, plants and microorganisms at the genetic, species and ecosystem levels and is necessary to sustain key functions of the ecosystem (Agbogidi, 2013). As a part of biological diversity, plant diversity also contributing to major provisioning of goods and ecosystem services. Mainly all higher plants play an important role in converting solar energy to chemical energy through photosynthesis initiating food production to the whole world. Photosynthesis itself helps to regulate CO_2 level in the atmosphere by using it as a major input for production of carbohydrates in plant leaves (Kumar, (2009).

Traditional homegardens are important platforms for conservation of plant agro-biodiversity on farm because they are centers of accumulation for a wide range of useful plants (Swaminathan, 1996). Few individuals of many species are cultivated in each homegarden under complex mixed cropping systems. The system maintains its integrity through traditional reuse and recycling of household and farm reuse, which in part accounts for its sustainability. The homegardens are home to a range of plant species and varieties. They harbor rare species or varieties of cultivated plants of different categories. Several landraces and cultivars, and rare and endangered species have been preserved in the homegardens (Zemede Asfaw, 2001; Kumar and Nair, 2004). However, species richness of homegardens within a region is influenced by the following factors:

• **Socio-cultural and economic factors:** Food habit, ethnicity, market, religious values and norms, gender role, structure of society (homogenous/heterogeneous), access to market, demand and supply of food materials.

• **Ecological factors:** Climatic and ecological factors such as availability of indigenous and exotic flora and fauna, altitude and ecological functions by soils, water and forest (Gautam *et al*., 2006).

Ethiopian homegardens collectively maintain a larger proportion of the country's useful plants. This diversity can be seen under the following categories of food producing

plants, spices, medicinal, live fence, shade, fodder, firewood, construction, furniture, cultural, spiritual, ornamental and multipurpose plants (Zemede Asfaw, 2001).

2.4.1 Food producing plants in homegardens

All homegardens contain some sort of food crops and many trees produce fruits or other forms of food. This shows that the most important function of homegardens is food production (Fernandes and Nair, 1986; Mohan, 2004). According to Zemede Asfaw (2001), about 74% of the crops documented in homegardens were categorized as food crops while the remaining 26% were non-food crops, showing the importance of homegardens in supplying food to the household. In addition, out of 112 species of crops found growing in southern and southwestern Ethiopia, 69 (62%) were recorded in homegardens only, 26 (23%) both in homegardens and crop fields and 17 (15%) in fields only. In most parts, about 85% of the cultivated species are encountered under cultivation in homegardens, about 50% always in home gardens and about 35% in homegardens and fields. Examples of crops that are found in Ethiopian homegardens include the juicy (saccharine) sorghum, popping sorghum, fast maturing and sweet types of maize, robust, thick-stemmed and large and thick leaved *Brassica carinata*, the perennial *Capsicum annuum* and climbing types of *Phaseolus* and other legumes (Zemede Asfaw, 2001).

Traditional vegetables are often adapted to low input agriculture, therefore these are free from chemicals and pesticides. Farmers plant a variety of crops in homegardens to ensure access to fresh produce throughout the year (Larios *et al.*, 2013). Many studies from Asia, Africa and Latin America conclude that homegardens provide early maturing varieties that carry families over the food deficit season until the main crops mature; contain reserve resources of plant genetic resources, should the main crops fail; and function as both conservation sites for special varieties, and as testing grounds for new varieties (Millat-e-Mustafa, 1997; Oakley, 2004).

The fruits and vegetables contribute to a balanced diet by providing not only energy-rich food but also supply of vital protective nutrients like vitamins and minerals (Mohan,

2004). Fresh fruits and vegetables provide us carbohydrate, protein, vitamins, mineral, fats which are essential to our body. Hence, homegarden can provide nutritious and balanced diet to the family that makes the farm families healthy and strong. This is the reason that homegarden is also called a Primary Health Centre (Thapa, 2004).

Along with nutrition supply and food security, homegarden is a source of income. The surplus cereals and vegetables can be sold in local market. Due to integration of different agriculture components in homegarden, the productivity of each component increases stability in income. In the rural and remote areas where other employment opportunities are meager, it plays an important considerable role in providing additional job and income (Gautam *et al*., 2006).

2.4.2 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. 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).

According to Subedi *et al*., (2004), spices are also an essential component in daily food recipes of Nepalese farmers. Spices are being widely used for flavors in vegetables, meat, dal, pickle, etc. These are also used as an appetizer. A total of 20 different species of spices were recorded from the surveyed homegardens. Out of them different varieties of chilli, ginger, garlic, onion, turmeric, perilla, and coriander are the most frequently grown spices in Nepal. Some indigenous varieties of chilli such *Capscicum sp*., ginger, garlic, onion and coriander and turmeric have become one of the major sources of cash income.

Many herbs are planted for their medicinal as well as food value while some of the species of homegarden crops are primarily cultivated for their medicinal use (Zemede Asfaw, 2001; Mohan, 2004). It is further noted that while the main garden crops within the same agroecological region are generally common, those cultivated as traditional medicinal plants vary considerably from household to household. The bulk of the medicinally used plants are also used as food and this may reflect the intertwined function of the homegarden for food production and as a primary health care delivery system (Zemede Asfaw, 2001).

Herbs or medicinal plants have been extensively reported for their various applications in treatment of a variety of ailments (Bajpai *et al*., 2013; Temesgen Magule *et al*., 2014). In a review of several studies presence of medicinal plant species was identified as one of the key characteristics of traditional homegardens. Research on traditional homegardens includes a list of plant species having medicinal use values in treatment of several ailments. Medicinal plants in homegardens are either deliberately cultivated or they come up spontaneously as wild species. All these studies list several medicinal plants, like *Adhatoda vasica, Nees, aloe vera, Asparagus racemosus, chlorophytum tuberosum Cucuma angustifolia, Discorea bulbifera, Diosscorea hispida, Emblica officinalis, Gymnema sylvestre, Rauwolfa serpentine, Terminalia arjuna* and *Tinospora cordifolia*. Some of which are endangered, regularly used for treatment of mundane ailments like common cold to some serious disease like cancer (Bajpai *et al*., 2013).

Temesgen Magule *et al*., (2014), reported that, the *enset* plant and its parts contribute to indigenous ethno-medicinal values of the Wolaita. Although the people of Wolaita know and believe that *enset* is medicinally important, only a few people use it for medicinal purpose. Traditional healers in the area confidentially keep ethno- medicinal knowledge of *enset* landraces and many other medicinal plant and species.

2.4.3 Plants maintained as homegarden live fence and shade trees

Live fences are grown around houses and homegardens. They have a number of advantages over wooden which are often considered to be unproductive parts of the land management system. The cost of live fencing is low, and apart from some attention at the beginning, the fence will continue to grow on its own. With properly selected species the fence can be a source of fuel wood, medicine, and fruit, household can improve soil conditions if appropriate species are selected (Zemede Asfaw, 2001).

Common live fence species that give edible fruits include *Rosa abyssinica, Carissa spinarum, Opuntia ficus-indica, Dovyalis abyssinica, Ziziphus spina-christi, Rubus* spp. and many others. *Phytolacca dodecandra* and *Adhatoda schimperiana* are commonly encountered as live fence plants. The former is used in traditional medicine and as traditional detergent while the latter is used as fodder during the dry season. In the dry lands, the usual live fence species are *Euphorbia* spp. *(*e.g. *E. abyssinica*, *E. tirucalli)*, *Ziziphus* spp., *Agave* spp., *Acacia* spp. and others. In rural areas the live plants of the fence may have been planted intentionally from stubs and cuttings pressed into the soil to strengthen the fence, or they may have been encouraged after they sprouted from the soil seed bank, or they may be a remnant of the original natural vegetation (Zemede Asfaw and Mesfin Tadesse, 2001).

In Tanzania highly used species for live fences are *Euphorbia tirucalli, Albizia harveyi,* and *Commiphora africana* (Hines and Eckman, 1993). Homegardens are sometimes bound by natural barriers such as rivers, gorges or mounds. However, they are generally fenced with dry wood material and sometimes with stone. In other cases, live plants (very often thorny shrubs) are grown or used as reinforcements (Zemede Asfaw, 2001).

2.4.4 Fodder, firewood, furniture and construction plants in homegardens

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 (Hines and Eckman, 1993).

Because livestock are an integral part of the farming systems and are generally kept within homestead, fodder trees have special place in homegardens (Shrestha *et al*., 2001). According to Subedi *et al*., (2004), fodder trees primarily for livestock purposes are planted in Nepal. The most common fodder species were species of Ficus, *Melia azederah* and *Anthocephaleus cadamba*. Fodder species like bamboo and broom grasses were planted in the homegarden to protect land from soil erosions and landslides. The twigs and branches of fodder trees left after the leaves have been eaten are used as firewood for household cooking. Homegarden trees are also commonly used as support for trailing vines of a number of vegetables (beans, yams, chayote, gourds, pumpkin, cucumber etc) (Shrestha *et al*., 2001).

In most rural areas of Tanzania plants are still the main sources of supply materials for constructing houses and fences. Even though house construction styles are slightly different in various regions of the country, and they are changing in some areas, the majority of rural people still rely on local trees for their house construction needs. The preferred species tend to vary according to availability and the specific use within the construction scheme. As well, the quantities required and the replacement period varies depending on the style of house and species used. Some of the highly preferred species identified for building materials include: *Acacia mellifera*, *Dichrostachys cinerea*,

Bridelia micrantha, *Dalbergia arbutifolia*, *Prunus africana*, and *Olea capensis* (Hines and Eckman, 1993).

2.4.5 Cultural, spiritual and ornamental plants in homegardens

Cultural diversity in a given country helps to conserve biodiversity in homegardens (Millat-e-Mustafa, 1997). The composition of unique plants in homegardens varies with ethnicity, food culture, religion, and spirituality. Unique flowers and fruits needed for religious and spiritual purposes are distinctive cultural feature of homegardens. Homegarden plants are also important for their aesthetic value and cooling effect and are regarded as a symbol of wealth and social prestige. Beautiful trees, orchids and climbers, ferns, ornamental plants and flowers are important species in homegardens (Sthapit *et al*., 2004). In a study conducted by Subedi *et al*., (2004) a total of 32 different religious plants were recorded from two surveyed sites of Nepal. Many religious plants were also being used as spices and for ornamental purposes. The most widely grown religious plants were *Capscicum spp, Zingiber officinale, Allium sativum, Perilla fructescens, Allium cepa, Coriandrum sativum* and *Foeniculum vulgare*. *Ocimum sanctum* is the only species, which was found the most common throughout the study sites.

Certain trees can serve to link the living with their ancestors, as it is often symbolized by the relationship between the sky and the earth. Sometimes gifts are given as a means of showing ancestors that they have not been forgotten. Gifts such as flowers or alcohol are placed at the foot of the tree as an offering which is symbolic of giving food to ancestors through the tree. Certain *Commiphora* spp. is regarded as spiritual trees that provide a means of communicating with ancestors (Hines and Eckman, 1993).

According to Hines and Eckman (1993), selected species are often considered sacred, possessing special powers that can aid, for instance in fertility and birth, sickness, or expelling evil spirits. For example, *Euphorbia candelabrum* is used to drive witches from a village. Members of the village take branches and leaves and place them on the doorstep of the witch. This indicates to all that the witch has been identified and acts as a warning that the witch should leave the village immediately. Both *Lannea schweinfitrthii*

and *Lonchocarpus capassa* are used to rid the body of witchcraft. If someone has been bewitched or has had a disaster, the person boils the roots of *L. schweinfurthii* and then washes in the water, which is then poured out at the nearest road junction. The root of *L. capassa* is tied around the leg of the bewitched person. After a certain time the bark of the root is boiled in water and the bewitched person takes a bath in the water.

2.4.6 Multipurpose plant species in the homegardens

Homegardens are intensively cultivated agro-forestry systems managed within the compounds of individual homes. They involve the deliberate management of multipurpose trees and shrubs (the woody component), grown in intimate association with herbaceous species (mainly annual, perennial, and seasonal agricultural crops), and livestock (Fernandes and Nair, 1986). A variety of trees and shrubs are found integrated within a majority of the homegardens. These trees and shrubs usually have multiple uses and provide food, fodder, firewood and timber for household uses (Townsend, 1984). Many species of homegarden crops have multiple uses. According to the survey conducted it was observed that many herbs such as *Allium sativum* and *Ruta chalepensis* are planted for their medicinal as well as food and spice (Matheos Agize *et al*., 2013).

2.5 Organization and spatial pattern of plants in Ethiopian homegardens

Although the crops in homegardens appear to be arranged in a kind of chaotic random pattern, a general structure could be drawn for the sake of understanding. The overall crop arrangement has stability while being dynamic with respect to the presence and developmental stages of perennial species and seasonal shifts in the kind, positions and amount of the herbaceous annual crop species. Some crops are always planted in regular patterns, while others are planted wherever space is available (Zemede Asfaw, 2001).

In the drier parts of eastern Ethiopia, *Chat* (*Catha edulis*)*;* perennial fruit trees such as coffee, citrus and banana are usually planted in the depressions of rows of ridged or terraced grounds made to accumulate enough water for deep-rooted perennial species, while the smaller crops like potato, sweet potato, groundnut, chili, onion, garlic, cabbage, and many other vegetables and spices are planted on the permanent soil ridges (Zemede Asfaw, 2001; Gebremedhin Teklehaimanot and Mulubrhan Haile, 2007). Nurseries are also prepared for raising seedlings of chili, onion, tomato and other species for later transplanting. When the garden is located adjacent to a stream, the section next to the stream is usually planted with banana, citrus and other perennial crops requiring more water. Perennial tree crops are planted far apart while the space in between is used for lower crops. During the early periods of growth, the space between tree crops is used for growing low crops of different herbaceous species and the density of such crops is synchronized with the horizontal and vertical expansion of the perennial tree crops. Changes are observed with the age of the garden and the seasonal cycles. In most gardens, some crops (*Arundo donax, Otostegia integrifolia* and *Rhamnus prinoides*) are planted on the inside margins next to the fence and others (e.g. *Agave* spp. and *Opuntia ficus-indica*) on the outer margins as reinforcements for fences (Zemede Asfaw, 2001).

The vines of bottle gourds, pumpkins and cherry tomatoes are arranged to climb on fences. Tall and robust garden crops are usually kept towards the outer end of the garden so that they also serve as a layer of fence to protect the more delicate and cherished crops. As one goes away from the house, garden crops tend to gradually increase in vertical height, making their inspection easier (Zemede Asfaw and Ayele Nigatu, 1995). However, there is usually a mixing of tall, medium-sized, low, and younger stages of larger plants. The pattern varies from garden to garden, and suggests a near random chaotic arrangement, but upon closer observation, some individual crops reveal a regular aggregated patchy pattern as an empirical practice of niche diversification and mixing of compatible crops (Zemede Asfaw, 2001).

The small circle maintaining more species per unit area contains spices, medicinal plants, vegetables, fragrance plants and others, which are mostly for home consumption. Being

aromatic plants, they give good odor to the environment of the house, in addition to their primary use in food preparation and healthcare. This part of the home garden is the domain of women, who take responsibility for the propagation, management, harvesting, and use of the material including selling it at the market or giving excess produce to friends and relatives. They can also be easily accessed for instant use as herbs, fresh vegetables, cosmetics, condiments, etc (Zemede Asfaw, 2001).

2.6 Indigenous knowledge and homegarden management in Ethiopia

The term "indigenous" knowledge or "local" knowledge is used to refer to that knowledge which is generated and transmitted by communities, over time, in an effort to cope with their own agroecological and socioeconomic environments (Hodgkin, 2002). Indigenous people often have detailed knowledge of the local agro-ecological conditions, characteristics of plants and animals, resources and ecological processes in the ecosystems and landscapes on which they depend for sustenance and life ways. This knowledge is accumulated over hundreds and sometimes thousands of years as it is passed from generation to generation, but is also constantly adjusted to changing conditions and new experiences (Kassam, 2009).

A range of management practices are employed by farmers to manage biodiversity in the agricultural landscapes (Hodgkin, 2002). According to Marsh (1998), normal management assists the gradual evolution of homegardens to the climax stage, where higher productivity is possible in a complex ecology where species richness and intensive land use are prominent features. The highly complex structure of the homegarden architecture as well as the patterning of plant categories in it has been designed and developed by indigenous skills and practices. The homegardening culture has developed a general structure with considerable diversity and flexibility that allows owners to produce crops of their choice (Zemede Asfaw and Ayele Nigatu, 1995).

The homegarden preserves indigenous knowledge and cultural history through preservation of the characteristic agricultural features, crops and crop combinations on-

farm (Zemede Asfaw, 2001; Parra *et al*., 2012). Owners of homegardens manage and direct much of the development process for the homegarden. The homegarden generally follows what might be called an open-door strategy in giving and receiving new crops and varieties. Germplasm is received and given out freely to relatives, friends, neighbors and acquaintances. Conversely, households also have traditional ways of restricting/discouraging the uncontrolled transfer of planting materials from homegardens, since the norm is to secure permission from the family. Such customary rules and norms would need to be respected in the interest of property rights and equity on a larger scale (Zemede Asfaw and Ayele Nigatu, 1995; Zemede Asfaw, 2001).

