ASSESSMENT OF WOODY SPECIES DIVERSITY IN HOMEGARDEN AND ASSOCIATED TRADITIONAL KNOWLEDGE IN ALARIGTA KEBELE IN ADIYO AND BEYEMMO KEBELE IN GIMBO DISTRICTS OF KAFA ZONE, SOUTH WESTERN ETHIOPIA

MSc THESIS

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JUNE 2016

JIMMA, ETHIOPIA

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MSc Thesis

Submitted to the School of Graduate Studies of Jimma University College of Agriculture and Veterinary Medicine

In Partial Fulfillment of the Requirements for the Degree of Master of Science in Natural Resource Management (Specialization, Forest and Nature Conservation)

Jimma University
June, 2016
Ethiopia

APPROVAL SHEET

JIMMA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

STATEMENT OF AUTHOR

I hereby declare that this thesis entitled; **Assessment of the woody species diversity in homegarden and associated traditional knowledge in Alarigeta Kebele in Adiyo and Beyemmo Kebele in Gimbo Districts of Kafa Zone, South Western Ethiopia**, is my original work and has not been submitted in any University and all the sources of materials used for the thesis are duly acknowledged. The thesis is deposed at the Jimma University Library to make available to borrowers under the rules of the Library.

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BIOGRAPHICAL SKETCH

The author, Terefe Woldegebreal, was born on Nov 1972 in Shishinda Rural Kebele, Kafa Zone, SNNPR, Ethiopia. He attended his primary and junior secondary school in Shishinda primary

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DEDICATION

This work is dedicated to my late beloved sweet daughter student Hermela Terefe; she passed away a few months ago by car accident when she was preparing to join University.

ACKNOWLEDGEMENT

First of all, I would like to thank and respect Almighty God for his helping me throughout my life including in the realization of this thesis. I would like to thank my advisors Dr. Kitessa Hundera and Dr. Debela Hunde for their valuable guiding, continuous and unreserved superivision during the whole my study period. I would also like to express my deepest respect to Mr Zerhun for his constructive comment on the proposal and draft thesis.

My deepest appreciation goes to my wife Kasaye Mekuria and my son Tekletsion Terefe for their unreserved care, love and encouragements throughout my study. I would like to thank Mr Abiy G.michael for his great support in SAS software analysis, and I would like to thank Tekalign Tafese, Kuleni Fekadu, Teshome Mamo, Bekele Haile, Moges Tekle, Kochito G/yesus, Berhanu Ademe, Zemede Andarge, Berhanu Gebre, Mesfin Mengesha, Agegnew Alemu, Worku Alemu and Kochito Desalegn for their great support for the success of my study. I also great fully thank Gimbo and Adiyo district Agricultural office, and Alarigeta and Beyemmo study site Kebele Development Agents for their cooperation by providing secondary data, supporting household selection and guiding during the reconnaissance survey and data collection

My special thanks also go to the farmers of Beyemo and Alarigeta study area, for sharing their wealth of knowledge and willingness, and for their time spent and patience in provision of the primary information during data collection. I also thank Abraham from Alarigeta study site Adiyo and Tarekegn from Gimbo district for their assistance in collecting data.

Finally, I would like to great fully thank with deep condolence for my late beloved sweet daughter student Hermela Terefe (who passed away a few months ago by car accident when she was preparing to join Bule Hora University in Engineering Department) for her constant encouragement to continue my studies and also she was supporting at data collection during surveying and data entering in computer. May God bless her soul.

ACRONYMS

ANOVA	Analysis of Variance
BA	Basal Area
DBH	Diameter at Breast Height
KZFEDD	Kafa Zone Finance and Economic Development Department
HGAF	Homegarden Agroforestry
HHs	Households

IVI	Important Value Index
JUCAVM	Jimma University College of Agricultural and Veterinary Medicine
LULUCF	Land Use, Land Use Change and Forestry
LSD	Least Significant Difference
MDBH	Mean Diameter at Breast Height
NGO	Non-governmental Organization
RF	Rainfall
SNNPRS	Southern Nation, Nationalities and Peoples Regional State
SPSS	Statistical Package for Social Sciences
SUPAK	Sustainable Poverty Alleviation in Kafa

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Abstract

Homegardens are important reservoir of diversity of woody species and have immensely contributed to in-situ conservation of plant genetic resources and provide a multiple contribution for household. Traditionally, local communities' carried out homegarden woody species management practice in their garden, and have accumulated a vast indigenous knowledge in managing homegarden woody species. The present study was carried out in two different altitudes in Alarigeta Kebele (highland) and Beyemmo kebele (midland) of Kafa Zone, South Western Ethiopia. The aim of the study was to assess woody species diversity in homegarden and traditional knowledge of woody species management practices. A total of 104 households from both study sites were randomly selected for the study by considering wealth category. Management related data were collected by using both informal and formal surveys. For species diversity and related parameters, woody species inventory were carried out in homegardens of

104 households. Accordingly, 10 m x 50 m rectangular sized plots established in the homegardens of sampled households. In each sample plot, all woody species with DBH≥5 cm at breast height were measured using caliper, diameter tape and recorder. Woody species having less than 5 cm DBH and≤1. 3 height at each plot were also counted to check regeneration potential. In the two study sites, a total of 77 woody species that belong to 68 genera and 35 families were identified and recorded. When considered separately, 39 woody species belonging to 37 genera and 25 families were recorded in Alarigeta (highland) site, whereas 63 woody species under 55 genera and 31 families were recorded in Beyemmo (midland) site. Tweenty six of the identified woody species were common to both study sites.The basal area of the two study sites are 1.69 m^2 per plot and 33. 87 m^2 per ha and 2.21 m^2 per plot and 44.24 m^2per ha for Alari geta and Beyemmo study site, respectively. This result shows that, the basal area value per plot and per ha of Beyemmo (midland) study site is greater than that of Alarigeta (highland) study site. Traditionally, both midland and highland agro ecology local communities' carried out woody species domestication and management in their homegarden in the two kebeles. This is because of the fact that farmers have accumulated indigenous knowledge in managing homegarden woody species and management knowledge gained by experience and transferred one generation to next generation. The assessment result shows that 18 and 3 exotic woody species introduced and domesticated in Beyemmo and Alarigeta study sites respectively.

Key words: Homegarden, Agroforestry, Traditional knowledge, Woody species, Household

1. INTRODUCTION

1.1 Background Information

Agricultue is the major economic source for Ethiopia. About 85% of rural population was depending on agricultural sector. Now a day, the expansion of agricultural land is one of the greatest threats to biodiversity losses. Because the population growth leds to the extensive agriculture system. The effect of extensive agricultural system has leds to deforestation and forest degradation, in tropical country including Ethiopia (Didita and Mengistu, 2012). In many tropical countries, extensive and small-holder farming systems and population growth, and besides increasing commercialization of products and the use of modern inputs are the most important factors that contribute to land use changes (Abebe, 2005). This leads for solution like the priorities to satisfy the immediate needs for food and cash under socioeconomic change and development often determine these changes (Gebeyew, 1995). The land use change in rural farming communities in Ethiopia is predominantly introduced by man when immediate needs are pressing and it also mostly carried out at the expense of the diversity and stability of existing land use systems, sustainable livelihoods and food security (Abebe, 2005: Abebe *et al.*, 2010).

In tropical countries, homegarden is an ancient practice and a part of a household livelihood strategy, and it also has gained prominence as a natural asset through which sustainable use of resources, for the livelihoods of the poor (Krishnal and Weerahewa, 2014). It also supplies diversified fruits, rich in micronutrients and meets cultural requirements and provides ecosystem services (Sthapit *et al.,* 2004). Homegardens are also important sources of fodder, fuel, medicines, spices, and construction materials in many countries around the world (Agbogidi and Adolor, 2013).

Homegarden is an area for tree management and an agroforestry practice known to be ecologically sustainable and land use system involving deliberate management of multipurpose trees and shrubs in intimate association with annual and perennial agricultural crops with in the compounds of individual houses, the whole tree-crop is being intensively managed by family labor (Kumar and Nair, 2006). It is one of the oldest forms of land use management system, considered to be the richest in species diversity per unit area and center for biodiversity

conservation means that, several landraces and cultivars, and rare and endangered species have been preserved in the homegardens (Kumar and Nair, 2004).

Homegarden is an important reservoir of diversity of plant species and have immensely contributed to the maintenance, promotion and in-situ conservation of plant genetic resources (Abishkar *et al.,* 2004: Agbogidi and Adolor, 2013). Genetic diversity valued by resource-poor farmers is often maintained, selected in the land available around the homestead (Sthapit *et al.,* 2004). Therefore, it is an importance site for in-situ conservation of the valuable agro-biodiversity and the sustainability of the surrounding ecosystem, homegarden is well appreciated (Biruk and Ephrem, 2014). The floristic composition of homegardens in Sabata showed that it is rich in plant diversity (Hailu and Asfaw, 2011). Moreover, in Debark District, high land part of Ethiopia woody plant species richness was much higher in homegardens than in adjacent crop fields, because of species richness, homeowners feel a stronger sense of ownership (Tefera *et al*., 2014).

Homegarden is also one of the most vital functions. It serves as intergenerational preservation and perpetuation of agrobiodiversity and indigenous knowledge (Asfaw and Woldu, 1997). Adoption of sustainable homegarden agroforestry practices that utilized and concerned biodiversity may ultimately improve environmental quality and limit agriculture expansion into natural forests as well as the negative impact of agriculture on biodiversity (Khumalo *et al.,* 2012). Moreover homegarden agroforestry is believed to be more diverse due to the combination of crops, trees and livestock (Amberber *et al.,* 2014) and also its diverse climatic conditions, different socio-cultural settings and multiple necessities of homegardens, farmers have maintained a unique composition of homegarden species diversity in their homegardens(Abishkar *et al*., 2004). According to Linger (2014), high plant diversity was found in homegardens of Jabithenan District, North-Western Ethiopia and he indicated that homegarden agroforestry is more diverse and provides multiple services for household than other monocropping system.

In South-Western Ethiopia, homegardens and other traditional agroforestry systems are found in a complex state (Asfaw, 2004). The homegarden agro forestry systems help to support very large

numbers of different plant species that interact in the same land-unit like Enset-Coffee-Maize-Sweet potato of southern and southwestern Ethiopia (Abebe, 2005; Abebe *et al.*, 2010). Yakob *et al*.(2014) indicated that in Kafa Zone, South-Western Ethiopia, woody species have various socio-economic and ecological roles and many existing native species, such as *Cordia africana, Millettia ferruginea, Albizia gummifera*, etc., are planted and retained dominantly as a basic component of their homegardens structure because of their roles in providing shade and soil fertility, wood and other products.

Homegarden agroforestry is a dominant land use practice in Southern Nations, Nationalities and Peoples Regional State (SNNPRS), Ethiopia and it has been known for its diversity, ecosystem balance and sustainability. Besides, its outputs are contributing to the sustainable livelihoods of the region and also crucial for the household food security and rural development (Gebrehiwot, 2013). The structure, functions, and contributions of homegardens vary in geographic regions that are homegardens fulfill social, cultural and economic needs, while providing a number of ecosystem services (Galhena *et al*., 2013).

Traditionally, local communities' carryout homegarden agroforestry practice in both developing and developed countries. In Ethiopia, homegarden agroforestry is widely practiced as a major source of daily food and income generation (Asfaw, 2002; Abebe, 2005). Traditional knowledge of homegarden woody species management practices has a big role to conserve and maintain woody species diversity. According to Zeleke (2006), in Lay-Gayint District, Tigray Region, the trees and shrubs are the major components in traditional agroforestry practices and they are also the part of homegardens. These practices are chief sources of indigenous knowledge in managing agroforestry. He also discussed that the farmers have accumulated a vast indigenous knowledge in managing agroforestry practices like about vegetation cover change and seedling raising and coppicing, pollarding, pruning and thinning of trees were considerable, that have been gained by experience and transferred from one generation to generation. In Wolayita Zone, South Ethiopia, plant species diversity of homegarden is relatively good due to the traditional management practice that involves planting and protection of woody perennials in combination, and also even traditionally the community prefers some plant species like *Cordia africana*, *Erythrina brucei*, and *Millettia ferruginea* to improving soil fertility and a capacity to conserve soil moisture (Seta

et al., 2012) and similarily, in Dawro Zone the local communities have tradition of diversifying their homegardens at least with enset, coffee, spices, vegetables, medicinal plants and fruits with other multipurpose plants. In addition to that Yakob *et al*., (2014), in Kafa Zone, South-West Ethiopia reported that, farmers traditionally manage important woody species like *Millettia ferruginea* and *Coffea arabica* through different methods which allow them to obtain planting material for free from locally available sources and even they assist naturally regenerated seedlings to grow in their gardens and also they manage woody species on their garden to obtain different benefits (Yakob *et al*., 2014).