The large majority of homegardens are owned by individual families with the head of the family (the father or the mother) being in charge of the overall management. To manage the garden space and the plants, the family head is usually responsible for designing the structure, identifying appropriate locations for positioning the major crops, and monitoring and strongly influencing the structure and the direction of homegarden development. The contribution of men is more important in large gardens which require more laborious work (Zemede Asfaw, 2001).

2.7 The future of garden based conservation

The last few hundred years have witnessed a rapid increase in the rate at which biodiversity is being altered. As populations have grown and their consumption needs increased, so has to extract more economically valuable resources more rapidly be it food, timber, or ornamentals (Kumar, 2009). Changes occurring under increasing demographic and economic pressures concern for the future of traditional homegardens and the genetic reservoir they contain. The global trend toward large-scale agriculture determines a gradual simplification of the agricultural systems and landscapes in which crops are produced and an erosion of the sophisticated knowledge associated to farming practices (Birol *et al.*, 2005). Replacement of rural areas once used for the production of services (homegardens, wooded areas, living fences, pastures) by monocultures has caused a depletion of local species, primitive varieties and wild relatives. Modern

varieties which replace local landraces in large scale industrialized agriculture represent undeniable advances in breeding offering higher yields under intensive growing conditions with optimal availability of water and other inputs (Agbogidi, 2013).

In high-income countries the growing demand for healthier life styles and closer connection with nature has driven a renewed interest towards sustainable agricultural systems and "traditional" food products, capable of connecting consumers to the natural and cultural heritage of a community or a geographical region. In Italy, regional governing bodies have set up subsidies to encourage the cultivation of landraces among networks of "custodians" who have preserved them so far, often in their homegardens (Casas *et al*., 2008). Associations and NGOs play a leading role in promoting garden agrobiodiversity by carrying out general educational activities or actively supporting cultivation and exchange of heirloom varieties. Exploring the conservation potential of the many diversified home garden systems discloses opportunities for interdisciplinary studies involving botanists, ecologists, geneticists, anthropologists and sociologists. An improved understanding of the factors which encourage or enable diversity within the domain of home gardens would allow conservation scientists and communities to foster and maintain important knowledge and biological resources while also preserving the health of services these multifunctional, sustainable agro-ecosystems provide to nature and people (Agbogidi, 2013).

3. MATERIALS AND METHODS

3.1 Description of the study area

3.1.1 Geographical location

Sinan district is located in south western part of Amhara Region. It is one of the 16 districts and 4 administration towns in East Gojjam Zone. The study area, Sinan district is located about 327 km North west of Addis Ababa, 292 km south west of Bahir Dar and 27 km North of Debre Markos. Sinan district is bordered by Bibugn woreda to the north, Gozamin woreda to the south, Debay tilat gin woreda to the east and Machakel woreda to the west. Sinan district has 16 rural administrative kebeles and 1 woreda town. Its absolute location extends between 10^0 40' 30"- 10^0 25' 13" N latitude and 37^0 40'00"- 37^0 50' 20"E longitude (Figure 1). According to Sinan district finance and economy office, the total area of the district is 41,134 hectare.

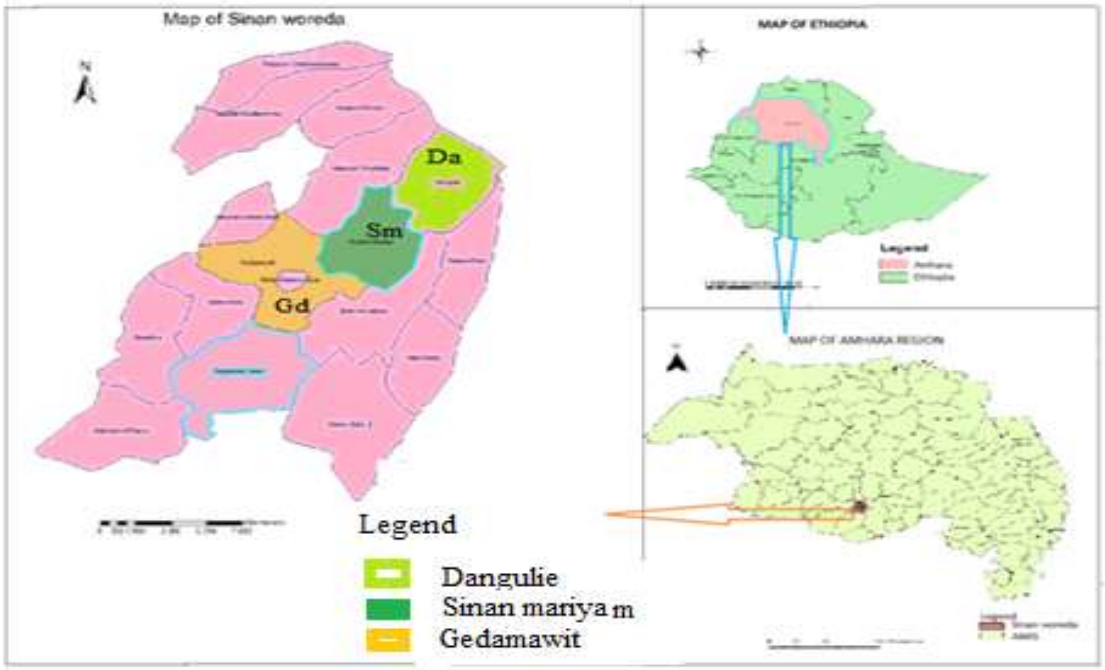


Figure l: Map of the study area

3.1.2 Climate

The altitude of the study area ranges from 2300–4100 meter above sea level. The climatic condition of the district is categorized as 23% Weyna Dega (sub-tropical), 75% Dega (temperate) and 2% wurch (cool temperate). The annual temperature of the area ranges from 0-15^{0}c and the district obtain annually 900-1500 mm rainfall (Bureau of Agriculture, 1999).

3.1.3 Soil and agriculture

The dominant soil in the Amhara National Regional State in their respective order are Luvisols (15.1%), Cambisols (14.3%), Nitosols (13.7%), Vertisols (10.8%), Aerisols (2.6%), and Regosols (2.1%) (Bureau of Agriculture, 1999). The study area is characterized by small-scale subsistence mixed farming system, with livestock production as an integral part. Crop production is mainly rain-feed. The study area crop lands are often planted with cereal crops such as Maize, Barley, Wheat, and, pulses (Beans, Peas) and potato. Farmers also cultivate vegetables and fruits mainly in home gardens or wherever irrigation is possible. According to Sinan Wereda Environmental and natural resource protection office (SWENRPO, 2014), there are several rivers and springs that can be used for irrigation purpose. It includes Chemoga, Godeb, Temcha and Shgez rivers. Table 2 shows that the land use/land cover of Sinan district.

Table 2: The land use of Sinan district in 2014

No	Land use type	Area in hectare	Percent
1	Cultivated land	24178	58.8
2	Grazing land	7509	18.3
3	Forest land	210	0.5
4	Construction /settlement	1320	3.2
5	West land	2440	5.9
6	Others	5477	13.3
	Total	41134	100

Source:-The Woreda Environment Protection, Land Administration and Use office (2014)

3.1.4 Population

Based on the CSA (2013) report, the total population of Sinan district is around 113,914 from these 56,655 are Males and 57,259 are females. Almost 97.7% of the population lives in rural areas and 6.3% of the people are living in towns.

3.2 Sampling techniques

3.2.1 Selection of study sites, informants and homegardens

According to Van der Maarel (2005), a reconnaissance survey was first conducted in September 2015 to gain an overview of the demographic, socio-economic, and biophysical conditions of Sinan district. Then, a multistage sampling technique was employed where by in the first stage, kebele administrations (kebeles) involved in the study were selected using a stratified random sampling technique. Altitude was used to stratify the sixteen kebeles in the district. In the second stage, proportional allocation techniques were used to determine the number of sample kebeles from each stratum. Accordingly, a total of three kebeles were selected randomely out of sixten kebeles found in Sinan district and separated by altitude: high altitude (above 3500 M) (Dangulia), medium altitude (between 2901 M and 3500 M) (Sinan mareyam), and low altitude (less than 2900M) (Gedamawit). The intention of sampling Kebeles from different altitudinal levels was to capture possible variations in nature of home garden. In the third stage, fifty informants from each kebele were randomly selected to participate in the ethnobotanical study from the selected three kebeles using lottery method. This was done by considering a list of households in each study kebele as a sampling frame. A total of one hundred fifty homegardens along with their owners as in formants were randomly selected for data collection and analysis.

3.3 Ethical considerations

Special ethical considerations were taken based on the cultural view of the local communities in the study area. In view of these considerations, approaching of the informants was very systematic. By telling the fact and convincing each informant following his or her culture strictly. They were also informed that the objective of the research is not for commercial purposes but for academic reasons. In doing so, the

informants in the study site were well informed about the objective of the research before data collection and/actual works.

3.4. Ethnobotanical data collection

The field study was conducted from January to end of February 2016. Transect was made from the house site to the margin of the garden which covers different useful plants. Within this transect 10 m x 10 m sample grids were generated, the types of plants found, the number of individuals of each type and habit of the plants were recorded. In the case of bamboo each clump was counted as one individual. Having been counted each plant was marked with chalk to avoid double counting.

3.4.1 Direct field observation and free- listing

A well-planned homegarden tour was made with informants that involve the combination of observations and listing while walking in their own homegarden. During walk along with informants, an attempt was made to let the informants discuss the cultural and ecological knowledge they had with the researcher including the management and different benefits they obtained from homegardens. They were also motivated to list plant species in their homegardens using local names that helped to characterize variation in homegardening knowledge and practices among home garden owners. The owners of homegarden involved in the study were given in Appendix 7.

3.4.2 Semi-structured interviews

Semi-structured interviews (Appendix 6) were conducted with 150 informants on the plant names, planting practices, source of planting materials, plant use, land use systems and other traditional and socio-cultural practices. The interview schedule prepared in English was translated into Amharic on the spot during the interview sessions. The nature of semi-structured interview was made it possible to entertain additional questions as the interview progresses. Homegarden observation (during the vegetation data collection)

that mentioned above was compared with farmers' ethnobotanical knowledge, attitudes, and beliefs to cross check their correspondence with real condition.

3.4.3 Focus group discussion

Discussion was conducted in each selected kebele with groups of people of different sex to understand the local categorization of resources, to ensure the consistancy of local names and use values of plants and to consolidate and verify all the information related to plant use patterns and conservation issues of the study area. The emphasis and convincing was specially given for the selection of farmers with relatively long practices and knowledge on the diversity and utilization of caltivated plants.

3.4.4 Market survey

Conducting a survey of useful plants in a market place is similar to carrying out an ethnobotanical inventory in a community. Market is a place where plant use culture and agricultural inovations as well as plant germplasm is shared among people from each and every corner of the area. Hence they complement to ethnobotanical studies of a community and are important components of ethnobotanical data collecting procedures (Martin, 1995).

3.5 Plant Specimen collection and identification

Useful plant species encountered in homegardens during the study were recorded and voucher specimens of the species when available including reproductive structures were collected, pressed, dried and identified. The specimens were determined with the help of keys, descriptions and illustrations provided in the Flora of Ethiopia and Eritrea (Volume 2 part one and two, Volume 3, 4 and 5) and by comparison with already identified specimens that are deposited at National Herbarium (ETH), Addis Ababa University. The local names, habits and other necessary information were recorded for each of the species and some were photographed. Additional references Azene Bekele, (2007) and Reinhard and Admasu Adi (1994) were used for facilitating the identification process.

3.6 Data analysis

The area of each home garden was measured, constructed maps indicating the disposition of plant areas and other components of the systems, recording the number of individuals of each plant species within the whole homegardens. The data collected in sample plots of 10 m x 10 m (100 M^2) in 150 homegardens randomly selected for the study were analyzed by using Microsoft Office Excel 2007 spreadsheet and descriptive statistical methods such as frequencies, relative frequencies, densities, relative densities, Sorenen`s index, Shannon and Wiener index and eveness index for species diversity were used.

3.6.1 Frequency and relative frequency

Frequency is the number of times a species occurs within the sample plot (Van der Maarel, 2005). It was studied by sampling the study area at several places at random and recorded the name of the species that occurred in each sampling units (Martin, 1995). It is calculated by the equation:

$$F = \frac{\text{Number of quadrants in which a species occurs}}{\text{Total number of quadrants in the sample}} \times 100$$

Relative frequency is the number of occurrences of a species, as a percentage of the total occurrences of all species (Martin, 1995).

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

3.6.2 Density and relative density

Density is a derivate variable, being the abundance per unit area (Van der Maarel, 2005). It is an expression of the numerical strength of a species where the total number of individuals of each species in all the quadrats is divided by the total number of quadrats studied. Density is calculated by the equation: (Martin, 1995).

$$\text{Density} = \frac{\text{Total number of individuals of a spcies in all quadrats}}{\text{Total area of the sample (M2)}}$$

Relative density 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).

$$\text{Relative density} = \frac{\text{density of a species in the sample}}{\text{Total density of all species in the sample}} \times 100$$

3.6.3 Shannon and Wiener diversity index

The Shannon and Weiner index is the most commonly used diversity indicator in plant communities, and it takes a value of zero when there is only one species in a community, and a maximum value when all species are present in equal abundance (Shannon and Wiener, 1949). Shannon's index accounts for both abundance and evenness of the species present. The proportion of species *i* relative to the total number of species (p_i) is calculated, and then multiplied by the natural logarithm of this proportion ($\ln p_i$). The resulting product is summed across species, and multiplied by -1:

$$H' = -\sum_{i=1}^{5} p_i \ln(p_i)$$

Where: H' = the Shannon diversity index, *pi* is the proportion of the total community abundance represented by the *i*th species and *ln* (*pi*) is the natural log of *pi*, S = numbers of species encountered and Σ = sum from species 1 to species S. The minimum value of H' is 0, which a value for a community with a single species and increases as species richness and evenness increases.

Interpretation: Typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. The Shannon index increases as both the richness and the evenness of the community increase (Kent and Coker, 1992).

Equitability or evenness index was calculated from the ratio of observed diversity to maximum diversity using the equation.

$$E = H'/\ln (S) = H'/Hmax$$

Where: E = Evenness; H` = Shannon-Wiener Diversity Index; Hmax = *ln*S; S = total number of species in the sample. The value of evenness index falls between 0 and 1. The higher the value of evenness index, the more even the species is in their distribution within the given area. Evenness metrics all attempt to examine how abundance is apportioned among species within a community. The basic concept underlying all of these measurements is that evenness is highest when a community is not dominated by a few species of very high abundance or equivalently that all species have an equal abundance. Low evenness implies that most species in the community are very rare, and consequently may contribute very little to the underlying ecological role the community plays within the ecosystem that contains it (Maguran and McGill, 2011).

3.6.4 Similarity among homegardens

Sorenson`s Index of similarity was used to compare the degree to which species composition of study sites matches in the study area. It is the most common binary similarity coefficient because it relies on presence or absence of data.

Sorensen`s Index $Ss = \frac{2a}{2a + b + c}$

Where Ss = Sorensen`s similarity coefficient, a = number of species common to study sites, b = number of species in sites 1 and c = number of species in site 2. The coefficient values range from 0 (complete dissimilarity) to 1 (total similarity) (Kent and Coker, 1992). This method was applied to calculate for all plant species in three selected sites of

the study area. Often, the coefficient is multiplied by 100 to give a percentage similarity index.

Interpretation: Sorensen`s Index of similarity is very straight forward since it is simply the fraction of species shared between the samples. Sorensen`s Index only utilizes the richness component of diversity, since it does not entail any information on abundance.

3.6.5 Preference ranking

Preference ranking is an ethnobotanical activity in which each person or informant arranges the items (i.e. in these case home garden plants) according to personal preference, perceived importance in the community. Therefore, preference ranking was performed using fourteen selected key informants (selected out of the total informants based on recommendations from elders and development agents) on the basis of homegarden plants use as medicine, having healing potential of several ailments. According to Martin (1995), preference ranking is one of the methods used to rank five to seven items and arrange those items based on a given criterion. Each rank is given an integer value, 1, 2, 3, 4, 5 and 6, the most important item given the highest value, while the least important assigned the smallest value. The fourteen informants were given six frequently encountered medicinal plant species having healing power of several ailments in their home gardens and asked to arrange them based on personal preferences. The numbers are summed for all respondents, giving an overall ranking for medicinal plants having healing potential of several ailments.

3.6.6 Direct matrix ranking

Direct matrix ranking was done for some homegarden plants based on the information which is gathered from informants on the multipurpose use category of the homegarden plants. Direct matrix ranking, according to Martin (1995), is one of the analytical tools which involve asking people to order their favorite plants in their homegarden by taking into account seven attributes (medicinal, construction, furniture, live fence, shade, charcoal/ fire wood, and fodder) at a time. Based on information gathered from selected

informants, seven multipurpose tree species were selected and the informants asked to assign the following values 7,6,5,4,3,2 and 1 to each attribute (7, being the most valuable and 1 least valuable). The plant believed to be the most desirable one gets the highest value and the one with the least the lowest value. At the end, the results of fourteen respondents were summed up to create a matrix that represents the community.