Spatial arrangement of woody species has different zoning nature in the homegarden of study area. The feature of homegarden (Daaddaa/Emeriyaa) in Dawro Zone, South West Ethiopia was somewhat similar to Kaffecho (Ageze *et al*., 2013). In Kafa also the homegarden is divided into four sections (*Bortto* or *Kello, Dambbak'ach, Daaddo and Deshk'ach),* relative position to the house (Woldeyes, 2000). Among the garden sections of Kafa, *Deshkaach* is the most distinct corner for woody species grows. Abebe (2005) study in Southern Ethiopia recognized two types of homegardens on the basis of their contribution to the welfare of households. The common practices in the tropics are small-scale supplementary food production systems around houses in areas where livelihood of the owners is based on other land use or other activities.

The second types, extended farm systems, are located around the house(s) from where farmers derive their subsistence and cash needs, and where they do not have additional land in other land use systems. But, homegardens in the study area showed no clear planting pattern. However, most of the woody species like *Euphorbia ampliphylla, Erythrina* sp., *Eucalyptus* spp., *Olea welwitschii* and *Vernonia amygdalina* occupied the garden borders, primarily for property demarcation and live fence (Yakob *et al*., 2014). FAO-SLMP (2008) field survey study indicated that, in Kafa Zone South-West Ethiopia, the total area of homestead zone ranges from 0.5 ha to 2 ha per household and farmers usually use the homestead intensively for growing a number of plants, are usually characterized by enset, vegetables and live fence. The present study aims at characterizing the woody species mixed homegardens of Kafa Zone, South-West Ethiopia.

1.2 Statement of the Problem

Due to its vast coverage inventory and documentation of home garden diversity and species composition in Ethiopia are very few (Asfaw and Woldu, 1997; Bekele, 2007; Asfaw, 2003). According to Abebe (2005), homegardens are variable with regard to species composition, management practices as well as the prevailing biophysical and socioeconomic environment. As indicated above some researchers have described the enset-coffee agroforestry homegardens of Southern Ethiopia, but a detailed analysis of their diversity, species composition and productivity is still missing. Only when this vital information is available, constraints and options for their improvement can be proposed. Moreover, as land-use is not static but changes over time, also the main factors causing these changes should be identified and their effect quantified before recommendations regarding improvements can be made. Besides, species diversity and composition of homegardens are influenced by ecological, socio-economic and cultural factors.

In addition, Yakob *et al*.(2014) stated that in Gimbo District (hereafter woreda) of Kaffa zone, it is obvious that farmers practice homegardens for economic, social and environmental benefits. However, management of woody species and their contribution is not well known by scientific communities. Hence, understanding on why and how farmers manage the homegardens: available knowledge on preference, arrangement, uses of woody species and other components is limited only to farmers. Besides lack of technical knowledge in managing, exotic woody species are also another aggravating the problem in the homegarden.

In Kafa Zone, the identifications of woody species diversity, their management techniques as well as factors affecting the diversity and management of woody species is very limited or not yet deeply identified in mid- and high altitude areas. Therefore, there is a need to assess and quantify woody species diversity, composition and the associated traditional knowledge of homegarden wood species management. The study was conducted in two contrasting agroecological areas (midland in Beyemmo and highland in Alarigeta sites).

1.3 Objective

1.3.1 General Objective

The general objective of this study is to assess and quantify the woody species diversity in homegarden and associated traditional knowledge in two names Districts in Kafa Zone.

1.3.2 Specific Objectives:

The specific objectives of study are:

- To identify and document woody species diversity at the high and mid altitudes in the two districts.
- To investigate the role of traditional knowledge on the homegarden woody species management practices in the two contrasting localities
- To identify factors influencing the sustainability of homegarden woody species diversity.
- To assess the socio-economic and cultural roles of homegarden woody species diversity

1.3.3 Research Questions

This research tried to give answer for the following questions.

- What are the factors of altitude variation on woody species diversity of homegarden in the two study area?
- What are the main factors leading to the success of homegarden woody species diversity?
- What are the current traditional management practices trends of homegarden woody species?

2. LITERATURE REVIEW

2.1. Overview of Homegarden

Homegarden literally means the 'backyard farm' while at the same time indicating the closeness of the cultivation plot to the house. Its common locations for gardens in relation to the house in Tigray are backyards, front yards, side-yards and those that almost encircle the house (Biruk and Ephrem, 2014). Homegarden has received several definitions, although none has gained universally acceptance (Kumar and Nair 2004 cited by Cubino *et al*., 2013) and besides its traditional agro forestry system where a clearly bounded piece of land immediately surrounding the dwelling house is cultivated with the mixture of perennials and annuals (Didita and Mengistu, 2012)

Homegardens are defined as a system of production of diverse plant species, which can be adjacent to household or slightly further away and is easily accessible (Yakob *et al*., 2014). It is also a small-scale traditional agricultural ecosystem and has played an important role in conservation and sustainable utilization of plant biodiversity as well as in adaptation to the changes in climatic conditions of the environment (Ageze *et al*., 2013) and it also an agro forestry practice known to be ecologically sustainable (Linger, 2014). Homegardens are repositories of biocultural assets of communities, the hub of plant based resources and the microcosms of agro biodiversity hotspots (Hailu and Asfaw, 2011).In addition to that, homegardens are often described as generic land-use systems with a high species diversity (Abebe *et al*., 2010).

Homegarden also center for agro forestry practices. Because, homegarden agro forestry can be defined as ‘land use system involving deliberate management of multipurpose trees and/or shrubs in intimate association with annual and/or perennial agricultural crops and invariably livestock within the compounds of individual houses, the whole tree-crop animal unit being intensively managed by family labor(Fernandez and Nair,1986). Traditional agroforestry land use should be viewed as a household strategy for providing food, fuel wood and fodder that could serve as a model for sustainable forestry and agricultural practices (Badege & Abdu,

undated cited by Gebrehiwot, 2013). It has been practiced in Ethiopia since time immemorial by villagers on farm lands (Gebrehiwot, 2013).

Homegarden agro forestry systems in the tropics are known for their structural complexity and diversity in crop and other plant species (Kumar and Nair 2006). The cultivation of different crops in homegardens is regarded as a strategy of farmers to diversify their subsistence and cash needs. Diversification also helps to stabilize yield and income in cases of incidences of disease and pests, and market price fluctuations. Although the positive impacts of crop diversity on home garden sustainability have been widely discussed (Fernandez and Nair, 1986). Meanwhile, homegarden agro forestry practices play great economic role through their significant contribution in purchasing power (for income generation) when sold for construction material, as fuel wood (Biruk and Ephrem, 2014). They are managed to: i) provide shade for coffee and variety of commercially valuable spices as well as for livestock; ii) supply rural communities with fuel wood and timber; iii) provide other products such as fodder, human and livestock medicine, food and they serve as bee forage; iv) play important ecological roles which could contribute to sustainability of agricultural systems (Yakob *et al.,* 2014). Homegarden high species diversity and a rich floristic composition that is worthy of in situ conservation of plant biodiversity, trial sites of new variety of income source vegetables and other species (Amberber *et al*., 2014).

2.2 Factors influencing the woody species diversity

According to Kidane and Tesfaye (2006) study, agro forestry practices in Sokota district, Amhara region of Ethiopia, the occurrence of tree species in any locality varies depending up on differences in environmental factors like altitude, rainfall, temperature and topography. Beside, Ageze *et al*., (2013) indicated that homegarden plant species are also vary in composition or diversity of plants based on ecological, socio economic, personal preference, as well as the distance and availability of markets. Homegardens are dynamic systems; in their structure, composition and species, and even its cultivar diversity are influenced by changes in the socio-economic circumstances and cultural values of the households that maintain these gardens. In Arsi zone, Oromiya Region, the ownership right is playing an important role in preserving woody species diversity and the highest species richness in homegardens (Tolera, 2006). In

Nepal, the homestead size, structure, climatic conditions, and market and socio cultural forces influenced on the species richness of home gardens within a region (Sthapit *et al*., 2004). Different factors including availability of water, socio-economic conditions and even homegarden size affect plant composition of homegardens in Sabata (Hailu and Asfaw, 2011).

2.2.1 Altitude variation

According to Berhanu and Gessesse (2013), in the South-West Ethiopia, particularly areas within 1350-2500 m above sea level, are rich in *Millettia ferruginea* tree, and it is largely available in both forests and homegarden areas in Jimma, Kafa, Ilubabor, Lekemte and part of Gambella. Diverse regions agro-geoclimatic conditions which have contributed to the high plant diversity in Nepalese homegardens, and in hill regions of Nepal, homegardens are comparatively rich in plant diversity than the *terai* region (Abishkar *et al.,* 2004). According to Abebe (2005) observation, when we go up to another agro-ecological zone, locally called *Dega* where the altitude is above 2300 m.a.s.l., the temperature is low and plant diversity is generally low.

2.2.2 Type of land use

According to Tolera (2006), in Arsi Negelle District, the highest number of woody species was recorded in homegardens as compared to crop fields and the natural forest. The planting of various exotic and native woody species in the homegardens lead to higher species richness. In the study area farmers introduced woody species including exotic species, different fruit trees, cash crops and some species which are brought from other localities. In Debark District, Northern Ethiopia, homegardens are characterized by a higher number of woody plant species than most other land use types (Tefera *et al*., 2014). It is also with small size; both in urbanized and rural areas have more diversity of plant species around than large sized ones (Ageze *et al*., 2013). But some study indicated that the homegarden size significantly varied between the sites while the number of species in a homegarden remained the same, this implies that other environmental and socio economic factors may limit species richness variation (Didita and Mengistu, 2012). According to Mendez (2000) discussion, the higher diversity was in large homegardens that produced for households' consumption as well as for commercial sales. A profound land use change was found in the homegarden agro forestry, as a consequence of the expansion of cash crops since 1990s (Gebrehiwot, 2013).

2.2.3 Wealth Status

According to Jogora (2011), in Shashemene District, Oromia Region, Southern part of Ethiopia, wealth status was another factor that influences woody species diversity of homegarden agro forestry practice. According to wealth status classification, largest home garden sizes were recorded in garden of rich farmers than medium and poor farmers in all villages. Wealth status also influenced the wood production of homegardens (Yakob *et al*., 2014), but the variation in conversion to cash crop between the three wealth categories (poor, medium and rich) was insignificant (Gebrehiwot, 2013). In Arbegona District, highlands of Southern Ethiopia, the average farm size of wealthy households was greater, and was characterized by a high number of tree species and a relatively larger wood yield than medium and poor households (Reshad, 2006).

2.2.4 Household Preference

In Nepal, many species are either already domesticated or are in the process of domestication in the homegardens. This indicates that farmers perceive homegardens as an experimenting site for their own research and also take them as the avenue for adopting/adapting new species/varieties (Gautam *et al.,* 2004), and for homegarden species diversity the change has been based on a conscious choice and decision made by individual farmers to meet their immediate financial income needs.(Gebrehiwot, 2013). In Sebeta town, oromia regional state, Ethiopia, households cultivate and protect a mixture of herbs**,** lianas, shrubs and trees depending on the need and decision of households (Hailu and Asfaw, 2011). The selection and maintenance of seeds and planting materials of plant species in the homegardens is influenced by farmers' household needs for food and income, and their knowledge and innovation. Unique plant species and varieties, often resulting from out-crossing; have been found being maintained in the homegardens (Gautam *et al.,* 2004).

2.2.5 Management Practices

According to Berhanu and Gessesse (2013), South-Western part of Ethiopia, particularly areas rich in *Millettia ferruginea* tree, the tree population is high in homegardens due to the effect of tree management practices by the society in order to improve the tree shading capacity for inter cropping of coffee and enset plantations. Beside, in Nepal, homegardens are generally managed under intensive and integrated production system a variety of plant species and varieties are

planted together and their interactions managed accordingly (Shrestha *et al., 2004).* The management of multi-species agrosystem for fulfilling the subsistence and cash needs of households enhances homegarden sustainability and agro biodiversity conservation (Seta *et al.,* 2012). In addition to that in South-Western Ethiopia, Kafficho people are managing woody medicinal plants in their homegarden (Awas and Deissew, 2009) and thus, the homegarden owners to get as high as possible diversity in their gardens, because it is a consequence of the way they manage their homegarden (Akinnifesi,2010).

Homegarden agro forestry woody species are also being refuges for indigenous woody plants that become rare in the environment because of homegardens are under the consistent supervision and care of the household, which has clear tenure rights for perennial plants grown around individual homesteads (Tefera *et al.,* 2014). In Sabata town, oromia regional state, Ethiopia, local management practices are customarily performed in the homegardens where households Endeavour to maintain diverse plant taxa (Hailu and Asfaw, 2011). The type of income sources available to a family greatly influenced homegarden management strategies (Mendez, 2000).

According to Zeleke (2006) study result, in Lay-Gayint District, South Gonder Zone, Ethiopia homegarden woody species diversity connected with agro forestry, therefore farmers have accumulated a vast indigenous knowledge in managing agro forestry practices that has been gained by experience and transferred from one generation to generation, because they have chief sources of indigenous knowledge in managing agro forestry. Due to management practices of farmers in homegarden of Mena-Angetu site in Bale, Oromia region, *Coffea arabica* is most abundant species (Didita and Mengistu, 2012). The amount of labor invested per family in homegarden management varied according to plot size, family size, and level of garden production (Alfred, 2009), hence also labor created influence on woody species management. For intensive management, the introduction of fruit trees also plays a major part in enhancing the woody species diversity of homegardens as compared to other areas (Tolera, 2006), and market opportunity has plays high role for the species diversity and for this reason farmers were maintaining a rich varietal diversity for the species (Sharmila *et al.,* 2006).

2.3 Socio economic and cultural roles of woody species diversity in Homegarden

2.3.1 Socio economic roles

According to Yakob *et al.*,(2014), in Gimbo district, woody species have various socio-economic and ecological roles. Many existing native species, such as *Cordia africana, Milletia ferruginea, Albizzia gummifera*, etc., are planted and retained dominantly as basic components of their homegardens structure because of their roles in providing shade and soil fertility, wood and other products, and in addition to that it plays a vital role in the predominantly biodiversity conservation. Besides, Sharmila *et al* (2006), also indicated that in Nepal, the accessibility of homesteads to market and road network infrastructure influenced the wood production in the homegardens, because it connected with economic benefits. Homegardens also considered as potential units for maintaining species diversity and conserving plant genetic resources through utilization. The economic considerations greatly influence the rate at which species diversity and home garden practices will change within gardens (Kusumaningtyas *et al*., 2006), and more also some households gave some homegarden products like fruits, vegetables, sugarcane to neighbors and relatives, which strengths neighbor and family relationship called social capital (Linger,2014). Homegarden activities even balancing gender inequality in Bangladish, the study indicated that, cultivation and management practices where women play a significant role in homegardens, like decision-making in case of species choice, utilization patterns of medicinal plants, seed selection, storage and pest control techniques, and behavioral patterns of fuel wood collection (Akhter *et al.,* 2010) and it is also provide significant contributions for the gardener and the society as source of supplementary food, medicinal functions, and income (Amberber *et al.,* 2014) and Farmers benefited from the homegarden in several ways. Homegarden act as a "reserve bank" of food and cash for farmers (Mohammed and Kazi, 2005). And also there is a relationship between diversity found and certain socioeconomic factors such as: greater diversity in homegardens owned by older farmers, in households where there is a larger number of family members (Agbogidi and Adolor, 2013).

Seta *et al., (2013)* indicated that, the management of multi-species agro system for fulfilling the subsistence and cash needs of households enhances homegarden sustainability and agrobiodiversity conservation. The accessibility of homesteads to market and road network

infrastructure influenced the wood production of home gardens (Yakob *et al.*, 2014). In Shashemene district, Oromia region, Ethiopia, farmers need to increase woody species of their homegarden for multitude purposes to providing household consumption and improving their household economy was the two most common among the purposes do to those reasons they are inforced to effectively conserve and sustainably use the products of diverse woody species in the homegarden (Jogora,2011). The standing stock of trees also varied widely among sites and households due to socio-economic factors, particularly farm size, access to highways (Abebe, 2005) and different socio-cultural settings and multiple necessities of homegardens farmers have found them as the major factors (Abishkar *et al.,* 2004).

Homegardens enhance the livelihood of the people by providing food, construction materials, and medicines and by contributing significantly to the gross annual income of the household and the income from homegardens depends on their size, number of marketable crops and management regime (Tynsong and Tiwari,2010: Amberber *et al.*,2013). Homegardens are plays an important role in providing additional job and income (Pulami and Paudel, 2004). Homegardens are also believed to provide a number of benefits to families, ranging from improving nutrition and providing a source for additional household income, to improving the status of women in the household (Mitchell and Hanstad, 2004).

The values and potential of a homegardens are for enhancing food security and livelihoods (Galhena *et al.,* 2013). In Jabithenan District,North-Western Ethiopia, plant Species diversity in the studied homegarden agroforestry (HGAF) supplements for household as food and income (Linger, 2014) and also homegarden act as a "reserve bank" of food and cash for farmers (Mohammed and Kazi, 2005).

2.3.2 Cultural role

Homegarden are strongely connected with cultural value. In Nepal, homegarden are important for their aesthetic value and cooling effect, and are regarded as a symbol of wealth and social prestige. Unique flowers, beautiful trees, climbers, orchids, ferns, ornamental plants and flowers are important species in Nepalese homegardens as they enhance the aesthetic value and harmony of the homestead environment (Sthapit *et al.,* 2004). The most diverse group of indigenous tree

species was also used for construction purposes, as ornamentals, for shade, or as hedging plants (Alfred, 2009). In homegarden, woody species are used for enjoyment and family satisfactions that are planting a garden provide enjoyment for many home owners. Watching your garden grow from bare ground to ripe produce or beautiful plants, offers a sense of satisfaction. Gardening also offers a form of moderate outdoor exercise (Agbogidi and Adolor, 2013).

2.4 Ecosystem Function and Services roles

Homegardens are micro-environments within the system that provide many goods and services of environmental, economic, social and cultural importance, and these are environmental goods and services also contribute to sustainable livelihoods in a number of ways. Besides biodiversity, especially that of the below ground part of the system, performs a variety of ecological services such as nutrient recycling, regulation of local hydrological processes, and detoxification of noxious chemicals (Sthapit *et al.,* 2004*).* It also helps to reduce environmental pollution and control soil erosion and environmental pollution in the form of air and water pollution and soil erosion have become a major problem in the country that needs to be addressed to make the environment healthy and safe for all the living beings to live. The different kinds of plants that are grown in the home-garden contribute in absorbing carbon dioxide and releasing oxygen in the environment. In slopping lands, it helps in conserving the soil and water and moreover, homegardens also support in recycling the household organic waste (Pulami and Paudel, 2004).

Homegardens woody plant species provide multiple environmental and ecological benefits. They serve as the primary unit that initiates and utilizes ecologically friendly approaches for food production while conserving biodiversity and natural resources (Galhena *et al.,*2013) and its importance for in situ conservation of the valuable agro-biodiversity and the sustainability of the surrounding ecosystem is well appreciated (Biruk and Ephrem, 2014). Potential environmental benefits of homegardens may be important not only for homegardening households, but for the broader society as well (Mitchell and Hanstad, 2004), and also its suitability contributed for the *in situ* conservation of plant genetic resource diversity (Kehlenbeck, 2007). The multi-layered, forest like vegetation structure of the homegarden in the area contributes substantially to the agro-ecological sustainability through reducing soil erosion (Derero *et al.*, 2012; Linger,

2014).The ecosystem services and environmental benefits claims of agroforestry systems and practices in both the tropical and temperate regions (Shibu, 2009).

2.5 Dynamicity Trends of Homegarden Species Diversity

Woody species diversity is considered as a basis for homegarden productivity and sustainability; however, it is not static over time. Gebrehiwot (2013), study in recent transitions in Ethiopian. homegarden Agroforestry indicated that, wealth status and accessibility of homesteads to market and road network infrastructure influenced the wood production of homegardens and production and trading of cash crops has led to a reduced area proportion of major staple food (enset), vegetables, roots tuber pulse, coffee livestock and trees to the immediate financial income needs of individuals.

According to Eichemberg *et al.,* (2009) study, the future of homegardens is uncertain, due to their continued use, and even their existence, may be threatened due to the rapid changes occurring in their physical aspects (for example, their deactivation for the construction of garages or cemented areas, like the five homegardens deactivated during this study in Rio Claro, Southeast of Brazil that composed part of our original sample) and urban land use pressure, as well as the rupture in the tradition of cultivation and care of the homegardens by new generations that are increasingly giving in to the pressures of economic development and new lifestyles, and are turning their backs to their homegardens.

3 MATERIALS AND METHODS

3.1 The Study Area Description

The study was conducted in, Adiyo and Gimbo district of Kafa Zone, Southwestern Ethiopia (Figure1).

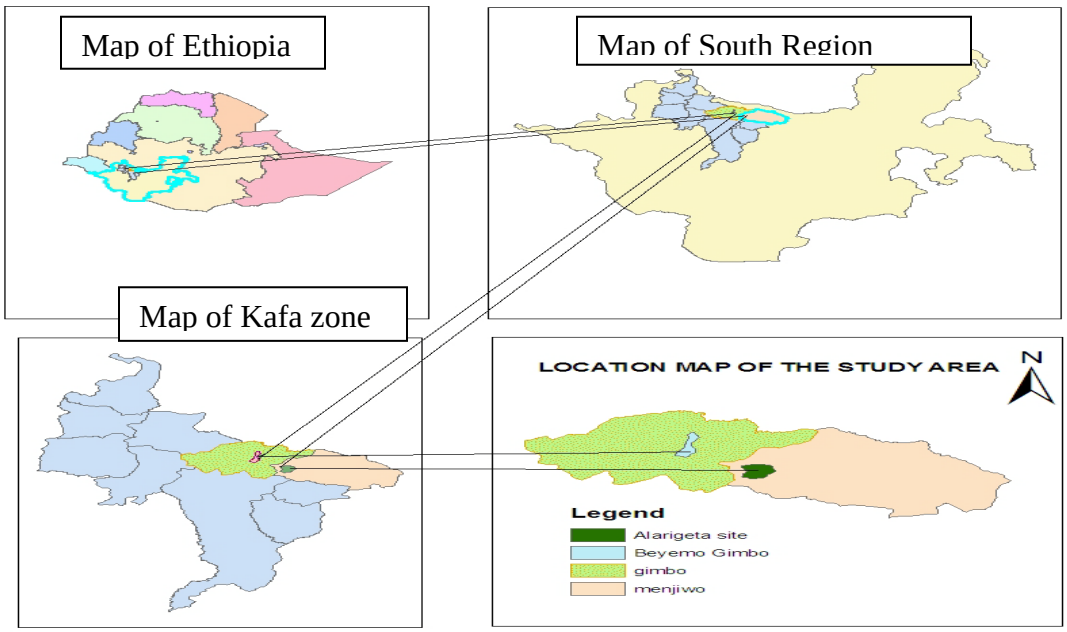

Figure 1: Map of Ethiopia and the study area

The Gimbo District is found at about 451 km away from Addis Ababa, the capital city of Ethiopia to the south-western on the main road of Jimma to Bonga. The District is geographically located between 36^0 – 36^0 47’ E longitude and 7^0 23’–7^0 49’ N latitude,and the District contains 30 rural kebeles and the capital of the District is Uffa and the District is bordered on the south by Decha, on the west by Chena, on the northwest by Gewata, and on the east by Adiyo district and north by Gojeb River which separates it from the Oromia Region and has estimated area of 87,182.33ha (KZFEDD, 2014).

The Adiyo District is situated at about 60 km away from Bonga, the capital city of Kafa Zone to East of Bonga. The District is geographically located between 36^0 30’ – 36^0 78’E longitude and 7^0 11’–7^0 43’N latitude and it contains 30 rural kebeles and the capital city is Kaka. It is bordered

on the south by Tello District, on the west by Konta special District, on the west by Decha and Gimbo districts, and north by Gojeb River which separates it from the Oromia Region and has an estimated area of 102,723.32 ha (KZFEDD, 2014).

3.1.1. Topography

Gimbo District has 3% of its area as highland (Dega), 84.4% middle land (Woyina daga) and 15.3% lowland (Qolla) and the altitude ranges from 1001-2500 m a.s.l (KZFEDD, 2014). The area has rugged and mountainous topography (Derero *et al.*, 2003) and also has gentle and flat landscape towards the Gojeb River (Asmelash, 2008). Specific study site altitude was ranges from 1750 to 1900 m.a.s.l.

Similarly, Adiyo District has 9.6% of its area as highland (Dega), 85.1% midland (Woyina daga) and 5.4% lowland (Qolla) and the altitude ranges from 1500-3500 m a.s.l. The area has rugged and mountainous topography and also has gentle and flat landscape towards the Gojeb River buffer of North part of the District and the highest "Rosha" mountain is found at an altitude of 3500 m.a.s.l in this District (KZFEDD, 2014). The Specific study site altitude was ranges from 2300 to 2450 m.a.s.l.

3.1.2 Soil type

The soil types of the two study sites are more or less similar. Different soil type survey in Kafa Zone indicates that the range of soil type variation is insignificant in all districts. Some Bonga area study indicate that, the dominant soil unit comprises chromic luvisol, very deep dark reddish and over dark reddish brown clay loam over clays (MoWR, 1996b; cited in Derero *et al.*, 2003). Nitosols, regosols and cambisols are among the different soil taxonomic groups of the study area (Senbeta**,** 2006**).**

3.1.3 Climate

Due to the evergreen montane forest cover and windward location to the moist monsoon winds Kafa highlands in general are among the places which receive the high amount of annual rainfall in Ethiopia. The meteorological data obtained from Bonga and Diri Goma stations confirms that the area is characterized by mild-humid climate. The average annual rainfall recorded at the two

stations during the time period of 1998 to 2006 is between 1300-2000 mm with the number of rainy days ranging between 150 and 200.