4. RESULT AND DISCUSSION

4.1 Household characterstics

Informants in the study area were grouped under three age groups the adulthood (25-40), middle age (41-60), and elders (greater than 60). Accordingly 45.3% were found between 25 and 40 years, 41.3% were found between 41 and 60 years and 13.3% of the informants were found above 60 years old. Out 150 informants involved in this study 57% of them were male and 43% were female. The educational levels of the informants were 68% illetrate, 24% basic, and 8% of them were at primary and high school. According to Getu Alemayehu *et al*., (2015), the ethnobotanical knowledge and practice within any culture varies depending on age, sex, and educationl level.

The average sizes of the homegarden in Gedamawit 2246 sq m, in Sinan mariyam 6306 sq m and Dangulia 4124 sq m were recorded respectively. The area of homegarden ranges from 760 to 10,000 sq M. At a household level, the sex composition, age structure, education level, and land size have an impact on the availability of labor in allocation for different tasks that has great role for the biodiversity of the homegarden (Olajide-Taiwo *et al*., 2010).

4.2 Local Classification systems in the study area

The people in the study area have their own system of classifying their environment and its components. This includes the classification of landscape, climatic zones, vegetation, agricultural practices and the biotic components.

4.2.1 Classification system of the landscape

The landscape is classified based on two main criteria: elevation and the purpose for which the land is used. The part of the landscape with maximum elevation in an area is called terara and the level (flat) land is called meda. Getu Alemayehu *et al*., (2015) reported that the people of Berehet classify landscapes into four categories; namely, “wetageba”, “terarama”, “medama” and “shelequoma” and the vegetation into kutquato, chaka, and dene.

Based on the purpose and its vegetation cover, the local people classify their surrounding as homegarden, crop field, fallow-land, grazing land and managed forest. Homegarden occupies some portion of the leveled land, the crop field occupies some portion of the leveled land and the slightly tilted land, managed forest occupies land with gentle slope. According to Feleke Weldeyes (2011), in Basketo, the landscape is divided into several parts: homegarden, crop field, sacred grove, grazing land, bamboo land, burial ground and wetland and further reported that the homegarden is the main unit of food production. The crop field which normally starts from the back part of the homegarden leads, in most cases, into the forest.

4.2.2 Classification system of climatic zone

The district recognizes three climatic zones: Wurch, Weynadega and Dega agroecological zones. Dangulie which corresponds to Wurch; Gedamawit which corresponds to Weynadega, and Sinan mariam corresponds to Dega. In addition, local people use plants to characterize the climatic zones.

4.2.3 Classification system of planting practices

Farmers in the study area classify planting practices. If grains are sprinkled during sawing, the practice is called as “Zer Mezrat”, if the practice involves digging a hole and putting a single grain of seed or tuber, or planting a cutting or transplanting, it is called “Metkel”, and any plant that has grown spontaneously (without planting) and then accepted and protected in the garden is referred as “woffzerash”.

4.3 Types of homegarden in Sinan district

According to Zemede Asfaw (2001), the homegarden survey indicated that, it comprises of gardens with different sizes and shape that including the animal houses, grain stores, and piece of land intended for growing garden species. The same observation was obtained in this study. The homegarden in position to the living house was counted i.e. house yard (front, side, back, round yard, and back and front yard gardens). Out of one hundred fifty houses, 33 (22%) were found in front yard gardens, 59(39.33%) side yard gardens, 50 (33.3 %) back yard of the living houses, and 8(5.33%) back and front yard gardens (Table 3).

Table 3: Types of homegarden surveyed in the study area

Kebeles	Number of houses surveyed	Front yard gardens	Side yard gardens	Back yard gardens	Round yard gardens	Back and front
Gedamawit	50	16	20	10	-	4
Sinan Mariyam	50	9	18	21	-	2
Dangulie	50	8	21	19	-	2
Total	150	33	59	50	-	8
Percentage		22	39.33	33.33	-	5.33

4.4 Species diversity, evenness and similarity among the three sample sites

The average record of species per homegarden was 18 in Gedamawit, 15 in Sinan Mariam and 16 in Dangulie respectively. These variations could be due to individual difference in management practices, size of homegarden, socio-economic backgrounds, altitude, soil fertility status, proximity to the market and road and religious factors (Mathewos Agize *et al.*, 2013). From the total number of species recorded from the study area, *Rhamnus prinoide* (76.67%) was the most frequent species followed by *Vernonia urticifolia* (60.67%) and *Ensete ventricosum* (57.33%) (Appendix 2). The leaves of *Rhamnus prinoide* was used in the preparation of locale beer (Tella) and it was a high cash income plant species. This made it widely distributed in most homegardens. The three study sites have diversity index values between 2.62 and 3.38. But when compared with each other, diversity index with the value of (H'= 3.38) highest for Gedamawit followed by Sinan Mariyam (H'= 2.80) and lowest diversity index (H'= 2.62) for Dangulie site. The evenness index revealed that the species in Gedamawit (E = 0.73) were more abundant and equally distributed as compared to Sinan Mariyam (E =0.65) and Dangulie (E=0.63) (Table 4). High species diversity and evenness in gedamawit could be attributed to the presence of optimum environmental factors such as altitude, slope, adequate nutrient and moisture, and proximity to the market and road.

Table 4: Shannon-Wiener Diversity Index (H`) and Evenness (E) for the three study sites

Study sites	Species richness	Shannon's index (H`)	Evenness (H' / H' max)
Gedamawit	102	3.38	0.73
Sinan Mariyam	72	2.80	0.65
Dangulie	62	2.62	0.63

One hundered twenty five plant species were recorded in the plots of the sampled homegardens and these were distributed in 51 families (Table 5). *Asteraceae* stood first containing 15 (12 %) species, *Fabaceae* came in the second place with11 (8. 8%) species, and *Poaceae* and *Rosaceae* each in the third with 8 (6.4 %) species. The families *Fabaceae, Asteraceae* and *Poaceae* were among the plants that are frequently used by Sebeta Hawas people (Habitamu Hailu and Zemede Asfaw, 2001) and Dawro people (Mathewos Agize *et al*., 2013). A report from Wolayta (Talemos Seta *et al*., 2013) indicated that they used more of *Fabaceae* (12.96%) and *Poaceae* (11.11%). Concerning the growth form of plants in the study area, 60 (48%) were recorded as herb species, 23 (18.4%) were tree species, 37 (29.6%) were shrubs, and 5 (4%) were climbers (Figure 2).

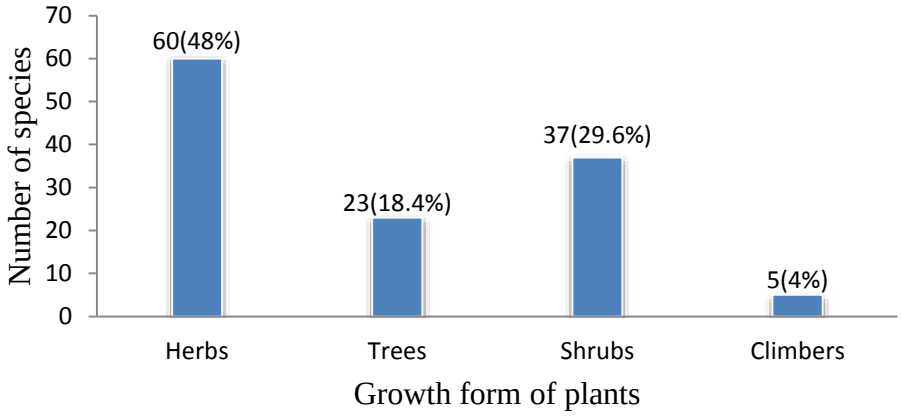


Figure 2: Growth form of plants in the study area

Table 5: Families with number of species recorded in the study area

No	Family name	No of species	No	Family name	No of species
1	Acanthaceae	3	27	Lamiaceae	6
2	Agavaceae	1	28	Linaceae	1
3	Alliaceae	2	29	Longaniaceae	1
4	Aloaceae	1	30	Melianthaceae	1
5	Anacardiaceae	2	31	Menispermaceae	1
6	Apocynaceae	1	32	Moraceae	2
7	Apiaceae	4	33	Musaceae	1
8	Araceae	2	34	Myricaceae	1
9	Asclepiadaceae	1	35	Myrsinaceae	2
10	Asteraceae	15	36	Myrtaceae	3
11	Brassicaceae	4	37	Oleaceae	1
12	Casuarinaceae	1	38	Phytolacaceae	1
13	Celastraceae	2	39	Plantaginaceae	1
14	Chenopodiaceae	1	40	Poaceae	8
15	Combretaceae	1	41	Polygonaceae	2
16	Crassulaceae	1	42	Ranunuculaceae	1
17	Cruciferae	1	43	Rhamnaceae	1
18	Cucurbitaceae	2	44	Rosaceae	8
19	Cupressaceae	2	45	Rubiaceae	3
20	Cyperaceae	2	46	Rutaceae	3
21	Ericaceae	1	47	Solanaceae	7
22	Euphorbiaceae	2	48	Sterculiaceae	1
23	Fabaceae	11	49	Tiliaceae	1
24	Flacourtiaceae	1	50	Urticaceae	1
25	Gramineae	1	51	Verbenaceae	1
26	Hypericaceae	1			

According to Matheos Agize *et al*., (2013), in closely planted homegardenss, plants grow poorly either growing thin, tall, weak and / or undersized which in turn decreases plant diversity in homegardens. Due to this reason, the small households plant less number of huge sized multipurpose plants and instead, they grow biennials and annuals like spices in their small sized plots. The same observation was shown in the homegardens of the study area.

A similarity in overall floristic composition among study sites was compared by using Sorenson`s index. (Table 6) indicates that the similarities among study sites were not consistent. It was highest between Sinan Mariyam and Dangulie 41.2 % (0.412) and lowest between Dangulie and Gedamawit 35.4% (0.354). This could be due to the reseason that Sinan Mariyam and Dangulie were clodely found and that of Dangulie and Gedamawit far apart.

Table 6: Sorenson`s Index of similarity of overall species in three selected sites of the study area

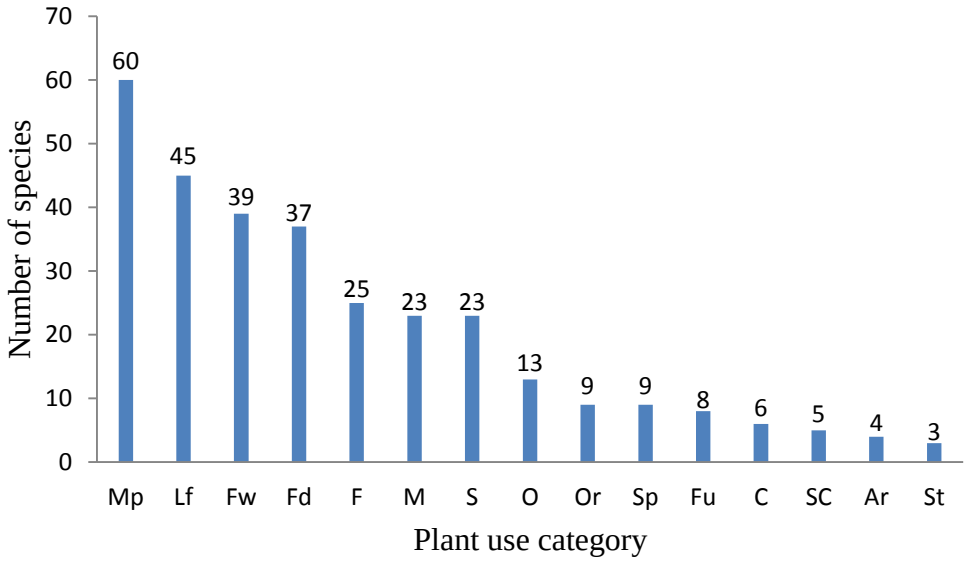
Study sites	Sm	Da	Gd
Sm	1.00		
Da	0.412	1.00	
Gd	0.387	0.354	1.00

Note: (Sm)-Sinan Mariyam, (Da)-Dangulie and (Gd)-gedamawit

4.5 Major plant use categories in the homegardens of Sinan district

Farmers cultivate diverse plant species in their homegarden to satisfy their subsistence needs. Simultaneously, those plants, which grow themselves, are either tolerated or protected for their known or perceived use (Feleke Weldeyes, 2011). Homegardens in the study sites provided a number of services to the local people. The local people used them to get balanced diet, to treat the day to day illness of their health and their domestic animals, firewood, construction, income generation, for soil fertility (to prevent the degradation of soil, to protect wind and others), and for social aspects.

Of the recorded plant species (125) in the plots of the sampled homegardens, 60(48%) plants that occurred in the homegardens with multiple uses took the top position of the plant categories followed by 45(36%) live fence plants, 39 (31.2%) firewood plants, 37(29.6%) fodder plants, 25(20%) food plants, 23(18.4%) medicinal plants, 23(18.4%) shade plants, 13(10.4%) others, 9(7.2%) ornamentals, 9(7.2%) spices, 8(6.4%) furniture, 6(4.8%) construction, 5(4%) Spritual and cultural, 4(3.2%) aromatic and 3(2.4%) stimulants were the major use categories in the study area (Figure 3). In Others use category, plants served as fumigant, beehive hanging, washing, soil fertility and soon were included. Major plant use categories recorded in each study site are shown in appendix 1.



Each category denoted as **Mp=** multipurpose, **Lf**= live fence, **Fd**=fodder**, Fw**= firewood and charcoal, **F**= food, **M**= medicinal, **S** =shade, **O**= others**, Or**= ornamentals, **Sp**=spices, **Fu**= furniture, **C**=construction, **SC**= Social and Cultural, **A**=aromatic plants and **St**= stimulants .

Figure 3: The use categories of plant species and their frequencies in the homegardens of Sinan district.

4.5.1 Plants used for food and nutrition security

The magnitude and rate of output of products, as well as the ease and Food producing plants are cultivated in the study area and are available in different seasons. However, significant amounts of nutrient supplying homegarden products are more available during the main rainy season between June and September (Zemede Asfaw, 2001). Farmers have a long tradition of using vegetables, pulses, roots/tubers and fruits in their traditional food culture. Out of the recorded 25 food plant species, 13 (52%) vegetables stood first, followed by 7 (28%) pulses and roots/tubers, and fruits accounted 5 (20%) species and the last position. According to Zemede Asfaw and Ayele Nigatu (1995), farmers have successfully integrated food crops like potato, leafy vegetables and pepper into their original dishes, often creating new ones. They have successfully maintained many introduced species such as *Malus sylvestris* and *Malus domestica* for fruit production in homegardens along with indigenous ones.

Another aspect of the important role of food production in home gardens is the maintenance of almost continuous production throughout the year from the unit. The combination of crops with different production cycles and rythms is uninterrupted (Zemede Asfaw, 2001). Depending upon the climate and other environmental characterstics, there may be some peak and slack seasons for harvesting the various products, but, in a general sense, there is something to harvest daily from most homegardens. Most of this production is for home consumption, but any marketable surplus can provide a safeguard against failure and a security for the interval between the harvests of other agricultural crops of the homegardens (Fernandest and Nair, 1986). Table 7 shows some of the cultivated species of vegetables that have a wider usage in the study area.

Table 7: Common vegetables growing in the study area

Botanical name	Vernacular name	Parts used	Frequency	Relative frequency
Brassica carinata A.Braun	Yabesha gomen	Leaf	32.66	2.18
Brassica oleracea L.	Tikel gomen	Leaf	25.33	1.69
Brassica rapa L	Kosta	Leaf	4.67	0.31
Capsicum annuum L.	Yabesha karia	pod	8.66	0.59
Daucus carota L.	Carot	Root	2.67	0.17
Solanum tuberosum L.	Denich	Stem	38	2.5

4.5.2 Spice plants

The tradition of using spices is well-established in Ethiopia as can be seen from the food cultures that use elaborate spicing across the diverse nationality groups of the country (Feleke Weldeyes, 2011). Nine species of spices were documented in the study area; some had only spice value while the others had also other values. Spices used in the study area were *Capsicum annuum, Allium sativum, Ruta chalepensis, Anethum foeniculum, Brassica nigra, Coriandrum sativum, Mentha spicata, Ocimum bacilicum,* and *Rosmarinus officinalis.* Some of spice plants in Sinan district with their use are presented in table 8.

Table 8: Lists of common spice plants growing in Sinan district with parts used.

Species	Parts used
Allium sativum L.	Bulb: chopped into pieces, added during `wot` and vegetable preparation.
Capsicum annuum L.	Pods and seeds: cut into pieces and added during wot and vegetable preparation.
Ruta chalepensis	Branches: used during coffee and tee drink
Mentha spicata	Leaves: used during tea drink
Rosmarinus officinalis L.	Branches: added during roasting of meat

4.5.3 Medicinal plants

From the total of 23 species of medicinal plants, 14 (60.8%) species were herbs, 6(26%) were shrubs, 2(8.7%) were climbers and 1(4.3%) was tree (Figure 4). The local community used these plant species as remedies for the treatment of human ailments and curing livestock diseases.