Gimbo and Adiyo districts have the same long rainy season from March to November, the wettest season being May and June due to their adjacent location. KZFEDD (2014) annual report indicated that two RF data recording station (Bonga and Diri Goma) indicated that the two study sites have receivied the same amount of RF. Unfortunately, Alarigeta Kebele site from Adiyo District which to the nearest to Bonga Station and also Beyemmo Kebele site from Gimbo District which to the nearest to Diri Goma station (Figure 2).

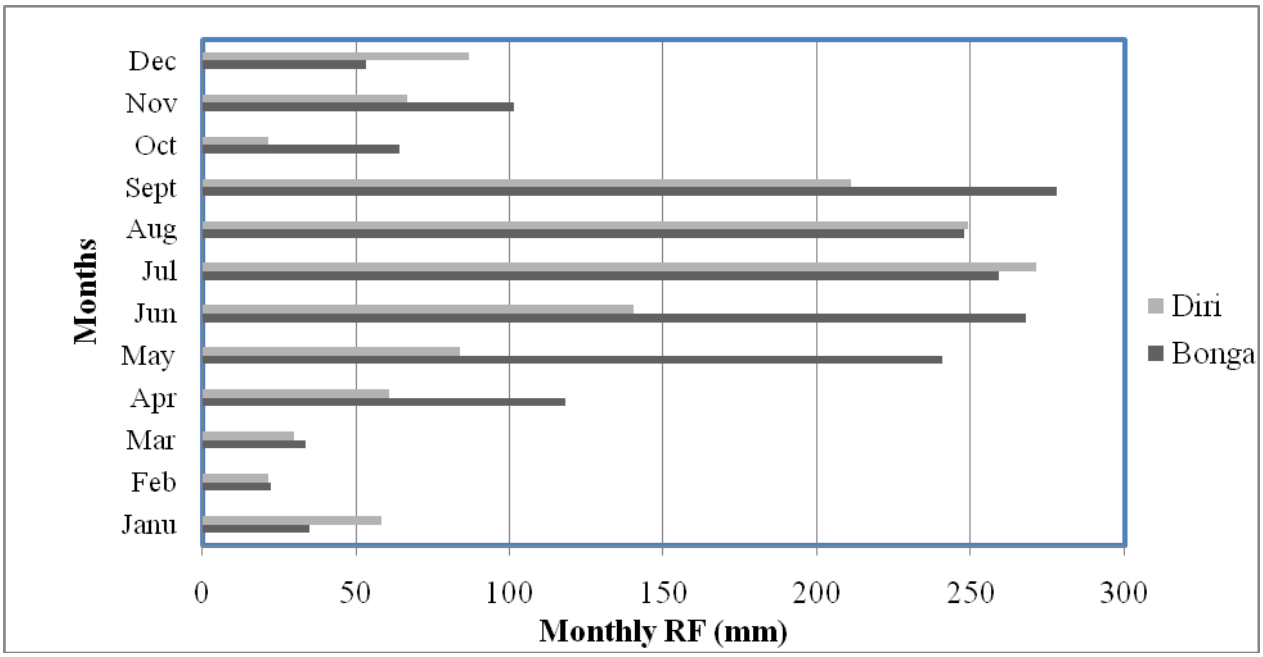

Figure 2: Monthly and annual rain fall data of two study area ***(Source: KZFEDD, 2014 report)***

The mean annual temperature of the two study sites are measured at Bonga Town which is ranging from 10 ^{0}C to 23.4^0 C. But the lower temperature range represented the Adiyo Districts because of its altitude variation.

3.1.4 Demographic and socio economic features

Based on statistics abstract of KZFEDD (2014) projection, the total population of the Gimbo District indicated that 110,746 of which 55,132 and 55,614 were males and females respectively,

with total household of 16,716, of which is 89.31 % of its population is rural dwellers and the population density was estimated 129 per kilometer square and the total population of the Adiyo District indicated that 131,206 of which 63,390 and 67,390 were males and females respectively, with total household of 15,349, of which 90.5 % of its population is rural dwellers and also the population density of the District is 121 persons per kilo meter square.

According to Kafa Zone Finance and Economic Development Department (KZFEDD) abstract report, agriculture is the main source of household's economy in the two study area. The dominant crops grown in the Gimbo District area are maize, teff, sorghum, beans and wheat. Besides, enset has a significant role for household's food security for the Woreda, whereas also more dominant crops in Adiyo District wheat, faba bean, pea, barley, maize, teff and in rare case sorhum are commonly produce. Livestock production is also the second major source of the household's economy in the two study districts. Cash crops, mainly coffe has also a significant contribution in the Gimbo District but minimum contribution in Adiyo District the limiting factor being agroecological.

3.1.5 Land use

According to KZFEDD (2014) report, the land use types of the Gimbo District are cultivated area of 38,999 ha and montane forest (undisturbed, disturbed and highly disturbed areas of 23,009, 8,357 and 3,162 ha respectively).Woodland, plantation, grassland and wetlands cover a totally11, 611ha. Adiyo District has cultivated area of 27,195.32 ha and montane forest (undisturbed, disturbed and highly disturbed areas of 19,303, 3693 and 3,485 ha respectively). Woodland, plantation, grassland and wetlands cover total area of 15,512 ha land. But in Adiyo District the land is dominantly covered by 17,895ha of undisturbed high land bombo the forest. In addition, traditional homegarden agroforestry system land use types are common in the two study district.

3.1.6 Vegetation

The south-western forests of Ethiopia are characterized as Moist Evergreen Montane Forest ecosystems (Abdena, 2010). The forests are located within altitudinal range of 1500-2700 m a.s.l. The forests in this area are normally the richest in species (Friis *et al*., 1982).

3.2. Methods

3.2.1 Sampling Methods

3.2.1.1 Study Site and Village Selection

In this research, stratified method was used for the two study districts identification. Adiyo and Gimbo districts were selected from the highland and midland respectively. The reason for stratification is the altitudinal variation in two selected districts. Two rural kebeles, namely, Beyemmo from Gimbo and Alarigeta from Adiyo district, were purposively selected from middle and highland agroecology respectively, to identify and/or evaluate altitudinal variation factors on homegarden species diversity and distribution. The reason for purposive selection of the two study kebeles, the main critera were fulfilling of altitude range, presence of homegarden woody species diversity practices in the area and proximity to road access to conduct the research.

3.2.1.2 Key Informant and Household Selection

Key informants (KIs) and household's selection were employed to assess the traditional knowledge. KIs are defined as persons who are knowledgeable about homegarden woody species diversity/agroforestry practices, the previous and current situation or changes occurred and factors influencing woody species of homegarden agroforestry practice and who lived there at least for 30 years. Community representation was considered for KIs selection. During the key informant (KIs) selection processes, kebele development agents and local government officials were consulted. Accordingly, a total of 30 KIs were selected from two study districts, which are fifteen from each study kebele depending on the above definition.

Household selection was done depending on the total household of each the two study kebeles. Accordingly, from the study sites households were selected purposively amongst the three wealth categories poor, medium and rich categories of homegarden owners. Allocations of the number of sample households to each study site (kebele) were proportionally 10% to the number of household head members of each kebele member. Accordingly, 52 sample households from each study site (Kebele), a total of 104 HHS were selected for the study. The primary data was collected from each household garden by using sampling techniques.

Table 1: Total number of households in each kebele

District Name	Name of Kebele	Total member HH	Sample size (10% HH)	KIs No.
Gimbo	Beyemmo	521	52	15
Adiyo	Alarigeta	517	52	15
Total	-	1038	104	30

3.2.2 Methods of woody species assessment

3.2.2.1 Woody species inventory methods

In the two study site, spatial arrangement of woody species was identified in different zoning nature in the homegardens. In Kafa, also the homegarden was divided into four sections front-yard ("*Bortto* or *Kello")*, upper-side-yard *("Dambbak'ach")*, back-yard *("Daaddo") and* lower-side-yard *("Deshka'ach")*, relative position to the house (Woldeyes, 2000; Ageze et al., 2013). Depending on the previous finding, among the garden sections of Kafa, lower-side-yard ("*Deshkaach")* was the most distinct corner for woody species grows and inventory.

Figure 3: Spatial arrangement of homegardens in the two study area (Source: photo by Terefe)

According to Jogora (2011), in order to determine the diversity of woody species existing in homegarden agroforestry practices, woody species inventory was made on homegardens of purposively selected household's ofthe study sites. Accordingly, 10 m x 50 m rectangular plot size was established one plot per homegarden of sampled households. At each sample plot, all woody species with DBH≥5 cm at breast height (1.3 m from the ground) were measured using

caliper and recorder. Woody species having less than 5cm DBH and ≥ 1.3m height at each plot were also counted to check regeneration capacity. Woody species local name identification and data collection were carried out using knowledgeable persons from the local community, and the researcher himself.

Figure 4: Woody species tree DBH measurement (Source: Photo by Terefe)

In this study, woody species identification was done by using useful trees and shrubs of Ethiopia (Bekele *et al.*, 1993). After vernacular names were known, scientific names were identified with the help of different publications of Flora of Ethiopia and Eritrea (Edwards *et al*., 1995; Hedberg *et al*., 2004; Hedberg *et al*., 2006). In addition, consulting of botanist was done for species that are difficult to identify through the above techniques. Nomenclature follows flora of Ethiopia and Eritrea. Supportive instruments were used such as, global positioning system (GPS) and digital camera, measuring tapes, clinometers and caliper when available. The geographical location of each homegarden plot (the reference point) was measured by a GPS**.**

3.2.2.2 Wood species data analysis

All individuals of species registered in all the sample quadrats were used in the analysis of vegetation structure. The Diameter at Breast Height (DBH), basal area, tree density, frequency and important value index were used for description of vegetation structure.

3.2.2.2.1 Diameter at breast height (DBH)

DBH measurement was taken at about 1.3 m from the ground using caliper for those woody plants and if no caliper or when the size of the tree being larger than the caliper diameter, common tape was used. Like caliper, the common tape does not measure diameter directly, but instead measures the circumference of the tree was done. The circumference must be converted to diameter by solving for DBH in the equation (FFA Forestry, 2010):

$$C = \pi * DBH$$

Therefore, $DBH = C/\pi$

Where:

C = circumference of tree, $\pi = 3.14...$,

DBH = diameter at breast height of tree.

3.2.2.2.2 Basal area (BA)

Basal area refers to a measure of species density that defines the area of a given section of land occupied by the cross-section of a tree. It is expressed in meter square per hectare. Basal area is also used to calculate the dominance of species.

$$BA = \pi (D / 2)^2 = (DBH/2)^2 * 3.14$$

Where

BA- Basal Area (M^2)

D (DBH) -is diameter at breast height (cm)

$\pi = 3.14$

3.2.2.2.3. The importance value index (IVI)

The IVI for a species was a composite of three ecological parameters: density, frequency and basal area, which measure different features and characteristics of a species in its habitat. IVI was calculated for each species to know the distribution of tree species in the homegarden in different wealth categories. Density of a species reflects the numerical strength of species in a given community (Kohli *et al.,* 2012). The vegetation data of the tree species were calculated on Excel spreadsheet using the following formulas.

$$\text{Density} = \frac{\text{Total number of stems all of trees}}{\text{Sample size in hectare}}$$

The species composition of the plots was described by the following parameters.

$$\text{Relative density} = \frac{\text{Number of individuals of a species}}{\text{Total number of individuals}} \times 100$$

$$\text{Relative Frequency} = \frac{\text{Frequency Number of individuals of tree species}}{\text{Frequency of all species}} \times 100$$

$$\text{Relative dominance} = \frac{\text{Total basal area per species}}{\text{Total basal area of all species}} \times 100$$

The importance value index (IVI) = relative dominance + relative density + relative frequency

3.2.2.2.4 Measurements of similarity

Similarity indices measure the degree to which the species composition of different systems is alike. Many measures exist for the assessment of similarity or dissimilarity between vegetation samples or quadrants. Some are qualitative and based on presence/absence data, while others are quantitative and was worked on abundance data. Of the large choice available, the Sorensen similarity coefficient was applied to qualitative data and was widely used because it gives more weight to the species that are common to the samples rather than to those that only occur in either sample (Kent and Coker, 1992). The similarity of species composition between the study two kebeles and/or six villages were calculated with the Sorensen coefficient of similarity with the formula:

$$S_s = \frac{2A}{2A + B + C}$$

Where:

Ss = Sørensen similarity coefficient, **A** = number of species common to two villages, **B** = total number of species in village 1 and **C** = total number of species in village 2.

3.2.2.2.5 Species diversity, richness and evenness indices

Diversity indices provide important information about rarity and commonness of species in a community. The indices could be used to compare diversity between habitat types. Species richness is simply the number of species present in an area and species evenness refers to the proportion that each species comprises of the whole (Nolan and Callahan, 2006). Thus, different diversity, species richness, species evenness indices were calculated for each transect as well as pooled data from each transects for both forest patch categories.

Shannon –Weiner Index provides useful measures of richness for homegarden species and the index was used to characterize the species diversity of home gardens (Sharmilla, 2004). The Shannon-Weiner species diversity index was calculated by taking the number of each species, the proportion of each species from the total number of individuals, and sums the proportion times the natural log of the proportion for each species. Since this is a negative number, we then take the negative of the negative of this sum. The higher the number, the higher is the species diversity (Nolan and Callahan, 2006).

$$\text{Diversity Index (H')} = -\sum_{1=i}^{s} pi \ln (pi)$$

Where

H’ = Shannon’s diversity index

S = total number of species in the quadrate

Pi = in/N, the number of individuals found in the i^{th} species as a proportion of the total

number of individuals found in all species.

In = natural logarithm to base e

The values of Shannon diversity index is usually found to fall between 1.5 and 3.5 and only rarely surpasses 4.5, where high values indicate high diversity (Magurran, 1988). However, species diversity was determined separately for each plot and the mean diversity can be calculated from the indices by stand.

Evenness (E) was calculated using the Shannon evenness index following the equation.

$$\text{Evenness (E)} = \frac{H'}{H'max} = \frac{-\sum^{s} pi \ln (pi)}{1=I} = \frac{}{\ln S}$$

Where:

H'- is the Shannon-Wiener diversity index and,

H′max = ln S

S- Is the total number of species at a site

Evenness is normal between 0 and 1, and with 1 representing a situation in which all species are equally abundant (the higher the value of E, the more even the species is in their distribution within the quadrats). Similarly, the higher the value of H', the more diverse are the quadrat.

Data analysis was used to determine difference in basal area (BA/ha) and number for tree per hectare (N/ha) among homegarden woody species users having different woody species types. Data analysis was carried out using the values on the number of stems per garden if there is significant difference among different wealth classes in homegardens.

3.2.3 Woody species management knowledge assessment in homegargen

Traditional knowledge has a great role for homegarden woody species domestication, diversity and management practices. Management practices also may have thier factor for species variation from place to place. Thus, to assess traditional knowledge of woody species

management practices in homegarden of study area, Key Informant and Household interview was done by preparing check list and questioners. Data collection strategy for traditional woody species management practices is described in details as follows.

3.2.3.1 Data Collection Strategy

Three complementary data collection strategies (methods) namely household survey, key informant interviews and physical observation where used for primary data collection and secondary data collection task was accomplished.

A. Reconnaissance survey

Reconnaissance survey is another method was used to collect primary data and carry out through systematic watching, observation like the land use, in area vegetation cover, topography, natural resources conservation system, agricultural system, forest resources utilization and management activities were observed in study area of two districts (Adiyo and Gimbo).

B. Secondary data collection

Secondary data were collected at office levels. General different data were collect from Kebele, District and Kafa Zone Agricultural office and from Kafa Zone Finance and Economic Department (KZFEDD). This part more focused on the homegarden wood species or agro forestry intervention practices, annual report and besides the socio economic information of the study area.

C. Household survey interview

This was a formal survey method where interview was employed with semi structured questions for eliciting information from respondents regarding household socio-economic benefits and their homegarden woody species/agroforestry management practices. Six trained technical assistants (especially development or experiences person) and by researcher intensive monitoring was administer a structured interview. The interview was conducted within the respondent's territory and in interviewing atmosphere by translating questioners to the local language. They were oriented on the objectives of the study and how to approach the sample homegarden traditional woody species users, how to ask questions and how to record the responses of the informants (Figure 5).

Figure 5: Household interview during woody species assessment (Source: Photo by Terefe)

The questionnaire was basically designed prior to the actual field work. The semi-structured questionnaire prepared and pre-tested through pilot study before directly applying to collect data in order to improve its clarity as well as its accuracy to collect the needed data. The interviewer read each of the questions as instructed on the survey form and records the interviewee's responses. However, the questions were prepared for the homegarden woody species users. Generally, the question has two parts: the first part is about background information of the respondents whereas, the second part specifically addresses the home garden plant species change/dynamicity trends, community perceptions, species preference criteria and its socio economic benefits and the management methods they were applying for species productivity and sustainability.

The household survey interview was fulfilled wealth categories that are including rich, middle and poor wealth classes. Because wealth status of the households influenced the wood production of home gardens (Yakob *et al.,* 2014). Most commonly three ranks (Rich, Medium, and Poor) were identified.The criteria used by the key informants to classify the households into three wealth categories were mainly based on number of cattle, land size, amount of annual crop production, education and type/standard of housing. These allowed comparisons to be made according to wealth ranks across homegardens studied. According to the focus group discussion, rich especially having large land size, food self-sufficiency, surplus production, large number of livestock, good standard of living, metal sheet cover housing and higher cash income, and medium this having medium plot land, small number of livestock, self-sufficiency in food, may

or may not metal sheet cover and medium level for cash income; and poor also characterized small land size, insufficient food for house consumption and low cash income were considered during wealth categorization. According to the above mentioned criteria, in Alarigeta study site (highland) the percent of rich (32.69), medium (40.38) and poor (26.92); whereas in Beyemmo study site (midland) the percent of rich (34.62), medium (32.69) and poor (32.69) were identified (Apendices 1).

D. Key informant interview

To complement the questionnaire and to have a detailed in sight in to the impact of homegarden species diversity, covering about socio economic and homegarden condition in the areas in-depth interviews and discussion were carried on by better-informed users and association leaders to triangulate or verify the responses of the household and to obtain additional information.The key informants of 30 individuals from all selected sites were interviewed on the homegarden woody species change/dynamicity trends of 20-30years, community perceptions, species preference criteria and its socio economic benefits and cultural values and the management system that they are practiced to maintain the homegarden species.

3.2.3.2 Methods for socio economic surveys of data analysis

Data was analyzed using both descriptive and inferential statistics so as to draw meaningful result about the problem under investigation. The data collected from household questionnairs and key informant interviews were coded, computerized and analyzed using the Microsoft Excel and Chi-Square test P-value at 0.05 level.

4. RESULTS

4.1 Diversity of Woody Species

4.1.1 Woody species richness, abundant and occurrence

The res this results of this study showed that there were a total of 77 woody species that belongs to 68 genera and 35 families which were identified and recorded. When considered separately, 39 woody species under 37 genera and 25 families were recorded in Alarigeta (highland) site whereas, 63 woody species under 55 genera and 31 families were recorded in Beyemmo (midland) site (Figure 6; Appendex 1). The family Fabaceae with nine species (14.29%) was the dominant in species richness in Beyemmo site or representing middle altitude, whereas Rubiaceae with five species (12.82%) dominant family in number of species in Alarigata site. Tweenty five common woody species were identified in the two study sites categoried under 23 genera and 16 families (Figure 6; Appendex 2). Under Fabaceae family 4(15.38%) of woody species were identified. This shows that the Fabaceae family was relatively a dominant family from common woody species.

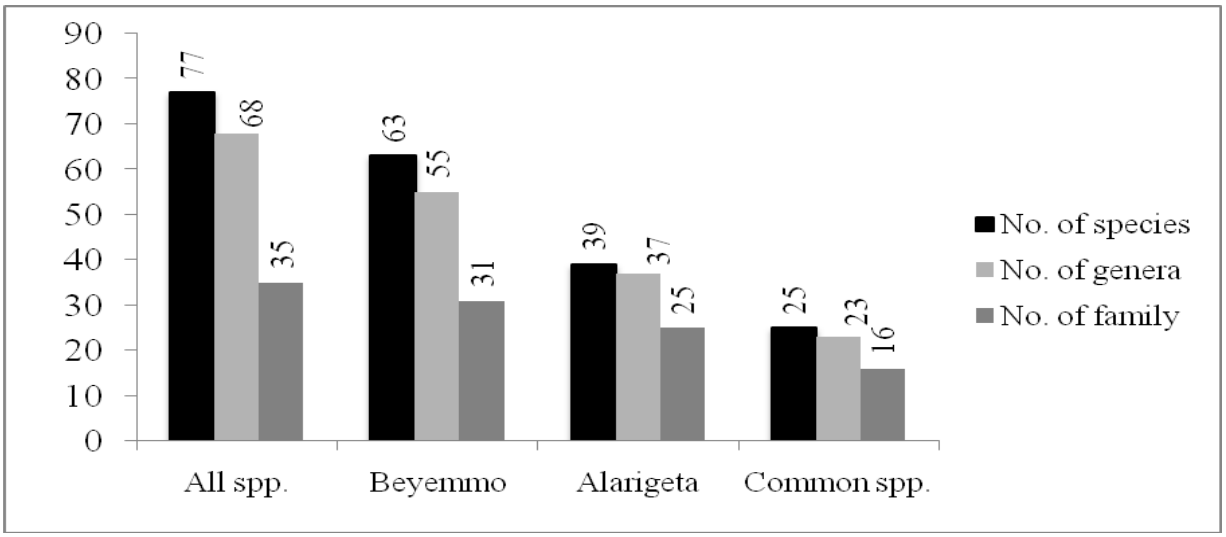

Figure 6: Number of species, genera and families of assessed woody species

Basal area (BA) measurement result indicated that, the relative dominance of individual woody species, from two study areas were characterized by a few species. The first five top relatively

dominant woody species were indentified. For example, *Cordia africana (14.92%)* had significantly high relative dominance in Beyemmo (midland) study site by following, *Albiza gummifera (11.44%), Millettia ferruginea (9.43%), Persea americana (8.03%)* and *Erythrina abyssinica(7.20%)* were recorded(Figure 7a), whereas in Adiyo Kebele(highland) study site *Erythrina brucei (*27.51%) is relatively dominant species following by *Millettia ferruginea (12.55%), Prunus Africana (9.82%), Euphorbia ampliphylla (7.24%) and Eucalyptus* spp. *(6.78%)* were recorded (Figure 7b).

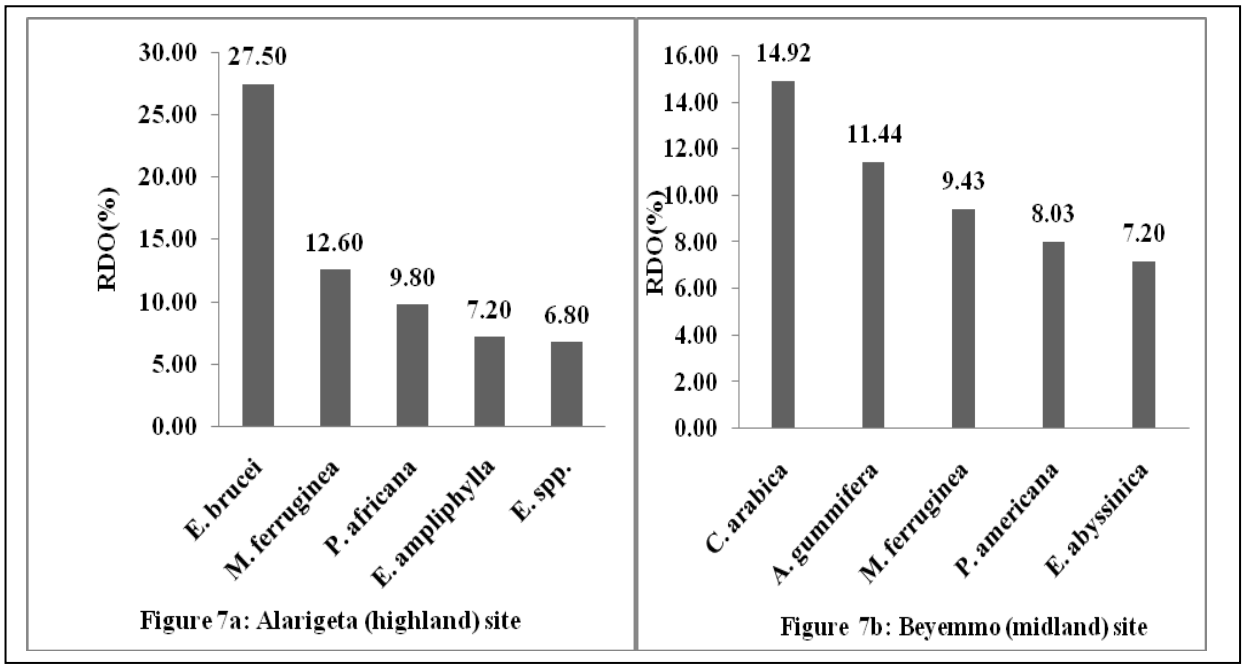

Figure 7: Relative dominancy (RDO) of woody species in two study sites

4.1.1.1 Density of woody species

Woody species density is expressed as the number of trees per unit area and it is a crucial parameter to know homegarden woody species status and for the sustainable homegarden woody species management. The density values of mature tree woody species were eight and 14 per plot (500 m^2), and 160 and 280 per ha recorded in Alarigeta (highland) and Beyemmo (midland) study sites respectively. Similarly, the densities of saplings 17 and 27 per plot, 340 and 540 per ha, and besides seedlings density count result indicted that, 20 and 30 per plot, 400 and 600 per ha were recorded in Alarigeta (highland) and Beyemmo (midland) study sites respectively

(Figure 7). This indicates that, the highest density (abundance) of woody species were densities (abundance) of woody species were recorded at in Beyemmo (midland) study site (Figure 7).