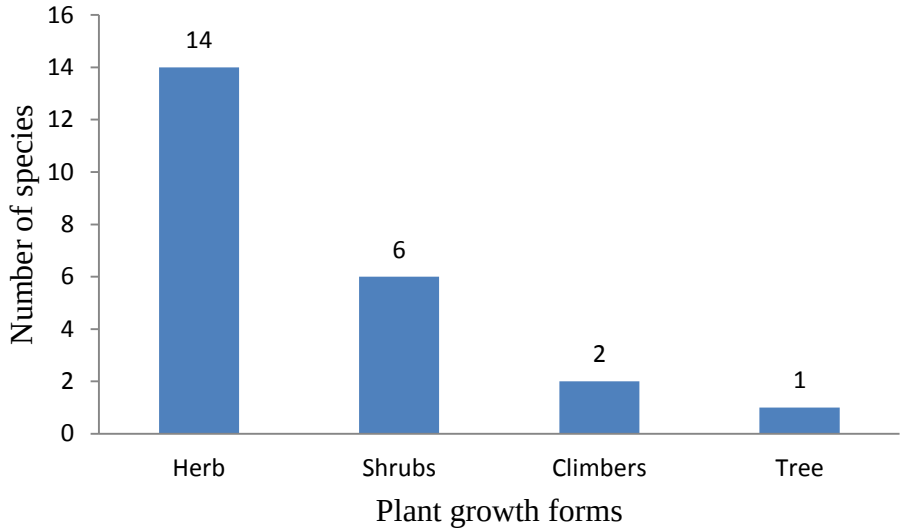


Figure 4: Plant growth forms of medicinal plants and number of species in the study area

A given plant species is used in the treatment of different diseases. People show direct preference towards plant species having healing potential of various ailments. Preference ranking performed by fourteen key informants for 6 selected plant species (Table 9) showed that *Allium sativum* to be the most preferred followed by *Lepidium sativum*. Mohammed Adefa and Berhanu Abraha (2011), reported that preference ranking in Tehuledere district for 8 selected plant species showed that *Allium sativum* was the most preferred one followed by *Negella sativa*.

Table 9: Preference ranking for six selected medicinal plants on the degree of healing several ailments (larger value (6) for a species having great potential and (1) for a species having low healing potential)

Botanical name	Vernacular name	Respondents(R)														Total	Rank
		R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	R_9	R_{10}	R_{11}	R_{12}	R_{13}	R_{14}		
Allium sativum L.	Nechi shinkurt	6	5	6	5	6	6	6	6	3	6	6	6	5	6	78	1
Ruta chalepensis L.	Tenadam	3	3	5	4	3	4	4	2	2	4	3	5	3	4	49	4
Lepidium sativum L.	Feto	4	6	4	2	1	3	3	4	6	3	5	4	6	5	56	2
Vernonia amygdalina Del.	Girawa	2	1	3	1	2	1	1	1	1	1	1	1	1	2	19	6
Zehneria scabra (Linn. F.) Sond.	Haregresa	1	4	2	3	5	5	5	3	4	5	4	2	4	3	50	3
Ocimum lamifolium Hochst. ex Benth	Damakese	5	2	1	6	4	2	2	5	5	2	2	3	2	1	42	5

Some species of plants used to treat livestock ailments were *Lepidium sativum*, *Vernonia amygdalina* and *Artemisia afra*. According to informants they used the seeds and leaves of these species to treat "mich" and eye diseases in domestic animals.

4.5.4 Live fence and shade plants

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. Most of them were trees and shrubs. According to Zemede Asfaw (2001), in rural villages, homegarden fences almost always contain live plants which provide additional benefits to families as food, medicine, material for construction, farm and household implements and cordage. Many of these can be traced back to the natural vegetation before the living quarter was established, while others are either planted purposely or encouraged and protected when they grow by themselves. The selected live fence plants most of the time are either shrubs with profuse stem growth and climber plants that stratify the fence prohibiting free sight and access to the garden.

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. Common live fence and shade species are listed in the table below (Table 10).

Table 10: Common live fence and shade species in the study area

Botanical name	Vernacular name	Frequency	Relative frequency
Cupressus lusitanica Mill.	Yeferenge tide	32.67	2.18
Cytisus proliferus L.F.	Meno	51.33	3.42
Discopodium penninervium Hochst.	Aluma	44.67	2.98
Eucalyptus globulus Labill.	Nechi baharzaf	54	3.68
Justicia schimperiana (Hchst ex Nees.) T. Anders	Simiza	16.67	1.11
Murus alba L.	Yeferej engori	13.33	0.9
Otostegia tomentosa A. Rich.	Yeferese zeng	16.67	1.11
Phytolacca dodecandra L'Her.	Endod	18.67	1.24
Rubus steudneri Schweinf	Injori	12.67	0.84
Solanecio gigas (Vatke) C. Jeffery	Boz	24.67	1.64

4.5.5 Plants used as fodder for livestock

The contribution of currently collected useful plants as fodder is about 37 species of homegarden plants. Considering their growth forms, 17(45.9%) species were herbs, 11(29.7%) were shrubs, 5(13.5%) were trees, and 4(10.8%) were climbers. As reported by informants the most important fodder plants were *Eleusine floccifolia*, *Vernonia amygdalina*, *Cytisus proliferus*, and different type of herbs. Solomon Tamrat (2011) reported that in Kochere district, *Vernonia amygdalina, Dombeya torrida* and *Millettia ferruginea* were the highest rank rating first in the culture. In addition, a significant amount of crop residues of *Zea mays, Hordeum vulgare, Eragrostis tef, Sorghum bicolor* and *Triticum aestivum* are used as fodder in the locality.

4.5.6 Plants used for firewood, furniture and construction

The local people were found to be dependent on firewood. The important plants used as firewood, furniture and construction to the local people in the area came from 39, 6 and 8

species of homegarden plants respectively. Most of the plants used for these purposes were trees and shrubs in their growth forms. As reported by informants the most important firewood, furniture and construction plant species were *Eucalyptus globulus*, *Cupressus lusitanica*, *Acacia abyssinica*, *Senecio steudelii*, *Dombeya torrid* and *Cytisus proliferus*. According to Solomon Tamrat (2011), the most important firewood species in Kochere district are *Millettia ferruginea, Albizia gummifera* and *Acacia abyssinica.* Most of these plant species are obtained at wild or semi-wild state and some are purposely planted in gardens.

4.5.7 Plants used as stimulants

Under this category only *Rhamnus prinoides, Coffea arabica, Catha edulis* were recorded in the study area. Except from *Rhamnus prinoides, Coffea arabica* and *Catha edulis* were represented by small number of individuals in Gedamawit Kebele. According to informants, they are trying to adapt high cash income plants in their homegardens.

4.5.8 Cultural, spiritual and ornamental plants

Homegardens are the domain of a number of plant species that are closely linked with the culture and religion of the particular community in different parts of the country (Solomon Tamrat, 2011). Five species were documented under spiritual and cultural use category. Among cultural and spiritual plant species identified, *Otostegia integrifolia* is believed to protect delivered mother and the child against bad sprit when it is smoked in the house. *Ruta chalepensis* is also used to get rid of bad sprits from children when it is smelled in their left nostril. The other plants *Cymbopogon citratus, Cyperus alternifolius* and *Cupressus lusitanica* were believed to have cultural as well as aesthetic values and used during holly days.

Ornamental plants documented in the study area were *Rosa x richardii, Solanecio angulatus, Phoenix reclinata, Cyperus esculentus, Cyperus alternifolius, Cupressus lusitanica, Bidens rueppelli, Cymbopogon citratus* and *Zantedeschia aethiopica*. As reported by informants these plants were used during festivities, holly days and cultural

ceremonies to decorate their house and give pleasure for the family. Ornamental plants also provided uses such as live fences, shade trees and others and most of them are found managed at the front yard of home gardens. The same observation was reported by Solomon Tamrat, (2011).

4.5.9 Multipurpose plant species

Plant species are utilized for multiple purposes apart from their single value (Zemede Asfaw, 2001). Some individuals of the study area practiced growing multipurpose trees, shrubs and grasses on the front or either sides of their houses. In such cases, direct matrix rank analysis is used to identify plant species that are preferable for multiple uses. In this study seven multipurpose species were selected out of the total 60 multipurpose plants and seven use categories (construction, furniture, firewood, shade, live fence, medicine and fodder) were listed for some of the most frequently encountered multipurpose plants during the study period. The result showed that multipurpose plants in the order of importance were *Eucalyptus globulus, Cupressus lusitanica, Acacia decurrens, Acacia abyssinica, Hagenia abyssinica, Vernonia amygdalina,* and *Dombeya torrid* (Table 11). Matheos Agize *et al*., (2013), reported that the most frequently encountered multipurpose plants in the order of importance in Loma and Gena Bosa Districts of Dawro Zone were *Ensete ventricosum, Ficus vasta, Cordia africana, Croton macrostachyus, Arundo donax, Jatropha curcas, Maerua oblongifolia, Moringa stenopetala, Tamarindus indica* and *Terminalia brownii.*

Table 11: The results of fourteen key informants' direct matrix ranking for seven homegarden plant species with multiple uses

Name of plants	Botanical name	*Eucalyptus globulus* Labill.	*Dombeya torrid* (J.F.Gmel.)P. Bamps	*Vernonia amygdalina* Del.	*Cupressus lusitanica* Mill.	*Acacia decurrens* (Wendl.f.) Willd.	*Acacia abyssinica* Hochst. ex Benth.	*Hagenia abyssinica* (Bruce) J. F. Gmelin.
	Vernacular name	Nechi beharzaf	Wulekifa	Girawa	Yeferenje tisde	Yeferenji girar	Girar	Kosso
Use values	Construction	90	37	25	75	64	29	24
	Furniture	75	34	19	83	33	30	55
	Charcoal/ fire wood	79	50	39	52	69	57	42
	Shade	51	55	48	63	47	56	50
	Live fence	69	39	33	50	58	52	22
	Medicine	60	18	83	18	25	40	58
	Fodder	22	56	67	41	53	59	64
	Total score	**446**	**289**	314	**382**	**349**	323	315
	Rank	**1**	**7**	6	**2**	**3**	4	5

Local people cultivated the most important ones with varied uses (Tefera Mekonnon, 2010; Matheos Agize *et al*., 2013). For example, *Eucalyptus globulus* was used for timber, medicinal, shade, furniture, building and takes the top rank followed by *Cupressus lusitanica*. The result of seven multipurpose species direct matrix ranking confirmed that the local people were using *Vernonia amygdalina* for more of medicinal purposes followed by *Eucalyptus globulus.* Among plant species identified by direct matrix ranking in Sinan district, *Eucalyptus globulus* is the most abundant tree species with the highest density and relative density followed by *Cupressus lusitanica.* Tefera mekonnon (2010) reported that among tree species identified by direct matrix ranking in Sabata Hawas district, *Cupressus lusitanica* is the most abundant tree species with the highest relative density followed by *Eucalyptus camaldulensis*. The more the multiple uses for local people and the more conservation of that plant resource through cultivation and protection in gardens.

More conservation was also shown for cash producing shrubs and herbs in the district. Shrubs such as *Rhamnus prinoides* and *Malus sylvestris* were represented with the most individuals, densities and relative densities where as *Solanum tuberosum, Brassica carinata* and *Brassica oleracea* were herb species with the most individuals, densities and relative densities represented respectively (Table 12) (Appendix 3,4 and5).

Table 12: Plant species with the highest number of individuals, densities, and relative densities of occurrences

Botanical name	Number of individuals	Densities	Relative densities
Tree species			
Eucalyptus globulus Labill.	1549	0.103	54.81
Cupressus lusitanica Mill.	391	0.026	13.83
Dracaena steudneri Engl.	161	0.011	5.697
Shrub species			
Rhamnus prinoides L'Herit.	6574	0.438	52.64
Malus sylvestris Miller.	1120	0.075	8.968
Justicia schimperiana T. Anders.	674	0.045	5.397
Herb species			
Solanum tuberosum L.	5958	0.397	23.95
Brassica carinata A. Braun	3819	0.255	15.35
Brassica oleracea L.	3075	0.205	5.397

4.6 Market supply and consumption of homegarden plants

The market place plays an important social and economic role in many rural areas of the world. Within the context of homegardens and from a genetic diversity perspective, the market place is crucial in facilitating the exchange of germplasm among the members of a community as well as between communities. Such exchange is important for crop evolution as well as improvement for the continued and sustainable production of food in the home gardens, even if the exchange of genetic diversity may be restricted to the local market. The market can also be an important entrance point for new crops or varieties and, in this way, can link the individual garden to a larger network (Engels, 2001).

Markets are set on Wednesday and Saturday at Rebu gebeya town. Farmers come from each kebele of the district to sell their homegarden products and to buy products they

need. Considering the marketability of products, both women, children and men are in charge of selling fruits (*Malus sylvestris*, *Malus domestica*, *Prunus persica*); vegetables (*Brassica oleracea*, *Brassica carinata*, *Beta vulgaris*, *Capsicum annuum*, *Lactuca sativa*, *Brassica rapa*, *Allium sativum*, *Cucurbita pepo* and *Solanum tuberosum*); medicinal plants (*Lepidium sativum* and *Allium sativum*); spices (*Ruta chalepensis* and *Coriandrum sativum*); stimulants (*Rhamnus prinoides*); aromatic and ornamental (*Cymbopogon citratus*, *Cyperus alternifolius*, and *Cyperus escolentus*), pulses and cereals were observed on market surveys. According to Solomon Tamerat (2011), the marketable products from homegardens are either in fresh (vegetable, fruits and medicinal plants) or deried (seeds of some crops) forms.

4.7 Local homegarden management practices in the study area

The advantage of the management of homegardens with its agrobiodiversity improve microclimates by sustaining permanent plant cover, improving soil, water and other resources, reducing carbon emissions and increasing sequestration and storing it above and below ground, reducing vulnerability and ensuring food security (Feleke Weldeyes, 2011). Diverse management practices that range from designing the spatial (vertical and horizontal) structure of the garden and maintaining soil fertility to planting and harvesting are performed in the homegardens. Habitamu Hailu *et al*., (2011), also reprted that a number of management practices are performed in homegardens, and one of which is the endeavor to maintain as high as possible plant types in the garden.

4.7.1 Gender role and the maintenance of plants in the homegardens

While most of the activities can be carried out by any household member, some are gender-centered because of religious and labor requirements (Habitamu Hailu *et al*., 2011). Men are the main managers of the homegardens practicing sowing, planting and maintenance. Women are responsible for trading their products and making compost with their children. Men also participate in activities such as fencing, weeding, watering and harvesting of products, mainly those of fruit producing shrubs. Both men and women cultivated and managed root and tuber, vegetable crops, spices, and medicinal plants. But

taking of fresh products of these plants to the market was carried out mainly by women and children. According to Matheos Agize *et al.*, (2013), such activity is expected to conserve the plants with the indigenous practices.

Soil fertility in the homegarden is maintained mainly through the incorporation of animal manure and other house hold wastes. People in the study area used compost made from dung of hens, sheep and other cattles mixed with plant parts and dust particles. According to Tefera Mekonnon (2010), this in turn increases crop production and conserve soil moisture. The figure below shows compost made to support plant growth in the home gardens and for potato plantation in the farm land (Figure 5).

Figure 5: Compost made to support plant growth in the study area.

4.7.2 Local seed management practices

Seed selection is the practice performed in homegardens. Yield quality and quantity, time length required from planting to harvesting, resistance to diseases, income and drought and some socio-cultural reasons are the farmer criteria for selection. Farmers also

perform practices such as propagation, thinning, transplanting, growing seedlings (Figure 6) and harvesting.

The local seed sources are important for plant genetic resource management at community level in homegardens (Sunwar, 2003). Farmers in the study area obtained seed and seedling of homegarden components; vegetables, fodder, fruits, medicinal plants, spices and other plant species from the market, self-saved, sharing between and among homegarden owners and agriculture bureau. The purchased seed contributed the first source of planting material where as self-saved seed and seed donated from the agriculture bureau contributed the second and third source of planting material. Vogl-Lukasser (2002), reported a similar result that purchased seed is the major source for planting materials in Austrialia. Sunwar (2003) reported that self-saved seeds by farmers themselves are the first source of planting materials and has the highest contribution of all homegarden components. The purchased seed contributed second important source where as sharing between and among homegarden owners contributed the third important source.

Figure 6: Seedlings of *Rhamnus prinoides* in the homegardens

4.7.3 The tradition of diversifying plants in the homegardens

The people in Sinan district have a tradition of diversifying their homegardens with different types of plants which provide spices, vegetables, medicinal plants, shade live fence, fodder and other benefits (Figure 7). A lot of spices, vegetables and fruits including *Brassica carinata*, *Allium sativum*, *Malus domestica*, *Prunus persica*, *Brassica oleracea*, *Ruta chalepensis*, and others were grown in the homegardens for immediate access. Food diversification will naturally be embedded in the systems positive outcomes of mixed cropping and integrating farming coupled with introduction of new crops and underutilized adapted species. According to Matheos Agize *et al*., (2013) the tradition of respecting and encouraging individuals with diverse plant species in their homegardens contributed to having the diverse flora for all year round in homegardens in the study area. According to Casas *et al*., (2008), this consequently has multiple advantages such as an effect on the conservation strategy for food plants, traditional agricultural systems, species and the indigenous knowledge for generations in the study area.

Figure 7: The tradition of diversifying plants in the study area

4.8 Factors affecting species diversity and productivity of homegarden plants

Plant diversity in the homegarden is affected by different environmental factors and socio-economic conditions (Casas *et al*., 2008; Talemos Seta *et al*., 2013). The main factors affecting the diversity and productivity of homegarden plants in Sinan District has been reported by informants. The six major factors include lack of access to water, animals, agricultural input support, lack of awareness, pests and occurrence of plant diseases and weeds (Table 13).