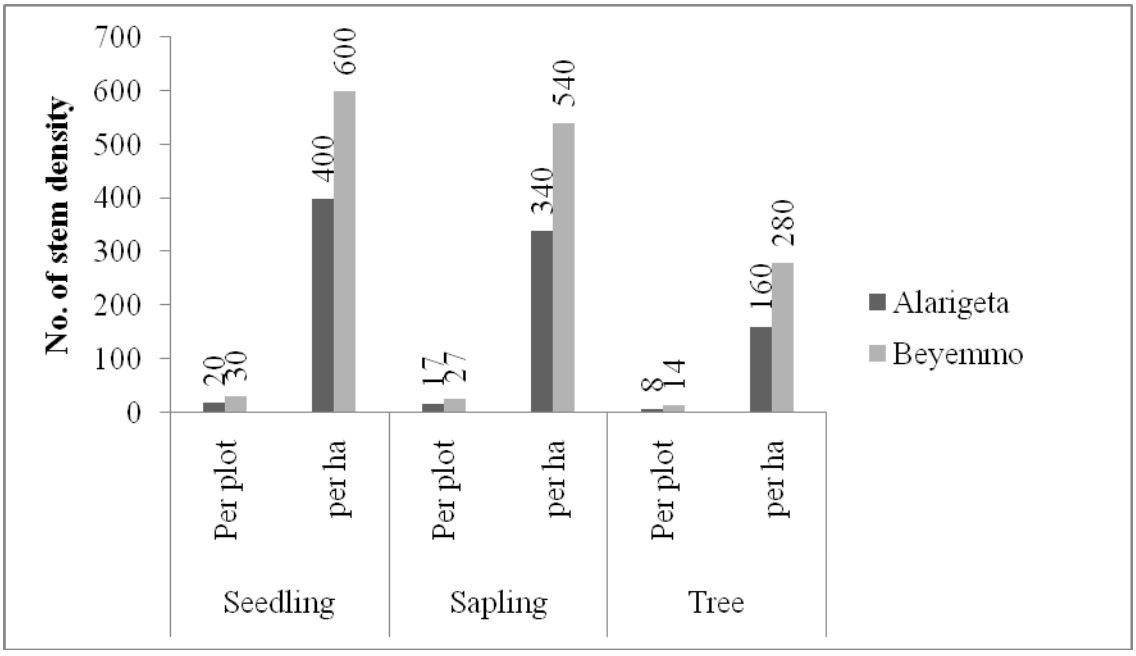

Figure 8: Woody species stem density per plot and per hectare in size class

Total number of woody species stem abundance assessment result indicated that the sum of seedlings, saplings and tree stems counted 45 and 71 per plot, 894 and 1437 per ha were recorded in Alarigeta (highland) and Beyemmo (mid land) respectively (Figure 9).

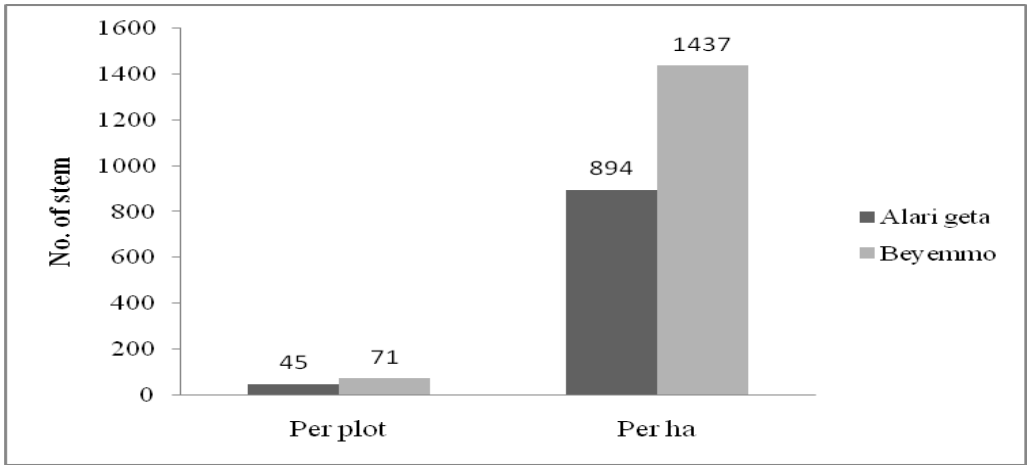

Figure 9: Total woody species stem abundancy per plot and per hectare

Moreover, from the total number of individual woody species some species stem count result were indicated the largest density in the study area. For example, five individual woody species i.e *Vernonia auriculifera(12.09%), Erythrina brucei(10.58%), Millettia ferruginea(10.45%), Eucalyptus* spp.*(10.32%)* and *Bersama abyssinica (7.01%)* were recorded from Alarigeta site (Table 2), *and* whereas, Beyemmo (midland) study site i.e *Coffea arabica (55.68%), Eucalyptus* spp. *(6.80%), Millettia ferruginea (5.68%), Persea americana (3.86%) and Albizia gummifera (3.08%)* from Beyemmo site were contributed the relatively largest density in the study site (Table 2).

Table 2: Relative density (RD) of woody species in each study site

Alarigeta(highland)		Beyemmo(midland)	
Woody species	RD (%)	Woody species	RD (%)
Vernonia auriculifera	*12.09*	*Coffea arabica*	*55.69*
Erythrina brucei	*10.58*	*Eucalyptus* spp.	*6.8*
Millettia ferruginea	*10.45*	*Millettia ferruginea*	*5.68*
Eucalyptus spp.	*10.32*	*Persea americana*	*3.86*
Bersama abyssinica	*7.01*	*Albizia gummifera*	*3.08*

4.1.1.2 Frequency

Each homegarden survey result indicated that, the overall frequency or occurrence of woody species varied between 1- 49 in Beyemmo Kebele (midland) study sites. For example, from frequently observed top six woody species, *Coffea arabica* was the most frequently occurred woody species in 49 homegardens. Even its relative frequency (9.19%) was recorded followed by five top woody species (Table 3). For example, *Persea americana (6.94%), Millettia ferruginea (6.94%), Albizia gummifera (6.19%), Cordia africana (5.39%) and Eucalyptus* spp. (4.13%) were relatively highly occurred in Beyemmo site (Table 3*),* in the same site, some woody species like *Polyscias fulva, Syzygium guineense* and others were recorded in one homegarden accounting for once occurred during surveying of household homegarden

(Appendex 5), whereas, in Alarigeta (highland) study site the frequently occurrence of woody species varied between 1-39. Here, from relatively highly occurred six top woody species, Vernonia auriculifera was the most frequently occurred woody species in 39 homegardens. From six top highly occurred woody species, the relative frequency of Vernonia auriculifera (10.03%), followed by Erythrina brucei (9.51%), Bersama abyssinica (8.23%), Millittia ferruginea (6.94%), Prunus africana (5.91%) and Dombeya torrida (5.66%) in Alarigeta site (Table 3). However, in the same site (Alarigeta) during survey of woody species, some species like *Ficus vasta, Albiza gumiferra* and others were observed once in the household homegarden (Appendex 1).

Table 3: Woody species occurrences/ frequency (F) and relative Frequency (RF)

Alarigeta(highland)			Beyemmo(midland)		
Woody species	F	RF (%)	Woody species	F	RF (%)
Vernonia auriculifera	*39*	*10.03*	*Coffea arabica*	*49*	*9.19*
Erythrina brucei	*37*	*9.51*	*Persea americana*	*37*	*6.94*
Bersama abyssinica	*32*	*8.23*	*Millettia ferruginea*	*37*	*6.94*
Millettia ferruginea	*27*	*6.94*	*Albizia gummifera*	*33*	*6.19*
Prunus Africana	*23*	*5.91*	*Cordia africana*	*28*	*5.39*
Dombeya torrid	*22*	*5.66*	*Eucalyptus* spp.	*22*	*4.13*

4.1.2 Importance value index (IVI)

To determine the importance value index (IVI) of the two study sites, ten top woody species were recorded and presented (Table 4). In Alarigeta study site (highland) *Erythrina brucei* was found have to the highest importance value index (*47.61*) followed by *Millettia ferruginea (29.94),Vernonia auriculifera (26.64), Eucalyptus spp.(22.48), Prunus Africana (20.04), Euphorbia ampliphylla (17.59), Bersama abyssinica (17.48), Dombeya torrid (13.16), Croton macrostachyus (11.32)* and *Maesa lanceolata (10.22)* were recorded (Table 4), whereas in Beyemmo (midland) site *Coffea arabica* has the highest importance value index *(64.91*) followed by *Millettia ferruginea (12.71), Eucalyptus* spp. *(10.97), Persea americana(10.88), Albizia gummifera (9.38), Cordia africana (8.05), Sesbania sesban (6.36), Croton macrostachyus (5.23), Vernonia amygdalina (4.73)* and *Mangifera indica (4.67)* (Table 4,

Appendex 1). But generally from the two study sites, some species were found to have the least important value index.

Table 4: Importance value index (IVI) of woody species in two study site homegarden

Alarigeta (highland)			Beyemmo (midland)		
Ten top woody species	IVI	%	Ten top woody species	IVI	%
Erythrina brucei	*47.61*	*15.87*	*Coffea arabica*	*64.91*	*21.64*
Millettia ferruginea	*29.94*	*9.98*	*Millettia ferruginea*	*12.71*	*4.24*
Vernonia auriculifera	*26.64*	*8.88*	*Eucalyptus* spp.	*10.97*	*3.66*
Eucalyptus spp.	*22.48*	*7.49*	*Persea americana*	*10.88*	*3.63*
Prunus Africana	*20.04*	*6.68*	*Albizia gummifera*	*9.38*	*3.13*
Euphorbia ampliphylla	*17.59*	*5.86*	*Cordia africana*	*8.05*	*2.68*
Bersama abyssinica	*17.48*	*5.83*	*Sesbania sesban*	*6.36*	*2.12*
Dombeya torrid	*13.16*	*4.39*	*Croton macrostachyus*	*5.23*	*1.74*
Croton macrostachyus	*11.32*	*3.77*	*Vernonia anlygdalina*	*4.73*	*1.58*
Maesa lanceolata	*10.22*	*3.41*	*Mangifera indica*	*4.67*	*1.56*

4.1.3 Similarity in woody species composition of study sites

The similarities in homegarden woody species composition were compared between two study sites. In Beyemmo kebele (Midland) 63 woody species and also in Alari-geta kebele (Highland) 39 woody species were recorded, and from two study sites 25 common species were identified. The Sorenson similarity coefficient index between two study sites is 0.329, indicating that there is low numbers of species in common between two study sites.

4.1.4 Diameter at breast height (DBH)

DBH measurement was done upto 1.3 m height from the ground using caliper for those woody plants and if no caliper or when the size of the tree being larger than the caliper diameter, common tape was used during DBH measurement. During DBH survey *Ficus lutea* woody species was recorded high circumference in Beyemmo (midland) study site homegarden.

In the two study sites, DBH measurement data result in class indicated that decreasing from seedling to mature trees. The DBH class from <10cm including seedling count result in

Beyemmo (midland) site 3008 tree stems and in DBH class 10.01-20(384), 20.01-30(178), 30.01-40(76),40.01-50(40),50.01-60(18), 60.01-70(8) and >70cm(23 stem) was recorded ; Whereas, in Alari geta (highland) site 1916 stems and in DBH class 10.01-20(193), 20.01-30(108), 30.01-40(42),40.01-50(17),50.01-60(19), 60.01-70(14) and >70cm(16 stem) was recorded in the DBH class. But in the two study sites the same trends observed because the number of stem decreases as the DBH class increases.

4.1.5. Basal area (BA)

The two study sites basal area result indicate that the mean basal area value per plot and per ha of Beyemmo (midland) site was greater than that of Alarigeta (highland) study sites (Table 5).

Table 5: Mean basal area per plot and per ha of woody species for two study sites

		Mean basal area (m^2)	
Site	Agro-climate	per plot	per ha
Alarigeta	Highland	1.69	33.87
Beyemmo	Midland	2.21	44.24

4.1.6 Diversity indices

In order to know the extent of woody species diversity, diversity indices were employed which include Shannon wiener diversity and Evenness indices for the two study sites. The highest Shannon wiener diversity index was recorded at Alarigeta (high land) study site but the species richness is low as compared to Beyemmo (midland) study site (Table 6). However, at Beyemmo study site (Midland) low Shannon diversity index was recorded but the woody species composition richness is very high (Table 6).

Table 6: Shannon, Evenness and Simpson diversity indices of woody species

District	**Kebele**	**Agro climate**	**Shannon Diversity index**	**Species Evenness**
Adiyo	Alari geta	High land	2.96	0.77
Gimbo	Beyemmo	Midland	2.11	0.55

4.2 Factors Affecting Woody Species Diversity

4.2.1 Altitude variation

Altitude is a major factor for woody species diversity in homegardens. The two specific study areas are laid in different altitude ranges. Alarigeta study site (the highland) altitude ranges from 2300 to 2450 m.a.s.l, whereas Beyemmo (midland) study sites ranges from 1750 to 1900 m.a.s.l, and as a result, the woody species were recorded in the homegarden 39 and 63 respectively (Figure 10). The difference in species diversity in two study sites is driven by the fact that the type of crops cultivated by the local people varies leading to the variation in the management and retention of trees in their homegardens.

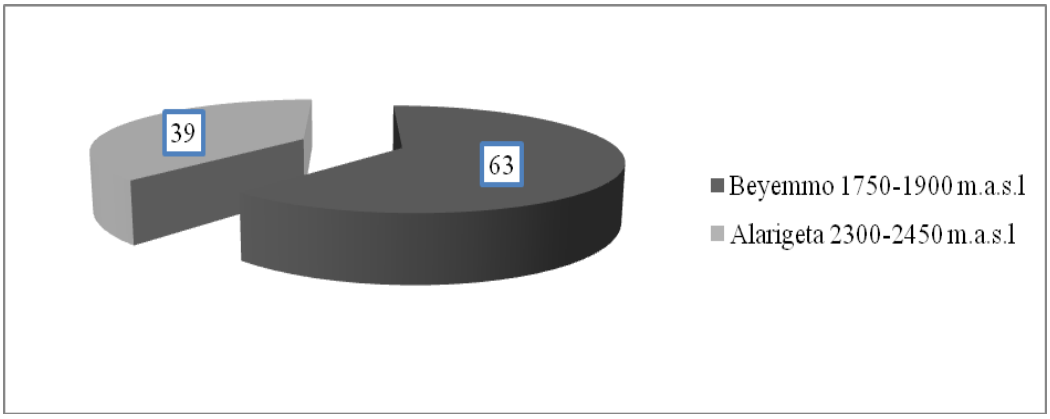

Figure 10: The woody species diversity in the two altitude range of the study sites

4.2.2 Land use type

In the two study areas the local people introduced woody species in their homegarden including exotic species, different fruit trees, and cash crops. This led to woody species richness or diversity in the homegardens. The study in the homegardens indicated that, there were different land use types in the two study sites. For example, land use type of Alarigeta (highland) is dominated by scattered tree with annual crops (90.38%), where as in Beyemmo (midland) is dominated by coffee shade trees (86.54%), and trees with annual crops contributed only 13.46% (Table 7). The result of land use type variation played a significant role in woody species diversity variation between two study sites.

Table 7: Land use type of two study sites (From n=52 respondent)

	Beyemmo		Alari geta	
Land use	No.of hh	%	No. of hh	%
Coffee with shade tree	45	86.54	2	3.85
Tree with annual crop	7	13.46	47	90.38
Grazing land with tree	0	0.00	1	1.92
Only tree grown land	0	0.00	2	3.85

4.2.3 Wealth status of the households

Wealth status also influenced the wood species retaining of homegardens. The land size of household ranged from 0.3 to 12 ha and 0.3 to 8 ha in Beyemmo and Alarigeta study sites respectively. Concern the role of wealth status in woody species diversity, the assessment result indicated that in Beyemmo (midland), the average land size has significant difference but the average species distribution was not observed significantly (Table 8), whereas in Alarigeta Kebele (highland) site, the average land size assessment showed significant different between different wealth category and slight species richness difference between wealth category (Table 8). In the two agro ecological zones, the Chi-Square test result indicated that land sizes are significantly dependent on wealth category because P (0.0007) and, but number of species insignificantly dependent on wealth category P (0.0640).

Table 8: Wealth category versus to land size and number of species

			Wealth classes of household		
Kebele	Altitude	Criteria	Rich	Medium	Poor
Beyemmo	Highland	Average Land size(ha)	5.64	3.24	1.47
		Average species(No.)	9.28	9.35	9.18
Alari-geta	Midland	Average Land size(ha)	4.97	2.88	1.24
		Average species(No.)	8.06	7.72	7.61

4.2.4 Stakeholder intervention

In any where homegarden woody species management may support by different stakeholders. During homegarden the study on woody species, the households (farmers) interview result 26(50%) of respondent were from Alarigeta (highland) only government (GO) institution and 35(67.31%) respondent from Beyemmo (midland) GO were involved in homegarden woody

species management. But 17(32.69%) of respondent of household and key informants like district office expert and kebele development agents were informed that in Beyemmo study site nongovernmental organization(NGO) like sustainable land management project (SLMP) that supported by World Bank Fund was involving on homegarden woody species management practites(Figure 11).

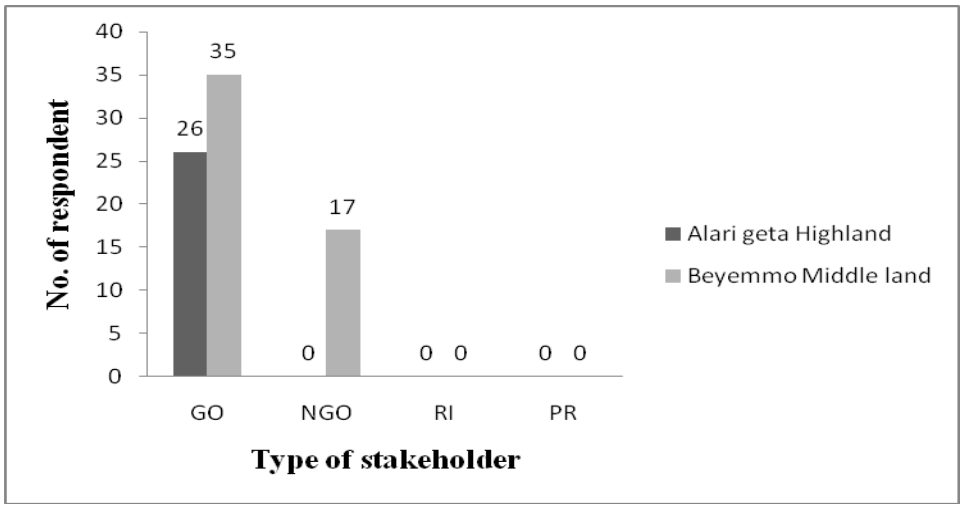

Figure 11: No. of respondents for type of stakeholder

In addition, the household respondent interview result indicated that, stakeholder intervention in Alarigeta(highland), 27(51.92%) of respondents say no intervention in the area, 20(38.46%) awareness creation and training, 4(7.69%) awareness creation and improved seed, and 1.92(24.92%) of respondents say awareness creation- improved seed and seedling provision were assessed(Table 9) and whereas Beyemmo(Midland), 4(7.69%) of respondents say no stakeholder intervention in the area, 5(9.62%) awareness creation and training, 5(9.62%) improved seed provision, 23(44.23%) awareness creation- improved seed and seedling provision, 8(15.38%) awareness creation and improved seed, and 7(13.46%) of improved seed and seedling provision (Table 9) were assessed from household interview.

Table 9: Type of stakeholder intervention

	Type of stakeholder intervention									
Kebele	NI	CRS	AWT	IPS	SDL	AGT	AWT + IPS	IPS + SDL	AWT+ IPS +SDL	Sum
Alarigeta	27	-	20	-	-	-	4	-	1	52
%	51.92	0.0	38.46	0.0	0.0	0.00	7.69	0.00	1.92	100.
Beyemmo	4	-	5	5	-	-	8	7	23	52
%	7.69	0.0	9.62	9.6	0.0	0.00	15.38	13.46	44.23	100.

Key: NI, no intervention;

4.2.5 Opportunities for woody species diversity

Different opportunities were influences on the diversity of woody species of homegardens. In two the study areas, the household interview indicated that, in Alarigeta(highland) study site, 3(5.77%) market; 33(63.46%) seedling access; 1(1.92%) only extension services; 5(9.62%) market and extension; and 10(19.23%) market, price, seedling access and extension services opportunities (Table 10), whereas in Beyemmo(midland) study site, 5(9.62%) market; 1(1.92%) only price; 11(21.15%) seedling access; 5(9.62%) only extension services; 12(23.08%) market and extension; and 18(34.62%) market, price, seedling access and extension services opportunities(Table 10) were affected woody species diversity in the homegarden.

Table 10: No. of respondent for opportunities for woody species growing in HG

	Opportunities for Woody Species growing in HG							
Kebele	**MRK**	**PRI**	**SDL**	**CRD**	**EXS**	**MRK + EXS**	**MRK+ PRI+SDL +EXS**	Sum
Alarigeta	3	-	33	-	1	5	10	52
%	5.77	0.0	63.5	0.00	1.92	9.62	19.23	100.00
Beyemmo	5	1	11	-	5	12	18	52
%	9.62	1.92	21.15	0.00	9.62	23.08	34.62	100.00

Key: MRK, Market; PRI, Price; SDL, Seedling; CRD, Credit; & EXS, Extension

4.2.6 Woody species preference of household

To assess woody species preference trends in the two agro-climatic study areas, respondents were asked to rank the three most important woody species among the species they retain or plant on their homegarden. Accordingly, in Alarigeta (highland) study area , *Millettia ferruginea, Bersama abyssinica* and *Vernonia auriculifera* woody species ranked of first, second and third corresponding to 25,20 and 18 respectively for fuel wood consumption purpose; *Bersoma abyssinica, Eucalyptus* spp. and *Prunus africana* woody species ranked of first, second and third corresponding to 28,20 and 16 respectively for construction purpose; *Eucalyptus* spp., *Millettia ferruginea* and *Coffee arabica* woody species ranked of first, second and third corresponding to 7,5 and 3 respectively for sale purpose; *Vernonia auriculifera, Croton macrostachyus* and *Hagenia abyssinica* woody species ranked of first, second and third corresponding to 7,6 and 4 for medicine purpose; *Hagenia abyssinica, Eucalyptus* spp. *and Prunus africana* woody species ranked of first, second and third corresponding to 15,11 and 5 respectively were preferred for farm implement purpose; and *Millettia ferruginea, Eyrthina brucei* and *Vernonia auriculifera* woody species ranked of first, second and third corresponding to 28,27 and 26 respectively for shade purpose.

More over, *Croton macrostachyus, Vernonia amygdalina* and *Schefferrela abyssinica* woody species ranked of first, second and third corresponding to 12,4 and 2 respectively for bee keeping forage purpose*; Vernonia auriculifera, Millettia ferruginea* and *Eyrthina brucei* woody species ranked of first, second and third corresponding to 35,25 and 19 respectively for soil fertility purpose*; Vernonia auriculifera, Millettia ferruginea* and *Eyrthina brucei* woody species ranked of first, second and third corresponding to 35,25 and 19 respectively preferred for soil fertility purpose*; Cupressus lusitanica, Hagenia abyssinica* and *Jacaranda mimosifola* woody species ranked of first, second and third corresponding to 7,5 and 1 respectively were preferred for aesthetic value purpose*; Eyrthina brucei, Euphorbia ampliphylla* and *Dombeya torrida* ranked of first, second and third corresponding to 33,10 and 8 respectively preferred and retained for fence purpose*; Prunus africana, Eyrthina brucei* and *Ekebergia capensis* ranked of first, second and third corresponding to 20,11 and 6 respectively preferred by respondents for cultural value (Table 11).

In Beyemmo (Midland) study area , *Millettia ferruginea, Albizia gummifera* and *Cordia africana* woody species ranked of first, second and third corresponding to 23,17 and 12 respectively were for fuel wood consumption purpose; *Cordia africana, Albizia gummifera* and *Millettia ferruginea* woody species ranked ranked of first, second and third corresponding to 28,26 and 25 respectively for construction purpose; *Coffea arabica, Persea americana* and *Eucalyptus* spp. woody species ranked of first, second and third corresponding to 44, 16 and 15 respectively were preferred by respondents for sale purpose; *Persea americana, Mangifera indica* and *Prunus persica* woody species ranked of first, second and third corresponding to 35,16 and 7 respectively for fruit purpose; *Coffea arabica, Croton macrostachyus* and *Vernonia auriculifera* woody species ranked of first, second and third corresponding to 15,12 and 8 respectively were preferred for medicine purpose; *Eucalyptus* spp., *Vernonia auriculifera* and *Vernonia amygdalina* woody species ranked of first, second and third corresponding to 13,8 and 7 respectively were preferred for farm implement purpose; *Albizia gummifera, Millettia ferruginea* and *Persea americana* woody species ranked of first, second and third corresponding to 31,25 and 17 respectively respondents were preferred for shade purpose; *Croton macrostachyus***,** *Albizia gummifera* and *Coffee arabica* woody species ranked of first, second and third corresponding to 18, 16 and 10 respectively were preferred for bee keeping purpose.