Shortage of water was mentioned as the main constraint in growing homegarden crops in the study area. As reported by Tefera Mekonen (2010), homegardens in the Sabata Hawas were primarily dependent on rain and as a result diversity and productivity of plants was highly affected during the dry season. According to Mekonnon Amberber *et al*., (2014) the diversity and productivity of of homegardens in Holeta town were mainly affected by lack of agricultural support/ extension service. The result from the present study also shows that animals and birds and lack of agricultural input support were the next top most factors.

The agricultural input support (seed/seedling) provision by the agriculture bureau in the district is limited. The bereau mainly provides seedlings of fruit producing species especially that of *Malus sylvestris* and *Malus domestica* with the aim of increasing the income of farmers. As an alternative farmers buy seelings from the market and neighbours.

The general opinion of people is that the effect of pests was not a determental problem. Habitamu Hailu *et al*., (2011) reported that the effect of pests on homegarden biodiversity in Sabata Hawas town was a determental factor. Somehow, those people who had fruit producing species in the study area such as *Malus sylvestris* and *Malus domestica* covered the fruits of their plants from birds by mosquito nets to prevent fruit lose.

Table 13: Frequency and percent of respondants on factors that affect homegarden plant diversity in sinan district

Factors	Frequency	Percent of respondants
Lack of acess to Water	82	54.6%
Animals and birds	44	29.3%
Crop pests	11	7.3%
Agricultural input (seed/seedling provision) support and advice	37	24.67%
Lack of awareness	23	15.3%
Plant diseases and weeds	7	4.6%

5. CONCLUSION

It can be concluded that homegardens in the study area contain different types of plants important for different purposes. Plants with multiple uses took the top position of the plant use categories followed by live fence, fodder, firewood, food, medicinal, shade, spices, furniture, ornamentals, construction, aromatic and stimulants. This indicates that, the more the multiple uses for local people, the more conservation of that plant resource through cultivation and protection in homegardens.

More emphasis was also given to the cultivation of cash producing plants such as *Eucalyptus globulus*, *Rhamnus prinoides*, *Malus sylvestris* and *Malus domestica* and for farmers who have grown them in their gardens. This would affect the biodiversity of the home gardens. However, homegardens in the study area served as sites for the domestication of new varieties of crops and a number of management practices were performed to maintain as high as possible plant types in the garden including mixed cropping coupled with introduction of underutilized adapted species; and adding compost in the soil.

Farmers in the study area obtained seed and seedling of homegarden components from different sources. The purchased seed contributed the first source of planting material. Self-saved seeds, sharing between and among homegarden owners, and seeds or seedlings obtained from agriculture bureau were also sources of planting materils. This has increased the genetic diversity of the district. But there are factors affecting the diversity and productivity of homegarden plants. These include lack of access to water, agricultural input support, lack of awareness, animals and birds, crop pests and occurrence of plant diseases.

6. RECOMMENDATION

In the course of rapid development in the agricultural sector, market pressure, commercialization and new technologies have been pressing major changes up on agroforestry system. Traditional agricultural activities currently have been affected by the shift to improved seeds that are commercially important. This decreases the biodiversity of traditional homegardens and the benefit obtained from them. Based on the results of the study the following recommendations were given:

- Encourage homegardening for plant biodiversity conservation and management as well as for cultivation of spices, food plants, medicinal plants and other multipurpose species;
- Intensive education, either formally or informally, and awareness creation should be given for the people on the necessity of conservation for sustainable use of plants in the homegardens.
- It is also advisable to scale-up the indigenous way of protecting and managing the plants in the homegardens; and
- Further in-depth study and strenghnening of agricultural support (seed/seedling provision) system for homegarden species are very important for long term on farm management of plant biodiversity.

REFERENCE

Abdoellah, O.S., Hadkusumah, H.Y., Takeuchi, K., Okubo and Parikesit, S. (2006). Commercialization of home gardens in an Infonesian village: Vegetation composition and functional changes. *Agro.Syt*. **68**: 1-13.

Agbogidi, O. M. (2013). Home gardens in the maintenance of biological diversity. PSCI Publications. *App.Sci.Rep.* **1** (1): 19-25.

Azene Bekele Tesemma (2007). Useful trees of Ethiopia: Identification, Propagation and Management in 17 agro-ecological zones*:* Nairobi, RELMA in ICRAF project, pp. 552.

Bajpai, S., Sharma, K.A. and Kanungo, K.V. (2013). Traditional home gardens: A preserve of medicinal plants. *I.J.H.M.* **1**(2): 152-161.

Birol, E., Bela, G. and Smale, M. (2005). The role of home garden in promoting multi-functional agriculture in Hungary. *Euro-choices.* **3**: 14-21.

Blancas, J., Casas, A., Pérez-Salicrup, D., Caballero, J. and Vega, E. (2013). Ecological and socio-cultural factors influencing plant management in Náhuatl communities of the Tehuacán Valley, Mexico. *J. E. E*, pp. 9:39.

Bureau of Agriculture (1999). Agricultural master plan, Amahara regional state technical report on soil management. Bahir Dar, Ethiopia.

Casas, A., Rangel-Landa, S. and Torres-García I. (2008). *In situ* management and conservation of plant resources in the Tehuacán-Cuicatlán Valley, Mexico: an ethnobotanical and ecological approach. **In***:* Current Topics in Ethnobotany. (Albuquerque, U.P., Alves-Ramos, and M. Kerala, India editors): Research Signpost, pp. 1–25.

Central Statistical Authority (2013). Agricultural sample survey: Land utilization. Volume IV, Statistical Buelletin 361, Addis Ababa, Ethiopia.

Duns, H. and Willems, D. (2013). Fact sheet Spice Ethiopia. Netherlands African business Council, Netherlands.

Engels, J. (2001). Home gardens -a genetic resource perspective, **In**: Contributions of home gardens to *in-situ* conservation of plant genetic resources in farming systems (*Proceedings of the Second International Home gardens Workshop*) (Watson, J.W. and Eyzaguirre, P.B. editors). 17-19 July 2001, Witzenhausen, Federal Republic of Germany, pp. 3-10.

FAO (2004). Livelihoods grow in gardens: Diversifying rural icomes through home gardens, Diversification booklet 2, Rome.

Feleke Weldeyes (2011). Homegardens and spices of Baketo and Kafa (South west Ethiopia): Plant diversity, product valorization and implications to biodiversity conservation. Ph. D Thesis, in Botanical science, Addis Ababa University, Addis Ababa.

Fernandes, E.C.M. and Nair, P.K.R. (1986). An evaluation of the structure and function of the tropical gomegardens, International Council for Research in Agroforestry (ICRAF), Nairobi, Kenya.

Galhena, H.D. and Karim, R.F. and Maredia, M. (2013). Home gardens: a promising approach to enhance household food security and wellbeing. *Agri.F.S.*, pp. 2:8.

Gautam, R., Sthapit, B.R. and Shrestha, P.K. (2006). HomeGardens in Nepal: Proceeding of a Work shop on "Enhancing the contribution of home garden to on-farm management of plant genetic resources and to improve the livelihoods of Nepalese farmers, 6-7 August 2004, Pokhara.

Gebremedhin Teklehaimanot and Mulubrhan Haile (2007). Women in backyards: Root crop production and biodiversity management in backyards: A Case study in five selected woredas of tigray regional State, Northern Ethiopia DCG Report No. 50.

Getu Alemayehu, Zemede Asfaw, and Ensermu Kelbesa (2015). Plant diversity and Ethnobotany in Berehet district, North Shoa Zone of Amhara Region (Ethiopia) with emphasis on edible plants. *J.M.P.S.* **3**(60): 93-105.

Gilbert, M.G. (1995). Euphobiaceae. **In:** Flora of Ethiopia and Eritrea, Volume 2 part 2: Canellaceae to Euphorbiaceae, pp. 268-380, (Edwards, Mesfin Tadesse and Hedberg I.editors). Addis Ababa, Ethiopia and Uppsala, Sweden.

Habtamu Hailu, Sebsebe Demisewand and Zemede Asfaw (2011). Home gardens and agrobiodiversity conservation in Sabata Towon, Oromia Regional State of Ethiopia, ***SINET:*** *Eth.J.Sci*., **34**(1): 1–16, 2011

Hamilton, A. and Hamilton, P. (2006). Plant conservation: an ecosystem approach. London.

Hines, A. D. and Eckman, K. (1993). Indigenous Multipurpose Trees of Tanzania: Uses and economic benefits for people. Working paper, Rome, Italy.

Hodgkin, T. (2002). Home gardens and the maintenance of genetic diversity. **In**: Home gardens and *in situ* conservation of plant genetic resources in farming systems (*Proceedings of the Second International Home gardens Workshop*) (Watson, J.W. and Eyzaguirre, P.B. Editors), 17-19 July 2001, Witzenhausen, Germany/IPGRI, Rome, pp. 14-18.

Hoogerbrugge, I. and Fresco, L.O. (1993). Homegarden Systems, Agricultural Characteristics and Challenges. London, UK: International Institute for Environment and Development; Gate keeper Series No. 39.

Jeffrey, C. (1981). Cucurbitaceae. **In:** Flora of Ethiopia and Eritrea, Volume 2 part two**:** Canellaceae to Euphorbiaceae, pp17-59 (Edwards, Mesfin Tadesse and Hedberg I. editors). Addis Ababa, Ethiopia and Uppsala, Sweden.

Kassam, K.A. (2009). "Viewing change through the prism of indigenous human ecology: Findings from the Afghan and Tajik Pamirs", *H.Eco*, **37**(6): 677-690.

Kent, M. and Coker, P. (1992). Vegetation description and analysis. A practical approach. New York, USA, pp. 363.

Kers, E. (1930). Phytolacaceae. **In:** Flora of Ethiopia and Eritrea, Volume 2 part one Magnoliaceae to Flacourtiaceae, pp. 121-160 (Sue Edwards, Mesfin Tadesse, Sebsbe Demissew and Hedberg I. editors). Addis Ababa, Ethiopia and Uppsala, Sweden.

Kumar, B.M., and Nair, P.K. (2004). The enigma of tropical homegardens. *Agro.Sys.,* Kluwer Academic Publisher. **61**: 135-152.

Kumar, S.A.M. (2009). Plant diversity in the home gardens and its contribution to household economy, in suburban areas in Sirilanka, Ph. D Thesis, Mahidol University, Srilanka.

Larios, C., Cases, A., Vallejo, M., Moreno-Calles, A.I. and Balancas, J. (2013). Plant management and biodiversity Conservation in Náhuatl homegardens of the Tehuacán Valley. Mexico, *J. E. E.*, pp. 9:74.

Leeunberg, A.J.M. (1990). Apocynaceae. **In:** Flora of Ethiopia and Eritrea, Volume 4 part 1: Apiaceae to Dispalaceae, pp. 87-98 (Hedberg I, Edwards and Sileshi Nemomissa editors).Addis Ababa, Ethiopia and Uppsala, Sweden.

Magguran, A. E. and McGill, B. J. (2011). Biological diversity: Frontiers in measurement and assessment, Oxford University press INC., Newyork.

Marsh, R. (1998). Building on traditional gardening to improve household food security. *F.N.Agr.* **22**: 4–14.

Martin, G.J. (1995**).** Ethnobotany: A Methods Manual. Chapman and Hall, London, UK.

Mathewos Agize, Sebsebe Demissew and Zemede Asfaw (2013). Indigenous Knowledge on management of home gardens and plants in Loma and Gena Bosa districts of Dawro Zone, Southern Ethiopia: Plant biodiversity conservation, sustainable utilization and environmental protection, *IJSBAR.* **10** (1): 63-99.

Mekonnen Amberber, Mekuria Aragaw and Zemede Asfaw (2014). The role of homegardens for *in situ* conservation of plant biodiversity in Holeta Town, Oromia National Regional State, Ethiopia, *A.J.* **6**(1): 8-16.

Mesfin Tadesse (1994). Asteraceae. **In:** Flora of Ethiopia and Eritrea, Volume 4 part two Asteraceae (Composite), pp. 1-408 (Hedberg, I., I Friis, Edwards and Mesfin Tadesse editors). AddisAbaba, Ethiopia and Uppsala, Sweden.

Mictchell, R. and Hanstad, T. (2004). Small home garden plots and sustainable livelihoods for the poor. Rural Development Institute, Livelihood Support Programme, FAO, pp. 1-43.

Millat-e-Mustafa, M. (1997). Overview of research in Home Garden Systems: In: Applied Ethnobotany in Natural Resource Managment-Traditional home gardens, pp. 13-38 (Rastogi, A., Godbole, A. and Shangii, p., editors), International Centre for Moutain Dvelopment, Nepal.

Mohammed Adefa Seid and Berhanu Abraha Tsegay (2011). Ethnobotanical survey of traditional medicinal plants in Tehuledere district, South Wollo, Ethiopia, *J.M. P.R.* **5**(26): 6233-6242.

Mohan S. (2004). An assessment of the ecological and socio-economic benefits provided by home gardens: A case study of Keala, India.

Moreno-Calles, A., Casas, A, and Blancas J. (2010). Agro-forestry systems and biodiversity conservation in arid zones: the case of the Tehuacán Valley, Central México. *A. S.* **80**: 315–331.

Oakley, E. (2004). Homegardens: a cultural responsibility. *LEISA*, pp. 22-23.

Olajide-Taiwo, F. B., Adeoye, I. B., Adebisi-Adelani, O., Odeleye, O. M., Fabiyi, A. O and Olajide-Taiwo L. O. (2010). Assessment of the Benefits and Constraints of Home gardening in the Neighborhood of the National Horticultural Research Institute, Ibadan, Oyo State. *Am-Eu.J. A.E.S.* **7** (4): 478-483.

Parra, F., Blancas, J, Casas, A. (2012). Landscape management and domestication of *Stenocereus pruinosus* (Cactaceae) in the Tehuacán Valley: human guided selection and gene flow. *J. E.E.* pp. 8:32.

Pulami, R. and Paudel, D. (2004). Contribution of Home gardens to Livelihoods of Nepalese farmers In : Home Gardens in Nepal in Enhancing the contribution of home garden to on-farm management of plant genetic resources and to improve the livelihoods of Nepalese farmers: Lessons learned and policy implications", (*Proceeding of a workshop*) (Gautam, R., Sthapit, B.R. and Shrestha, P.K. editorss) 2006.6-7 August 2004, Pokhara, Nepal. LI-BIRD, Biodiversity International and SDC.

Reinhard, F. and Admasu Adi (1994). Honeybee flora of Ethiopia. (Sue, E. and Admasu Adi editors), Weikersheim: Margraf Verlag, Germany.

Ryding, O. (1962). Lamiaceae. **In:** Flora of Ethiopia and Eritrea, Volume 5 Gentianaceae to Cyclocheilaceae, pp. 516-604 (Hedberg ,I., Ensermu Kelbessa, Edward S., Sebsbe Demissew and Eva P. editors). Addis Ababa, Ethiopia and Uppsala, Sweden.

Shrestha, P., Gautman. R., Rana, B. R., and Sthapit, B. (2001). Home gardens in Nepal: Status and Scope for research and development **In**: Contributions of home gardens to *in situ* conservation of plant genetic resources in farming systems (*Proceedings of the Second International Home gardens Workshop*) (Watson, J.W. and Eyzaguirre, P.B. editors). 17-19 July 2001, Witzenhausen, Federal Republic of Germany, pp. 125-139.

Sinan Woreda Environmental and Natural Resource Protection Office (SWENRPO) (2014).

Shannon, C.E. and Wiener, W. (1949). The Mathematical theory of communication. University of Illinois, Chicago, USA.

Solomon Tamrat Debessa (2011). Study of Useful plants in and around Gate Uduma (Traditional Gedeo Homegardens) in Kochere Wereda of Gedeo Zone, SNNPR, Ethiopia: an Ethnobotanical Approach, Master`s Thesis, Addis Ababa University, Addis Ababa.

Sthapit, B. R, Rana, R. B., Hue, N. N. and Rijal, D.R. (2004). The diversity of taro and sponge gourds in traditional home gardens in Nepal and Vietnam (2004). **In**: (Eyzaguirre, P.B. and Linares editors). Home gardens and agrobiodiversity, Smithsonian Books, Washington, pp. 234-254.

Subdi, A., Suwal, R., Gautm, R., Sunwar, S. and Shrestha, P. (2004). Status and composition of plant genetic diversity in Nepalese Home gardens **In**: home gardens in Nepal (*Proceedings of a national workshop*), 6-7 August 2004, Pokhara, Nepal, (Gautman, R., Sthapit, B., Shrestha, P., editors).

Sunwar, S. (2003). Home gardens in western Nepal: Opportunities and challenges for on-farm management of agrobiodiversity International Master Programme at the Swedish Biodiversity Centre, Master`s Theses. Uppsala, Sweeden.

Swaminathan, M.S. (1996). Sustainable agriculture towards food security. Konark Publications Pvt. Ltd., Delhi.

Talemos Seta, Sebsebe Demisew and Zemede Asfaw (2013). Home gardens of Wolayta, Southern Ethiopia: An ethnobotanical profile; *A.J.M.P.* **1**(1): 014-030.

Tefera Mekonen Kebede (2010). Home gardens Agrobiodiversity Conservation in Sebeta-Hawas Wereda, Southwestern Shewa Zone of Oromia Region, Ethiopia. Master`s Theses, Addis Ababa University, Addis Ababa.

Temesgen Magule Olango, Bizuayehu Tesfaye, Marcello, C. and Mario, E. (2014). Indigenous knowledge, use and on-farm management of *enset* (*Ensete ventricosum* (Welw.) Cheesman) diversity in Wolaita, Southern Ethiopia, *J. E. E.* pp. 10:41.

Thapa, B.B, (2004). "Establishment of Homestead garden". Bagwani Bani. Bagwani Kendra, Kirtipur, Kathmandu (in Nepali), No. 11.

Townsend, F. G. (1984). Multi-purpose trees for Honey Production. Echo Technical Note, University of Gulf, Gulf, Ontario, Canada.

Van der Maarel, E. (2005). Vegetation Ecology, Blackwell Science Ltd, USA.

Vogl-Lukasser, B., Vogl, C.R. and Bolhar N.H. (2002). The composition of Home gardens on small peasant farms in the alpine regions of Osttirol (Austria) and their role in sustainable rural development. **In**: Ethnobotany and Biocultural Diversity (Stepp, J.R., Wyndham, F.S. and Zarger, R.K. editors). University of Georgia Press; Athens, Georgia, USA.

Vollesen, K. (1958). Rhaminaceae. **In:** Flora of Ethiopia and Eritrea, Volume 3 Pittosporaceae to Araliaceae, pp. 385-398 (Hedberg I. and Edwards editors). Addis Ababa and Asmara, Ethiopia and Uppsala, Sweden.

Vollesen, K. (1980). Malvaceae. **In:** Flora of Ethiopia and Eritrea, Volume 2 part2**:** Canellaceae to Euphorbiaceae, pp 190-256 (Edwards, Mesfin Tadesse and HedbergI.editors). Addis Ababa, Ethiopia and Uppsala, Sweden.

Zemede Asfaw (2001). Home Gardens in Ethiopia: Some observations and genralizations, **In**: Contributions of home gardens to *in situ* conservation of plant genetic resources in farming systems (*Proceedings of the Second International Home gardens Workshop*) (Watson, J.W. and Eyzaguirre, P.B. editors). 17-19 July 2001, Witzenhausen, Federal Republic of Germany, pp. 125-139.

Zemede Asfaw and Ayele Nigatu (1995). Home Gardens in Ethiopia: Characteristics and Plant diversity**.** *SINET:Ethio. J. Sci.* **18**(2): 235-266.

Zemede Asfaw and Mesfin Tadesse (2001). Prospects for sustainable use and development of wild food plants in Ethiopia. *Econ.Bot*. 55(1):47-62.

Appendices

Appendix 1: Plants encountered in the homegardens of Sinan district and their use category.

No	Coll. No	Botanical name	Vernacular name(Amharic)	Family name	Plant form	Use category
1	P69	*Acacia abyssinica* Hochst. ex Benth.	Girar	Fabaceae	T	Lf, S,fw
2	P65	*Acacia decurrens* (Wendl. f.) Willd.	Yefernji girar	Fabaceae	T	Fu,Lf,S, Fw
3	P74	*Acacia melanoxylon* R. Br.	Omedla	Fabaceae	T	Fw, Lf, S
4	P34	*Acanthus senni* Chiov.	*	Acanthaceae	S	Lf,Fd
5	P20	*Allium porrum* L.	Baro shinkurt	Alliaceae	H	F
6	P114	*Allium sativum* L	Nechi shinkurt	Alliaceae	H	M, Sp
7	P102	*Aloe berhana* Reynolds.	E`ret	Aloaceae	H	M
8	P97	*Anethum foeniculum* L.	Kamun	Apiaceae	H	Sp
9	P115	*Artemisia afra* Jacq. ex Willd.	Chikugn	Asteraceae	H	M
10	P51	*Arundinaria alpina* K. Schum.	Kerkeha	Poaceae	S	Fu,Lf,Fw
11	P50	*Arundo donax* L.	Shenbeko	Poaceae	S	Fu, Lf,Fw
12	P61	*Bersama abyssinica* Fresen.	Azamera	Melianthaceae	S	O
13	P06	*Beta vulgaris* L.	Keyser	Chenopodiaceae	H	F
14	P70	*Bidens rueppelli* (Sch. Bip. ex Walp.) Sherf.	Adey abeba	Asteraceae	H	Fd, Or, SC

15	P29	*Brassica carinata* A. Braun.	Yabesha gomen	Brassicaceae	H	F
16	P67	*Brassica nigra* (L.) Koch.	Senafich	Brassicaceae	H	M,F,Sp
17	P04	*Brassica oleracea* L.	Tikel gomen	Brassicaceae	H	F
18	P78	*Brassica rapa* L.	Kosta	Brassicaceae	H	F
19	P25	*Buddleja polystachya* Fresen.	Anfar	Longaniaceae	T	Lf,Fw
20	P71	*Cajanus cajan* (L.) Millsp.	Yeamora ater	Fabaceae	H	Fd
21	P28	*Callistemon citrinus* (Curt.) Skeels.	*	Myrtaceae	S	O
22	P05	*Capsicum annuum* L.	Yabesha karia	Solanaceae	H	F,Sp
23	P30	*Carduus chamaecephalus* (Vatke) Oliv. & Hiern.	Kosheshela	Asteraceae	H	Lf, Fd
24	P46	*Carissa spinarum* L.	Agam	Apocynaceae	S	Lf,F,Fd,Fw
25	P100	*Casuarina cunninghamiana* Miq.	Arzelibanos	Casuarinaceae	T	Fu,Lf, S,Fw
26	P44	*Catha edulis* (Vahl) Forssk. ex Endl.	Chat	Celastraceae	S	St
27	P07	*Cirsium schimperi* (Vatke) Cut.	Gongobila	Asteraceae	H	Lf, Fd
28	P72	*Clausena anisata* (Willd.) Hook. F. ex Benth.	Limich	Rutaceae	S	O
29	P31	*Clematis simensis* Fresen.	Yeazohareg	Ranunuculaceae	C	Fd
30	P120	*Coffea arabica* L.	Buna	Rubiaceae	S	St
31	P60	*Combretum molle* (R. Br. ex Don.) Engl. & Diels.	Avalo	Combretaceae	S	Fd, Fw
32	P122	*Conium maculatum* L.	Fanfuye	Fabaceae	H	Fd, O
33	P49	*Coriandrum sativum* L.	Dimblal	Apiaceae	H	Sp, M
34	P64	*Cotula abyssinica* Sch. Bip. Ex A. Rich	Yewusha melas	Asteraceae	H	Fd
35	P55	*Crassocephalum vitellinum* (Benth.) Moore.	*	Asteraceae	H	Fd
36	P57	*Croton macrostachyus* Hochst. ex Del.	Bisana	Euphorbiaceae	T	M,Fw,SFd,Lf
37	P58	*Cucurbita pepo* L.	Duba	Cucurbitaceae	C	F
38	P21	*Cupressus lusitanica* Mill.	Yefernge tide	Cupressaceae	T	Fu,C,Lf,S,w,Or

39	P75	*Cymbopogon citratus* (DC.) Stapf.	Tejesar	Poaceae	H	Ar, Or, SC
40	P52	*Cyperus alternifolius* L.	Quietema	Cyperaceae	H	Fd, Or,CS
41	P63	*Cyperus esculentus* L.	Geranta	Cyperaceae	H	Fd,Or,CS
42	P16	*Cytisus proliferus* L. F.	Meno	Fabaceae	S	LF,Fd,S,,Fw
43	P87	*Datura stramonium* L.	Astenager	Solanaceae	H	M
44	P11	*Daucus carota* L.	Carot	Appiaceae	H	F
45	P18	*Discopodium penninervium* Hochst.	Aluma	Solanaceae	S	Lf,S,Fw,
46	P37	*Dombeya torrida* (J. F. Gmel.) P. Bamps.	Wulekifa	Sterculiaceae	T	Fu,Lf,S, Fw
47	P83	*Dovyalis caffra* (Hook. f. & Harv.) Hook. f.	Koshim	Flacourtiaceae	T	Fw,fd, F,S
48	P10	*Dracaena steudneri* Engl.	Lankuso	Agavaceae	T	Lf,Fd, Fw,
49	P59	*Echinops hispidus* Fresen.	Costendero	Asteraceae	H	Fd
50	P86	*Eleusine floccifolia* (Forssk.) Spreng.	Serdo	Poaceae	H	Fd
51	P41	*Embelia schimperi* Vatke.	Enqoqo	Myrsinaceae	S	M,Fw, Lf, S
52	P03	*Ensete ventricosum* (Welw.) Cheesman.	Coba/Enset	Musaceae	S	Fd, O
53	P104	*Erica arborea* L.	Asta	Ericaceae	T	Lf,S, Fd,Fw
54	P24	*Erythrina abyssinica* Lam. ex DC.	Korch	Fabaceae	T	Lf,S, Fw
55	P08	*Eucalyptus globulus* Labill.	Nechi beharzaf	Myrtaceae	T	Fu,C,Lf,S,M,Fw
56	P47	*Euphorbia abyssinica* Gmel.	Kulqual	Euphorbiaceae	S	Lf,Fw
57	P107	*Ficus sur* Forssk.	Shola	Moraceae	T	F,Fd,fw, S,Lf
58	P89	*Foeniculum vulgare* Mill.	Insilal	Apiaceae	H	M
59	P92	*Galinsoga parviflora* Cav.	Yewusha arem	Asteraceae	H	Fd
60	P33	*Galium simensis* Fresen.	Ashkit	Rubiaceae	H	O
61	P124	*Gomphocarpus stenophyllus* Oliv.	Chifirig	Asclepiadaceae	H	O

62	P62	*Grewia ferruginea* Hochst. ex A Rich.	Tulet/lenquata	Tiliaceae	S	Fd
63	P95	*Hagenia abyssinica* (Bruce) J. F. Gmelin.	Kosso	Rosaceae	T	Lf,Fw,
64	P84	*Hordeum vulgare* L.	Mesnogebs	Poaceae	H	F
65	P85	*Hypericum revolutum* Vahl.	Ameja	Hypericaceae	S	Lf,Fw,Fd
66	P09	*Juniperus prosera* Hochst. Ex Endl.	Yehabesha tid	Cupressaceae	T	Fu,C,Lf,S,Fw,
67	P23	*Justicia schimperiana* T. Anders.	Simiza	Acanthaceae	S	Lf, Fw
68	P96	*Justitia ladanoides* Lam.	Telenge	Acanthaceae	H	Fd
69	P88	*Kalanchoea densiflora* Rolfe.	Andahulla	Crassulaceae	H	O
70	P91	*Lactuca sativa* L.	Selata	Asteraceae	H	F
71	P81	*Lepidium sativum* L.	Feto	Cruciferae	H	M
72	P103	*Linum usitatissimum* L.	Telba	Linaceae	H	F
73	P105	*Lippia adoensis* Hochst. ex Walp.	Kessie	Verbenaceae	H	Ar
74	P106	*Lupinus albus* L.	Gebito	Fabaceae	H	F,O
75	P108	*Lycopersicon esculentum* Mill.	Timatim	Solanaceae	H	F
76	P111	*Maesa lanceolata* Forssk.	Qelambo	Myrsinaceae	T	Fw,Lf, S
77	P02	*Malus domestica* Borkh.	Cheriplem	Rosaceae	S	F
78	P94	*Malus sylvestris* Miller.	Apple	Rosaceae	S	F
79	P26	*Mangifera indica* L.	Mango	Anacardiaceae	S	F
80	P14	*Maytenus arbutifolia* (Hochst. exA. Rich.) Wilczek.	Atat	Celastraceae	T	Lf,fd, Fw
81	P98	*Mentha spicata* L.	Nana	Lamiaceae	H	Sp
82	P99	*Murus alba* L.	Yeferej engori	Moraceae	S	Fd,Lf
83	P15	*Myrica salicifolia* Hochst. ex A. Rich.	Shinet	Myricaceae	S	Lf,Fw
84	P32	*Myrtus communis* L.	Ades	Myrtaceae	H	O

85	P66	*Ocimum bacilicum* L.	Besobla	Lamiaceae	H	Sp
86	P112	*Ocimum lamifolium* Hochst. ex Benth.	Damakese	Lamiaceae	H	M
87	P48	*Olea europea* subsp *cuspidate* (Wall. ex. DC.) Gifferri.	Weiyra	Oleaceae	T	C,Lf,S,Fd
88	P45	*Otostegia integrifolia* Benth.	Tunjit	Lamiaceae	S	O, M, CS
89	P121	*Otostegia tomentosa* A. Rich	Yeferese zeng	Lamiaceae	S	Lf,Fd,M, fw
90	P109	*Pentas schimperiana* (A. Rich.) Vatke.	Weynagifte	Rubiaceae	H	Fd,fw
91	P54	*Phoenix reclinata* Jacq.	Zembaba	Arecaceae	T	S, Or
92	P17	*Phytolacca dodecandra* L'Her.	Endod	Phytolacaceae	S	Lf, O
93	P113	*Pisum sativum* L.	Ater	Fabaceae	H	F
94	P80	*Plantago lanceolata* L.	Gorteb	Plantaginaceae	H	Fd, M
95	P82	*Prunus africana* (Hook. f.) Kalkm.	Homa	Rosaceae	T	Fw, Lf,S
96	P27	*Prunus persica* (L.) Batsch.	Kock	Rosaceae	T	F
97	P01	*Rhamnus prinoides* L'Herit.	Gesho	Rhamnaceae	S	St
98	P38	*Rhus nantalensis* Bernh.ex Krauss.	Chakima	Ancaradiaceae	S	Fw, M, Lf
99	P19	*Rosa abyssinica* Lindley.	Kega	Rosaceae	S	M,F, Fd,Fw
100	P68	*Rosa x richardii* Rehder.	Tsigereda abeba	Rosaceae	S	Or
101	P79	*Rosmarinus officinalis* L.	Yesiga-metibesha	Lamiaceae	H	Sp
102	P39	*Rubus steudneri* Schweinf.	Injori	Rosaceae	S	Lf, F, Fd
103	P101	*Rumex abyssinicus* Jacq.	Mekmeko	Polygonaceae	H	M
104	P116	*Rumex nepalensis* Spreng.	Qtele-rejim	Polygonaceae	H	Fd
105	P12	*Ruta chalepensis* L.	Tenadam	Rutaceae	H	M,Sp
106	P77	*Saccharum officinarum* L.	Shenkora ageda	Poaceae	H	F
107	P93	*Salix subserrata* Willd.	Kiya	Salicaceae	T	Lf, Fw,
108	P123	*Senecio myriocephalum* Sch. Bip. ex A. Rich.	Sinbut	Asteraceae	S	Lf, S,Fw

109	P125	*Senecio steudelii* Sch. Bip. Ex. A. Rich.	Gemiye	Asteraceae	H	Fw,Lf
110	P118	*Snowdenia polystachya* (Fresen.) Pilg.	Muja	Gramineae	H	Fd
111	P35	*Solanecio angulatus* (Vahl.) C. Jeffrey.	Hareg	Rutaceae	C	Lf, Or
112	P43	*Solanecio gigas* (Vatke) C. Jeffery	Boz	Asteraceae	S	Lf
113	P56	*Solanum indicum* L.	Imboy	Solanaceae	S	O
114	P76	*Solanum tuberosum* L.	Dench	Solanacaae	H	F
115	P36	*Stephania abyssinica* (Quart.Dillo & A. Rich.) Walp.	Yaythareg	Menispermaceae	C	Fd
116	P110	*Tagetes minuta* L.	Yahiya shito	Asteraceae	H	Fd
117	P119	*Trifolium rueppellianum* Fresen.	Magett	Fabaceae	H	M,Fd
118	P73	*Triticum aestivum* L.	Yedabo Sindi	Poceae	H	F
119	P40	*Urtica simensis* Steudel.	Samma	Urticaceae	H	Lf,Fd, M
120	P42	*Vernonia amygdalina* Del.	Girawa	Asteraceae	S	Fd,Lf,S M, fw
121	P13	*Vernonia urticifolia* A. Rich.	Gengerita	Asteraceae	S	Lf,S,Fw
122	P117	*Vicia faba* L.	Bakela	Fabaceae	H	F
123	P22	*Zantedeschia aethiopica* (L.) Spreng.	Tirumba abeba	Araceae	S	Or
124	P90	*Zea mays* L.	Bekolo	Poaceae	H	F
125	P53	*Zehneria scabra* (Linn. F.) Sond.	Haregresa	Cucurbitaceae	C1	M, Fd

Key * indicates plants that do not have common name in the area

Plant form: **T**=tree, **S**= shrub, **H**=herbs, **C**= Climbers

Function: **F**= food, **Fu**= furniture, **Fw**= fire wood and charcoal, **C**=construction, **M**= medicinal, **Sp**=spices, **St**= Stimulant, **Or**= ornamentals **A**=aromatic plants, **Fd**=fooder, **LF**= live fence, **S** =shade, **MP=** multipurpose and O= others.

Appendix 2: Frequencies and relative frequencies of plant species

No	Botanical name	No of quadrats a species occur	Frequency	Relative frequency
1	*Acacia abyssinica* Hochst. ex. Benth.	44	29.33	1.95
2	*Acacia decurrens* (Wendl. f.) Willd.	51	34	2.27
3	*Acacia melanoxylon* R..Br.	11	7.33	0.48
4	*Acanthus senni* Chiov.	9	6	0.40
5	*Allium porrum* L.	2	1.33	0.088
6	*Allium sativum* L.	13	8.67	0.57
7	*Aloe berhana* Reynolds.	1	0.67	0.044
8	*Anethum foeniculum* L.	1	0.67	0.044
9	*Artemisia afra* Jacq.ex Willd.	1	0.67	0.044
10	*Arundinaria alpina* K. Schum.	20	13.33	0.91
11	*Arundo donax* L.	3	2	0.13
12	*Bersama abyssinica* Fresen.	3	2	0.13
13	*Beta vulgaris* L.	20	13.33	0.91
14	*Bidens rueppelli* (Sch. Bip.ex Walp.) Sherf.	9	6	0.4
15	*Brassica carinata* A. Braun	49	32.67	2.18
16	*Brassica nigra* (L.) Koch.	3	2	0.13
17	*Brassica oleracea* L.	38	25.33	1.69
18	*Brassica rapa* L.	7	4.67	0.31
19	*Buddleja polystachya* Fresen.	21	14	0.93
20	*Cajanus cajan* (L.) Millsp.	1	0.67	0.044
21	*Callistemon citrinus* (Curt) Skeels	1	0.67	0.044
22	*Capsicum annuum* L.	13	8.67	0.59
23	*Carduus chamaecephalus* (Vatke) Oliv. & Hiern	1	0.67	0.044
24	*Carissa spinarum*L.	8	5.33	0.35
25	*Casuarina cunninghamiana* Miq.	1	0.67	0.044
26	*Catha edulis* (Vahl) Forssk. ex Endl	3	2	0.133
27	*Cirsium schimperi* (Vatke) Cut.	62	41.33	2.76
28	*Clausena anisata* (Willd.) Hook. F. ex Benth.	3	2	0.133

29	*Clematis simensis* Fresen.	32	21.33	1.42
30	*Coffea arabica* L.	1	0.67	0.044
31	*Combretum molle* (R.Br. ex Don.) Engl. & Diels.	9	6	0.4
32	*Conium maculatum* L.	35	23.33	1.55
33	*Coriandrum sativum* L.	6	4	0.26
34	*Cotula abyssinica* Sch. Bip. Ex A. Rich.	43	28.67	1.91
35	*Crassocephalum vitellinum* (Benth.) Moore.	2	1.33	0.088
36	*Croton macrostachyus* Hochst. ex Del.	1	0.67	0.044
37	*Cucurbita pepo* L.	5	3.33	0.22
38	*Cupressus lusitanica* Mill.	49	32.67	2.18
39	*Cymbopogon citratus* (DC.) Stapf.	10	6.67	0.44
40	*Cyperus alternifolius* L.	4	2.67	0.18
41	*Cyperus esculentus* L.	15	10	0.66
42	*Cytisus proliferus* L.F.	77	51.33	3.42
43	*Datura stramonium* L.	4	2.67	0.178
44	*Daucus carota* L.	4	2.67	0.178
45	*Discopodium penninervium* Hochst.	67	44.67	2.98
46	*Dombeya torrida* (J. F. Gmel.) P. Bamps.	52	34.67	2.36
47	*Dovyalis caffra* (Hook. f. & Harv.) Hook. F.	6	4	0.273
48	*Dracaena steudneri* Engl.	45	30	2.004
49	*Echinops hispidus* Fresen.	2	1.33	0.088
50	*Eleusine floccifolia* (Forssk.) Spreng.	12	8	0.53
51	*Embelia schimperi* Vatke.	17	11.33	0.75
52	*Enset ventricosu* (Welw.) Cheesman.	86	57.33	3.83
53	*Erica arborea* L.	1	0.67	0.044
54	*Erythrina abyssinica* Lam. ex DC.	11	7.33	0.48
55	*Eucalyptus globulus* Labill.	81	54	3.60
56	*Euphorbia abyssinica* Gmel.	2	1.33	0.088
57	*Ficus sur* Forssk.	1	0.67	0.044
58	*Foeniculum vulgare* Mill.	3	2	0.133
59	*Galinsoga parviflora* Cav.	3	2	0.13
60	*Galium simensis* Fresen.	12	8	0.53
61	*Gomphocarpus stenophyllus* Oliv.	24	16	1.06
62	*Grewia ferruginea* Hochst. ex A. Rich.	57	38	2.53

63	*Hagenia abyssinica* (Bruce) J. F. Gmelin.	41	27.33	1.82
64	*Hordeum vulgare* L.	22	14.67	0.98
65	*Hypericum revolutum* Vahl.	3	2	0.13
66	*Juniperus prosera* Hochst. Ex Endl.	5	3.33	0.222
67	*Justicia schimperiana* T. Anders.	25	16.67	1.11
68	*Justitia ladanoides* Lam.	15	10	0.668
69	*Kalanchoea densiflora* Rolfe.	9	6	0.4
70	*Lactuca sativa* L.	1	0.67	0.044
71	*Lepidium sativum* L.	7	4.67	0.312
72	*Linum usitatissimum* L.	1	0.67	0.044
73	*Lippia adoensis* Hochst. ex Walp.	1	0.67	0.044
74	*Lupinus albus* L.	1	0.67	0.044
75	*Lycopersicon esculentum* Mill.	5	3.33	0.222
76	*Maesa lanceolata* Forssk.	3	2	0.13
77	*Malus domestica* Borkh.	20	13.33	0.89
78	*Malus sylvestris* Miller.	64	42.67	2.85
79	*Mangifera indica* L.	1	0.67	0.044
80	*Maytenus arbutifolia* (Hochst. ex A. Rich.) Wilczek.	6	4	0.267
81	*Mentha spicata* L.	2	1.33	0.088
82	*Murus alba* L.	20	13.33	0.89
83	*Myrica salicifolia* Hochst. ex A. Rich.	2	1.33	0.088
84	*Myrtus communis* L.	1	0.67	0.044
85	*Ocimum bacilicum* L.	4	2.66	0.177
86	*Ocimum lamifolium* Hochst. ex Benth.	14	9.33	0.62
87	*Olea europea* subsp *cuspidate* (Wall. ex. DC.) Gifferri.	8	5.33	0.356
88	*Otostegia integrifolia* Benth.	14	9.33	0.623
89	*Otostegia tomentosa* A. Rich.	25	16.67	1.11
90	*Pentas schimperiana* (A. Rich.) Vatke.	2	1.33	0.088
91	*Phoenix reclinata* Jacq.	3	2	0.13
92	*Phytolacca dodecandra* L'Her.	28	18.67	1.24
93	*Pisum sativum* L.	5	3.33	0.22
94	*Plantago lanceolata* L.	1	0.67	0.044

95	*Prunus africana* (Hook.f.) Kalkm.	3	2	0.133
96	*Prunus persica* (L.) Batsch	34	22.67	1.51
97	*Rhamnus prinoides* L'Herit.	115	76.67	5.12
98	*Rhus nantalensis* Bernh.ex Krauss	32	21.33	1.42
99	*Rosa abyssinica* Lindley	5	3.33	0.22
100	*Rosa x richardii* Rehder.	10	6.67	0.44
101	*Rosmarinus officinalis* L.	1	0.67	0.044
102	*Rubus steudneri* Schweinf.	19	12.67	0.84
103	*Rumex abyssinicus* Jacq.	1	0.67	0.044
104	*Rumex nepalensis* Spreng.	8	5.33	0.35
105	*Ruta chalepensis* L.	42	28	1.87
106	*Saccharum officinarum* L.	2	1.33	0.088
107	*Salix subserrata* Willd.	2	1.33	0.088
108	*Senecio myriocephalum* Sch.-Bip. Ex A. Rich.	40	26.67	1.78
109	*Senecio steudelii* Sch.Bip. Ex. A. Rich.	18	12	0.801
110	*Snowdenia polystachya* (Fresen.) Pilg.	3	2	0.13
111	*Solanecio angulatus* (Vahl) C. Jeffrey.	7	4.67	0.312
112	*Solanecio gigas* (Vatke) C. Jeffery.	37	24.67	1.64
113	*Solanum indicum* L.	15	10	0.668
114	*Solanum tuberosum* L.	57	38	2.53
115	*Stephania abyssinica* (Quart.-Dillo & A. Rich.) Walp.	21	14	0.93
116	*Tagetes minuta* L.	1	0.67	0.04
117	*Trifolium rueppellianum* Fresen.	1	0.67	0.04
118	*Triticum aestivum* L.	6	4	0.26
119	*Urtica simensis* Steudel.	67	44.67	2.98
120	*Vernonia amygdalina* Del.	35	23.33	1.55
121	*Vernonia urticifolia* A. Rich.	91	60.67	4.05
122	*Vicia faba* L.	4	2.67	0.18
123	*Zantedeschia aethiopica* (L.) Spreng.	5	3.33	0.22
124	*Zea mays* L.	2	1.33	0.088
125	*Zehneria scabra* (Linn. F.) Sond.	23	15.33	1.02
		TotalFre=1496.67		**100**

Key * indicates plants that do not have common name in the area

Appendix 3: Densities and relative densities of herbs

No	Botanical name	No of individuals	Densities	Relative densities
1	*Allium porrum* L.	55	0.00366	0.221
2	*Allium sativum* L.	195	0.013	0.783
3	*Aloe berhana* Reynolds.	2	0.00013	0.008
4	*Anethum foeniculum* L.	50	0.00333	0.200
5	*Artemisia afra* Jacq.ex Willd.	2	0.00013	0.008
6	*Beta vulgaris* L.	932	0.06213	3.7464
7	*Bidens rueppelli* (Sch.Bip.ex Walp.) Sherf.	41	0.00273	0.1648
8	*Brassica carinata* A. Braun	3819	0.2546	15.351
9	*Brassica nigra* (L.) Koch.	1	6×10^{-5}	0.0040
10	*Brassica oleracea* L.	3075	0.205	12.360
11	*Brassica rapa* L.	300	0.02	1.205
12	*Cajanus cajan* (L.) Millsp.	1	6×10^{-5}	0.0040
13	*Capsicum annuum* L.	427	0.02846	1.7164
15	*Carduus chamaecephalus* (Vatke) Oliv. & Hiern.	104	0.0069	0.4180
16	*Cirsium schimperi* (Vatke) Cut.	331	0.02206	1.3305
17	*Conium maculatum* L.	721	0.04806	2.8982
18	*Coriandrum sativum* L.	35	0.00233	0.1406
19	*Cotula abyssinica* Sch.Bip. Ex A.Rich.	1057	0.07046	4.2489
20	*Crassocephalum vitellinum* (Benth.) Moore.	1	6×10^{-5}	0.0040
21	*Cymbopogon citratus* (DC.) Stapf.	206	0.01373	0.8280
22	*Cyperus alternifolius* L.	29	0.00193	0.116
23	*Cyperus esculentus* L.	123	0.0082	0.4944
24	*Datura stramonium* L.	10	0.00066	0.0402
25	*Daucus carota* L.	844	0.05626	3.3926
26	*Echinops hispidus* Fresen.	102	0.0068	0.4100
27	*Eleusine floccifolia* (Forssk.) Spreng.	577	0.0384	2.3194
28	*Foeniculum vulgare* Mill.	12	0.0008	0.0482
29	*Galinsoga parviflora* Cav.	15	0.001	0.0603
14	*Galium simensis* Fresen.	98	0.00653	0.3939
30	*Gomphocarpus stenophyllus* Oliv.	61	0.00406	0.2452
31	*Hordeum vulgare* L.	1831	0.12206	7.3602
32	*Justitia ladanoides* Lam.	6	0.0004	0.0241
33	*Kalanchoea densiflora* Rolfe.	91	0.00606	0.3658
34	*Lactuca sativa* L.	60	0.004	0.2411
35	*Lepidium sativum* L.	101	0.00673	0.406
57	*Linum usitatissimum* L.	30	0.002	0.1205

36	*Lippia adoensis* Hochst. ex Walp.	10	0.00066	0.0402
37	*Lupinus albus* L.	1	6×10^{-5}	0.0040
38	*Lycopersicon esculentum* Mill.	99	0.0066	0.3979
39	*Mentha spicata* L.	37	0.00246	0.1487
40	*Myrtus communis* L.	3	0.0002	0.0120
41	*Ocimum bacilicum* L.	72	0.0048	0.2894
42	*Ocimum lamifolium* Hochst. ex Benth.	6	0.0004	0.0241
43	*Pentas schimperiana* (A. Rich.) Vatke.	87	0.0058	0.3497
44	*Pisum sativum* L.	12	0.0008	0.0482
45	*Plantago lanceolata* L.	10	0.00066	0.0402
47	*Rosmarinus officinalis* L.	9	0.0006	0.0361
46	*Rumex abyssinicus* Jacq.	1	6×10^{-5}	0.0040
48	*Rumex nepalensis* Spreng.	58	0.00386	0.2331
49	*Ruta chalepensis* L.	288	0.0192	1.1577
50	*Saccharum officinarum* L.	1	6×10^{-5}	0.0040
51	*Senecio steudelii* Sch. Bip. Ex. A. Rich.	58	0.00386	0.2331
52	*Snowdenia polystachya* (Fresen.) Pilg.	10	0.00066	0.0402
53	*Solanum tuberosum* L.	5958	0.3972	23.949
54	*Tagetes minuta* L.	5	0.00033	0.0201
55	*Trifolium rueppellianum* Fresen.	9	0.0006	0.0361
56	*Triticum aestivum* L.	161	0.01073	0.6471
58	*Urtica simensis* Steudel.	2611	0.17406	10.495
59	*Vicia faba* L.	23	0.00153	0.0924
60	*Zea mays* L.	4	0.00026	0.0160
	Total		**1.658533**	**100.00**

Appendix 4: Densities and relative densities of shrubs

No	Botanical name	No of individuals	Densities	Relative densities
1	*Acanthus senni* Chiov. Catha edulis (Vahl) Forssk. ex Endl.	62	0.0041	0.4924
2	*Arundinaria alpina* K. Schum.	149	0.0099	1.1931
3	*Arundo donax* L.	8	0.0005	0.0640
4	*Bersama abyssinica* Fresen.	31	0.0020	0.2482
5	*Callistemon citrinus* (Curt) Skeels	5	0.0003	0.0360
6	*Carissa edulis* (Forssk.) Vahi.	1	6×10^{-5}	0.0080
7	*Catha spinarum*L.	12	0.0008	0.0960
8	*Clausena anisata* (Willd.) Hook. F. ex Benth.	1	6×10^{-5}	0.0080
9	*Coffea arabica* L.	1	6×10^{-5}	0.0080
10	*Combretum molle* (R. Br. ex Don.) Engl. & Diels.	41	0.0027	0.3283
11	*Cytisus proliferus* L. F.	10	0.0006	0.0800
12	*Discopodium penninervium* Hochst.	607	0.0404	4.8606
13	*Embelia schimperi* Vatke.	21	0.0014	0.1681
14	*Enset ventricosum* (Welw.) Cheesman.	300	0.02	2.4023
15	*Euphorbia abyssinica* Gmel.	3	0.0002	0.0240
16	*Grewia ferruginea Hochst.* ex A Rich.	469	0.0312	3.7556
17	*Hypericum revolutum* Vahl.	36	0.0024	0.2882
18	*Justicia schimperiana* T. Anders.	674	0.0449	5.3971
19	*Malus domestica* Borkh.	91	0.0060	0.7287
20	*Malus sylvestris* Miller.	1120	0.0746	8.9686
21	*Mangifera indica* L.	1	6×10^{-5}	0.0080
22	*Murus alba* L.	127	0.0084	1.0169
23	*Myrica salicifolia* Hochst. ex A. Rich.	102	0.0068	0.8167
24	*Otostegia integrifolia* Benth.	23	0.0015	0.1841
25	*Otostegia tomentosa* A. Rich.	160	0.0106	1.2812
26	*Phytolacca dodecandra* L'Her.	109	0.0072	0.8728

27	*Rhamnus prinoides* L'Herit.	6574	0.4382	52.642
28	*Rhus nantalensis* Bernh.ex Krauss	114	0.0076	0.9128
29	*Rosa abyssinica* Lindley	16	0.0010	0.1281
30	*Rosa x richardii* Rehder.	27	0.0018	0.2162
37	*Rubus steudneri* Schweinf.	77	0.0051	0.6165
31	*Senecio myriocephalum* Sch.-Bip. ex A. Rich.	351	0.0234	2.8107
32	*Solanecio gigas* (Vatke) C. Jeffery.	498	0.0332	3.9878
33	*Solanum indicum* L.	115	0.0076	0.9208
34	*Vernonia amygdalina* Del.	80	0.0053	0.6406
35	*Vernonia urticifolia* A. Rich.	467	0.0311	3.7395
36	*Zantedeschia aethiopica* (L.) Spreng.	5	0.0003	0.0400
		Total	**0.8325**	**100**

Appendix 5: Densities and relative densities of trees

No	Botanical name	Total no of individuals	Densities	Relative densities
1	*Acacia abyssinica* Hochst. ex Benth.	84	0.005	2.97239
2	*Acacia decurrens* (Wendl. f.) Willd.	93	0.006	3.29087
3	*Acacia melanoxylon* R. Br.	5	0.0003	0.17692
4	*Buddleja polystachya* Fresen.	64	0.004	2.26468
5	*Casuarina cunninghamiana* Miq.	4	0.0003	0.14154
6	*Croton macrostachyus* Hochst. ex Del.	1	$6x\ 10^{-5}$	0.03538
7	*Cupressus lusitanica* Mill.	391	0.0260	13.8358
8	*Dombeya torrida* (J. F. Gmel.) P. Bamps.	140	0.0093	4.95399
9	*Dovyalis caffra* (Hook. f. & Harv.) Hook. F.	7	0.0004	0.24769
10	*Dracaena steudneri* Engl.	161	0.0107	5.69709
11	*Erica arborea* L.	12	0.0008	0.42462
12	*Erythrina abyssinica* Lam. ex DC.	29	0.0019	1.02618
13	*Eucalyptus globulus* Labill.	1549	0.1032	54.8124
14	*Ficus sur* Forssk.	7	0.0004	0.24769
15	*Hagenia abyssinica* (Bruce) J. F. Gmelin.	100	0.0066	3.5385
16	*Juniperus prosera* Hochst. Ex Endl.	15	0.001	0.5307
17	*Maesa lanceolata* Forssk.	2	0.0001	0.0707
18	*Maytenus arbutifolia* (Hochst. ex A. Rich.) Wilczek.	19	0.0012	0.6369
19	*Olea europea* subsp *cuspidate* (Wall. ex. DC.) Gifferri.	18	0.0012	0.63694
20	*Phoenix reclinata* Jacq.	11	0.0007	0.38924
21	*Prunus africana* (Hook. f.) Kalkm.	22	0.0014	0.77848
22	*Prunus persica* (L.) Batsch.	88	0.0058	3.11394
23	*Salix subserrata* Willd.	4	0.0002	0.14154
		Total	**0.1884**	**100**

Appendix 6: Semi-structured interview administered to homegarden owners

Name of informant _____ Kebele_____

A. Sex _____

B. Age _____

D. Level of education

Illiterate ☐ Basic Primary school High school

College/University ☐ Others ☐

1. What are the dominant plants or crops in your home garden? List accordingly.
2. Are there crops in your home garden that grow throughout the year?
3. Which plants or crops in your garden are more important? Rank accordingly.
4. List names of plants in your homegarden used as multi pupose tree species
5. What are the aims and advantages of growing plants in your home gardens?
6. Which plants/ crops products more common in the market?
7. Is there task division based on gender? Yes/no
8. If your answer for question number 15 is yes, who is involved in the management practice to cultivate plants in home garden in a prolonged time? ----------
9. To what extent conservation practices are undertaken by the people in home gardens?
10. For what purpose do people, in the study area use home gardens?
11. Who is responsible for the proper management of home gardens?
12. Where do you obtain your desired variety of seedling/seed?
13. Is there any professional expertise, who is responsible and advice you how to manage your home gardens? Yes/No
14. Do you select the variety of the particular species you want to use in your garden?
15. List the factors that affect biodiversity in your home garden?
16. What management practices you have been doing in your home garden in order to maintain soil Fertility and sustain production?

Appendix 7: List of ordinary respondents, Educational background, age, sex and altitude of each homegarden

No	Name	Sex	Home garden code	Altitude of home garden	Age	Educational Background	Marital status	Kebele
1	Kassa Manaye	M	SHN1	3274M	40	Basic	Married	Sm
2	Zewudie Manaye *	F	SHN2	3292M	45	Illiterate	Married	Sm
3	Fentaye Mekonnon	F	SHN3	3288M	62	Basic	Married	Sm
4	Belayenesh Mekonnon	F	SHN4	3285M	45	Illetrate	Married	Sm
5	Sharew Tirusew	M	SHN5	3296M	40	Basic	Married	Sm
6	Asrat Ayalew	F	SHN6	3303M	56	Illiterate	Married	Sm
7	Simegn Tirusew *	M	SHN7	3304M	53	Basic	Married	Sm
8	Anchinalu Bitew	F	SHN8	3289M	48	Illetrate	Married	Sm
9	Enkuane Lulia	F	SHN9	3283M	40	Illetrate	Married	Sm
10	Meneyikesew Tamene	F	SHN10	3271M	62	Illetrate	married	Sm
11	Abeba Mengestia	F	SHN11	3251M	43	Illetrate	Married	Sm
12	Yewubsera Awoke	F	SHN12	3261M	59	Illetrate	Married	Sm
13	Tena Aseresia	F	SHN13	3265M	30	Illetrate	Married	Sm
14	Yiftu kahile	F	SHN14	3262M	35	Basic	Married	Sm
15	Yenguse Asmare	F	SHN15	3267M	50	Illiterate	Married	Sm
16	Yamrot Lule	F	SHN16	3279M	35	Illiterate	Married	Sm
17	Mulu Gebeyehu	F	SHN17	3276M	40	Illiterate	Married	Sm
18	Birhane Emeria*	M	SHN18	3278M	62	Primary School	Married	Sm
19	Degitinu Yeshanew	F	SHN19	3280M	62	Basic	Married	Sm
20	Simegn Belayineh	F	SHN20	3288M	46	Illiterate	Married	Sm
21	Tachawut Getu	F	SHN21	3289M	39	Basic	Married	Sm
22	Tirukelem Eneyew	F	SHN22	3287M	46	Illiterate	Married	Sm
23	Adane Demeke	M	SHN23	3287M	55	Primary school	Married	Sm
24	Damete emere	M	SHN24	3298M	65	Basic	Married	Sm
25	Yideneku Ayalew	F	SHN25	3288M	35	Illiterate	Married	Sm
26	Zewudie Anteneh	M	SHN26	3314M	42	Illiterate	Married	Sm
27	Wogayehu Muluye	M	SHN27	3314M	49	Basic	Married	Sm
28	Biadigia muluye	M	SHN28	3322M	34	Illiterate	Married	Sm
29	Leetigeb Admas	M	SHN29	3316M	55	High school	Married	Sm
30	Molla Sinishaw	M	SHN30	3318M	42	Basic	Married	Sm
31	Yifru Ayenew	M	SHN31	3346M	45	Illiterate	Married	Sm
32	Alemneh Eneyew	M	SHN32	3346M	51	Basic	Married	Sm
33	Manayesh biazen	M	SHN33	3320M	40	High school	Married	Sm
34	Teferi Mewa	M	SHN34	3319M	72	Illiterate	Married	Sm
35	Asheber Redate	M	SHN35	3321M	55	Basic	Married	Sm
36	Abebe Zewudu	M	SHN36	3250M	39	Illiterate	Married	Sm
37	Wonedemaneh Mehari	M	SHN37	3346M	38	Basic	Married	Sm

38	Mekecha Ashebir	M	SHN38	3326M	39	Basic	Married	Sm
39	Waga mekonnon *	F	SHN39	3304M	40	Illiterate	Married	Sm
40	Lake Muluye	M	SHN40	3281M	39	Basic	Married	Sm
41	Alameria Gela	M	SHN41	3271M	35	Illiterate	Married	Sm
42	Eneyew Adamu	M	SHN42	3276M	48	Illiterate	Married	Sm
43	Demeke Yeshu	M	SHN43	3271M	29	Basic	Married	Sm
44	Yemata Hunia	F	SHN44	3280M	45	Illiterate	Single	Sm
45	Azene Ayenew	M	SHN45	3250M	61	Basic	Married	Sm
46	Yasab Adamu	M	SHN46	3252M	47	Basic	Married	Sm
47	Adanch Getaneh	M	SHN47	3253M	49	Illiterate	Single	Sm
48	Mengest Shete*	M	SHN48	3253M	57	Basic	Single	Sm
49	Desaglegn Abere	M	SHN49	3254M	52	Illiterate	Married	Sm
50	Kasia Ayehu	M	SHN50	3256M	36	Illiterate	Married	Sm
51	Yeshareg Bizualem	F	DHN1	3578M	37	Illiterate	Single	Da
52	Lemenew Mehirete	M	DHN2	3578M	53	Illiterate	Married	Da
53	Asdenek Embiale	F	DHN3	3580M	60	Illiterate	Single	Da
54	Endalew Lenegeria	M	DHN4	3572M	61	Basic	Single	Da
55	Tsehay Alemnew	F	DHN5	3572M	60	Illiterate	Married	Da
56	Yasab Mekonnon*	F	DHN6	3581M	61	Illiterate	Married	Da
57	Belachew Miheretia	M	DHN7	3564M	47	Basic	Married	Da
58	Yalemtej Lenegerew	F	DHN8	3559M	36	Illiterate	Married	Da
59	Sewmehon Wasia	F	DHN9	3568M	31	Illiterate	Married	Da
60	Sinetsehay Maru	F	DHN10	3573M	40	Illiterate	Married	Da
61	Simegnew Dessie	M	DHN11	3568M	29	Primary school	Married	Da
62	Netsuh Yelekal	F	DHN12	3571M	29	Illiterate	Married	Da
63	Silenat gebeyehu	F	DHN13	3585M	40	Illiterate	Married	Da
64	Mebet Tadele *	M	DHN14	3586M	28	Primary school	Married	Da
65	Tagegn ashale	F	DHN15	3605M	39	Illiterate	Married	Da
66	Aschale Tenaw	F	DHN16	3605M	60	Illiterate	Married	Da
67	Alehegn Gashu	M	DHN17	3584M	40	Illiterate	Married	Da
68	Yitaye Bellay	F	DHN18	3567M	49	Illiterate	Married	Da
69	Ayal Zeria	F	DHN19	3560M	40	Illiterate	Married	Da
70	Melkam Muluken	F	DHN20	3572M	29	Illiterate	Married	Da
71	Banchayehu Lake	F	DHN21	3566M	36	Illiterate	Married	Da
72	Beletech Endalamaw	F	DHN22	3581M	39	Illiterate	Married	Da
73	Tewabia Demeke	F	DHN23	3572M	60	Basic	Married	Da
74	Yezena Bitewulegn*	F	DHN24	3564M	57	Illiterate	Married	Da
75	Kassa Alemneh	F	DHN25	3550M	39	Illiterate	Married	Da
76	Wubsera Anteneh	F	DHN26	3557M	57	Illiterate	Married	Da
77	Letigeb Birke	M	DHN27	3602M	29	High school	Married	Da
78	Mulu Mitiku*	M	DHN28	3593M	57	Illiterate	Married	Da
79	Addis Mengistia	M	DHN29	3557M	61	Illiterate	Married	Da
80	Meku Getaneh	M	DHN30	3558M	38	Illiterate	Married	Da
81	Wube Molla	F	DHN31	3558M	40	Illiterate	Married	Da
82	Wubayehu Asabia	F	DHN32	3556M	55	Illiterate	Single	Da

83	Assefa Shiferaw	M	DHN33	3557M	39	Illiterate	Married	Da
84	Zegale Abebe	M	DHN34	3571M	39	Basic	Married	Da
85	Manaye Sewalem	M	DHN35	3556M	61	Primary school	Married	Da
86	Demes Alemayehu	M	DHN36	3568M	60	Illiterate	Married	Da
87	Abebe Tiruye	M	DHN37	3567M	53	Illiterate	Married	Da
88	Chania Maru	M	DHN38	3567M	46	Illiterate	Married	Da
89	Muluadam Yemare	M	DHN39	3578M	47	Illiterate	Married	Da
90	Biyayih Bassia	M	DHN40	3598M	44	Illiterate	Married	Da
91	Yilekal Ayalew	M	DHN41	3598M	49	High school	Married	Da
92	Kumia Mengistu	M	DHN42	3517M	61	Illiterate	Married	Da
93	Endalew Tsegaw	M	DHN43	3519M	60	Illiterate	Married	Da
94	Ager Endawokes *	F	DHN44	3604M	29	High school	Married	Da
95	Fentia Yigzaw	M	DHN45	3560M	47	Basic	Married	Da
96	Denkia Yigzaw	F	DHN46	3556M	43	Illiterate	Married	Da
97	Simegn Tegbare	F	DHN47	3558M	61	Illiterate	Married	Da
98	Muya Biazen	F	DHN48	3571M	43	Illiterate	Married	Da
99	Lekinesh Maru	F	DHN49	3570M	33	Illiterate	Married	Da
100	Gojjam Fentia	F	DHN50	3558M	57	Illiterate	Married	Da
101	Binalf Azemeraw	M	GHN1	2816M	38	Illiterate	married	Gd
102	Sheferaw Dagne	M	GHN2	2811M	55	Illiterate	married	Gd
103	Eneyehu Abitew	M	GHN3	2811M	40	Illiterate	married	Gd
104	Geze Binalf	M	GHN4	2814M	40	Illiterate	married	Gd
105	Mamare Binalf	M	GHN5	2813M	55	Illiterate	married	Gd
106	Nebret chania	M	GHN6	2813M	59	Illiterate	married	Gd
107	Aleqa Meseret	M	GHN7	2814M	38	Illiterate	married	Gd
108	Bayu Getia	M	GHN8	2818M	40	Illiterate	married	Gd
109	Gesese Debasu*	M	GHN9	2828M	44	Illiterate	married	Gd
110	Molla Lashetia	M	GHN10	2824M	62	Illiterate	married	Gd
111	Mehiretia birhanie	F	GHN11	2816M	49	Illiterate	married	Gd
112	Mera Meselu	M	GHN12	2515M	56	Illiterate	married	Gd
113	Mulu Debasu	M	GHN13	2804M	49	Illiterate	married	Gd
114	Tiguaded mulatu	M	GHN14	2800M	39	Illiterate	married	Gd
115	Siset Eyasu	F	GHN15	2794M	27	Illiterate	married	Gd
116	Enchalew Yesegat	M	GHN16	2794M	29	Illiterate	married	Gd
117	Yesegat Yersaw	M	GHN17	2779M	60	Illiterate	married	Gd
118	Semachew Debasu	M	GHN18	2802M	40	Basic	married	Gd
119	Aleshegn Ayaleneh	F	GHN19	2793M	29	Illiterate	married	Gd
120	Amare Molla	M	GHN20	2804M	40	Illiterate	married	Gd
121	Gudaye Tenaw*	F	GHN21	2829M	60	Illiterate	married	Gd
122	Nega Nebiyu	M	GHN22	2789M	61	Illiterate	married	Gd
123	Shetanesh Mekonnon	F	GHN23	2809M	62	Illiterate	married	Gd
124	Abate Esubalew	M	GHN24	2804M	40	Illiterate	married	Gd
125	Bizuayehu Endale	M	GHN25	2818M	39	Illiterate	married	Gd
126	Muluken Bimerew	M	GHN26	2828M	61	Illiterate	married	Gd
127	Ewunete Gelaw	M	GHN27	2807M	61	Illiterate	married	Gd

128	Banchayehu Dires*	F	GHN28	2805M	60	Illiterate	married	Gd
129	Tesefaye Alamerew	M	GHN29	2809M	38	Basic	Single	Gd
130	Abere Mekonnon	M	GHN30	2788M	45	High school	married	Gd
131	Yezengaw Lulia	M	GHN31	2782M	46	Basic	married	Gd
132	Bialefew Simegn	M	GHN32	2791M	47	Basic	married	Gd
133	Sende Biazen	M	GHN33	2792M	27	High school	married	Gd
134	Bedelu demele	M	GHN34	2801M	39	Basic	married	Gd
135	Yiresaw Tegebare	M	GHN35	2800M	47	Basic	married	Gd
136	Kebret Terefe	M	GHN36	2808M	40	Primary school	married	Gd
137	Mognenet Semegnew*	M	GHN37	2830M	39	Basic	married	Gd
138	Anemut Denekew	M	GHN38	2827M	39	Basic	married	Gd
139	Endalew Lengeria	M	GHN39	2830M	49	Illiterate	married	Gd
140	Demekech Yasab	F	GHN40	2831M	39	Illiterate	married	Gd
141	Yitayish Fetene	F	GHN41	2724M	38	Illiterate	Divorced	Gd
142	Atalaye Walle	F	GHN42	2815M	46	Illiterate	married	Gd
143	Bayines Sineshaw	M	GHN43	2828M	49	Basic	married	Gd
144	Demeke Gelasew	M	GHN44	2880M	42	Basic	married	Gd
145	Banchigezia Nebret	F	GHN45	2889M	35	Illiterate	married	Gd
146	Fentia Mengistia	F	GHN46	2795M	39	Illiterate	married	Gd
147	Belayinesh Ashenef	F	GHN47	2795M	40	Illiterate	married	Gd
148	Yelfe Abiyu	F	GHN48	2794M	61	Illiterate	married	Gd
149	Mulusew Anemaw	F	GHN49	2794M	40	Illiterate	married	Gd
150	Atalaye Bere	F	GHN50	2803M	51	Illiterate	married	Gd

Key, Gd – Gedamawit; Sm- Sinan mariyam; Da- Dangulie

- * indicates key informants

Declaration

I, the under signed declare this thesis is my original work; it has not been presented elsewhere in other institutions, colleges or universities for seeking similar degree or other purposes.

Name _____ signature _____

This thesis has been submitted for examination with our approval as university advisor:

1. _____

Date _____ Date_____

Signature_____ Signature_____

Place of submission: Addis Ababa University, department of Zoological sciences Department, September 2016