In this study site also, *Albizia gummifera, Millettia ferruginea* and *Vernonia anlygdolina* woody species ranked of first, second and third corresponding to 29, 27 and 14 respectively were preferred for soil fertility improvement purpose*; Vernonia auriculifera, Millettia ferruginea* and *Eyrthina brucei* woody species ranked of first, second and third corresponding to 35,25 and 19 respectively were preferred for soil fertility purpose*; Coffea arabica, Cupressus lusitanica,* and *Casuarinas cunninghamiana* woody species ranked of first, second and third corresponding to 13,5 and 3 respectively preferred for aesthetic value purpose*; Eyrthina abyssinica, Eucalyptus* spp. and *Millettia ferruginea* ranked of first, second and third corresponding to 13,9 and 7 respectively were preferred for fence purpose*; Coffea arabica, Prunus africana, and Albizia gummifera* ranked of first, second and third corresponding to 15,9 and 7 respectively were preferred and retained in Beyemmo (midland) study site for cultural value purpose (Table 11).

Table 11: No. of respondents per purpose of woody species preference

		Purpose of woody species preference														
Site	Scientific name	Fuel wood	Construction	Sale/cash	Fruit	Medicine	Farm implement	Shade	Bee keeping	Soil fertility	Aesthic value	Fence	Cultural value	Fodder	Charcoal
Alarigeta	*Bersama abyssinica*	20	28	-	-	-	-	7	-		-	-	-	-	-
	Brucea antidysenterica	-	7	-	-	3	-	-	-	-	-	-	-	-	-
	Buddleia polystachya	-	6	-	-	-	-	-	-	-	-	4	3	-	-
	Coffea arabica	-	-	3	-	-	-	-	-	-	-	-	2	-	-
	Croton macrostachyus	8	13	-	-	6	-	9	12	7	-	-	-	-	-
	Cupressus lusitanica	-	-	-	-	-	-	-	-	-	3	-	-	-	-
	Dombeya torrid	-	11	-	-	-	-	-	-	-	-	8	-	-	-
	Ekebergia capensis	-	-	-	-	-	-	-	2	-	-	-	6	-	-
	Erythrina brucei	-	-	-	-	-	-	27	-	19	-	3	6	-	-
	Eucalyptus species	16	20	7	-	-	11	-	-	-	-	5	-	-	-
	Euphorbia ampliphylla	-	8	-	-	-	-	-	-	-	-	0	-	-	-
	Ficus vasta	-	-	-	-	-	-	-	-	-	-	-	1	-	-
	Hagenia abyssinica	7	14	-	-	4	15	-	2	-	-	5	-	-	-
	Jacaranda mimosifola	-	-	-	-	-	-	-	-	-	1	-	-	-	-
	Millettia ferruginea	25	-	5	-	-	-	28	-	25	-	-	-	-	-
	Persea americana	-	-	-	2	-	-	-	-	-	-		-	-	-
	Prunus Africana	13	16	-	-	3	5	-	-	-	-	-	20	-	-
	Schefflera abyssinica	-	-	-	-	-	-	-	2	-	-	-	-	-	-
	Syzygium guineense	-	-	-	-	2	-	-	4	8	-	-	1	-	-
	Vernonia auriculifera	18	-	-	-	7	-	26	-	35	-	-	-	-	-

Beyemmo	*Albiza gummifera*	17	26	3	-	-	-	31	16	29	-	-	9	-	-
	Brucea antidysenterica	-	4	-	-	3	-	-	-	-	-	6	-	-	-
	Carica papaya	-	-	-	5	-	-	-	-	-	-	-	-	-	-
	Casimiroa edulis	-	-	-	5	-	-	-	-	-	-	-	-	-	-
	Casuarina cunninghamiana	-	-	-	-	-	-	-	-	-	3	2	-	-	-
	Catha edulis	-	-	9	-	-	-	-	-	-	-	-	-	-	-
	Clausena anisata	-	-	-	-	2	-	-	-	-	-	-	-	-	-
	Coffea arabica	-	28	44	-	15	4	-	10	-	13	-	26	-	-
	Cordia Africana	12	28	6	-	-	-	14	9	10	-	-	-	-	-
	Croton macrostachyus	10	21	-	-	12	-	12	18	5	-	-	-	-	-
	Cupressus lusitanica	-	-	-	-	-	-	-	-	-	5	-	-	-	-
	Ehertia cymosa	4	6	-	-	-	5	-	-	-	-	-	-	-	-
	Erythrina abyssinica	-	-	-	-	-	-	9	3	7	-	5	3	-	-
	Eucalyptus species	9	16	15	-	-	13	5	-	-	-	9	-	-	-
	Grevillea robusta	-	5	1	-	-	-	-	-	-	1	3	-	-	-
	Mangifera indica	-	-	7	6	-	-	9	-	-	-	-	-	-	-
	Millettia ferruginea	23	25	-	-	2	-	25	5	27	-	7	-	-	3
	Persea americana	-	-	16	5	-	-	17	-	7	-	-	-	-	-
	Prunus Africana	10	13	-	-	4	-	8	7	-	-	-	15	-	-
	Prunus persica	-	-	4	7	-	-	-	-	-	-	-	-	-	-
	Psidium guajava	-	-	-	7	-	-	-	-	-	-	-	-	-	-
	Ricinus communis	3	-	-	-	-	-	5	-	-	-	-	-	-	-
	Sapium ellipticum	7	10	-	-	-	-	9	5	-	-	-	-	-	-
	Schefflera abyssinica	-	-	-	-	-	-	-	2		-	-	-	-	-
	Sesbania sesban	-	-	-	-	-	-	10	-	10	-	-	-	5	-
	Vernonia amygdalina	7	-	-	-	7	7	12	7	14	-	-	-	4	-
	Vernonia auriculifera	8	-	-	-	8	8	14	-	12	-	-	-	-	-

4.3 Tradional Knowledge of of Woody Species Management Practices in the Homegarden

4.3.1 Seedling production and planting in homegarden

Tradtionally farmers have accumulated knowledge to produce and plant woody species seedling in their homegarden. According to household interview result farmer get woody species seedling and plant and/or retained from different sources. Present study household interview result indicated that in Beyemmo (Midland) Kebele homegarden from self raised his garden 35(67.31%), Self regenerated 46(88.46%), wild 41(78.85%) and from agricultural office nursery site 28(53.85%), and also from 52 interviewed household 50(96.15%) were planted woody species in their homegarden but 2(3.85%) were not planted (Table 12), whereas in Alarigeta (highland), sources of seedling from self raised 19(36.54%), Self regenerated 38(73.08%), wild 32(61.54%) and from agricultural nursery site 8(15.38%), and also from 52 interviewed household 51(98.08%) were planted woody species in their homegargen but 1(1.92%) were not planted (Table 12).

Table 12: No. of respondent for planting of woody species and sources of seedling

	Planting of woody species			**Sources of seedling**			
Kebele	Yes	No	Sum	SLR	SLRG	WLD	AGD
Alarigeta	51	1	-	19	38	32	8
%	98.08	1.92	0.00	36.54	73.08	61.54	15.38
Beyemmo	50	2	-	35	46	41	28
%	96.15	3.85	0.00	67.31	88.46	78.85	53.85

Key: SLR, Self raise; SLRG: self regenerated; WLD: from wild & AGD; Agricultural Development

4.3.2 Seedling management practices

Farmers in the study area traditionally managed woody species seedling in their homegarden to get multiple benefits. Household interview result indicated that thinning, composting and weeding are most commonly used woody species management practices in the site (Table 13). Thinning and weeding 25 (48.08%), Weeding and hoeing six (11.54%), thinning, weeding and hoeing 10 (19.23%) and only weeding 11 (21.15%) traditional management way of woody species management practices in homegarden by households in Alarigeta (highland) Kebele site (Table 13), whereas, weeding and hoeing 28 (53.85%), thinning, weeding and hoeing nine (17.31%), compositing, weeding and hoeing

eight (15.38%). and only weeding five (9.62%) homegarden woody species management practices were implementing by households in Beyemmo (midland) Kebele site (Table 13).

Table 13: No. of respondent for homegarden woody species seedlingmanagement (n=52)

	Type of management practices									Sum
Site	TH	PR	CMP	WDG	HOG	TH+WDG	WDG+HOG	TH+WDG+HOG	CMP+WDG+HOG	
Alarigeta	-	-	-	11	-	25	6	10	-	52
%	0.00	0.00	0.00	21.15	0.0	48.08	11.54	19.23	0.00	100.0
Beyemmo	-	-	-	5	-	-	28	9	8	50
%	0.00	0.00	0.00	9.62	0.0	0.00	53.85	17.31	15.38	96.15

Key: TH, Thinning; PR, pruning; CMP, composting; WDG, Weeding; & HOG, Hoeing

Traditionally, farmers also manage woody species in their homegarden mainly to reduce competition, provide shade, enhance growth and increase productivities of intercropped and understory crops, and to obtain sufficient construction and fuel wood. According to household interview on reason of woody species management, from Alarigeta (highland) study site, 52 respondent 25 (48.08%) for growth, 24 (46.15%) for growth and reduction of competition, two (3.85%) for growth, reduction of competition and reducing of shade, one (1.92%) for fodder purpose (Table 14), whereas, from Beyemmo (midland) Kebele study site, from 52 household interview respondent 25 (48.08%) for growth, nine (17.31%) for growth and reduction of competition, 16 (30.77%) for growth, reduction of competition and reducing of shade purpose (Table 14).

Table 14: No. of respondent for reason for homegarden woody species management (n=52)

		Reason for woody species management							
Site	**Village**	**GR**	**RDC**	**RDS**	**FD**	**FW**	**GR+RDC**	**GR+RDC+RDS**	**Sum**
Alarigeta	Total	25	-	-	1	-	24	2	52
	%	48.08	0	0	1.92	0	46.15	3.85	100
Beyemmo	Total	27	-	-	-	-	9	16	52
	%	51.92	0	0	0	0	17.31	30.77	100

Key: GR, Growth; RDC, Reduction of competition; RDS, Reduction of shade; FD; Fodder; FW, Fuel wood

In the two study sites, different factors were affecting traditional knowledge of homegarden woody species management. Household interviewed result showed that, in Alarigeta (highland) area were animals damage 35 (67.31%) area serious problem, whereas in Beyemmo (midland) site diseases 28 (53.85%) relatively high problem(Table 15). But, nine (17.31%) and 10 (19.23%) of respondents from Alarigeta (highland) and Beyemmo (midland) respectively were informed none homegarden woody species management problems (Table 15).

Table 15: No. of respondent for problem of homegarden woody species management (n=52).

	Problems for woody species management								
Site	**NP**	**AN**	**INP**	**DS**	**THF**	**AN+DS**	**INP+DS**	**AN+THF**	**Sum**
Alarigeta	9	35	-	-	-	4	-	4	52
%	17.31	67.31	0.00	0.00	0.00	7.69	0.00	7.69	100.00
Beyemmo	10	2	2	28	-	10	-	-	52
%	19.23	3.85	3.85	53.85	0.00	19.23	0.00	-	100.00

Key: NP, No problem; AN, Animal; INP, Insect-pest; DS, Disease & THF, Thief

However, local farmers traditionally practice fencing, guarding and rarely application of insecticides to solve the problems (Table 16). Fencing and guarding 30(57.69%) were highly used by highland area (Alarigeta) household; whereas in midland (Beyemmo) study site households relatively were using fence 10 (19.33%) as the solution to protect their woody species damage from animals. In addition the two study sites five (9.62%) and one (1.92%) of household respondents from Alarigeta (highland) and Beyemmo (midland) were uses guarding solution to reduce woody species losses in the homegarden (Table 16).

Table 16: No. respondent for solution for woody species management problem (n=52)

	Solution for woody species management problem						
Site	NS	FN	INS	GRD	GRD + INS	FN+ GRD	**Sum**
Alari geta	13	3	-	5	1	30	52
%	25.00	5.77	0.00	9.62	1.92	57.69	100.00
Beyemmo	41	10	-	1	-	-	52
%	78.85	19.23	0.00	1.92	0.00	0.00	100.00

Key: NS, No solution; FN, Fence; INS, Insecticide & GRD, Guarding

4.3.3 Responsible for woody species management

Household interview result showed that, traditionally household members were involved in homegarden woody species management practices. For example, in Alarigeta (highland) study area, 24 (46.15%), 15 (28.80%), nine (17.31%), two (3.85%) and one (1.92%) of respondents were agreed on men, men and boy, all family members (men, women, boy and girls) were respectively responsible for homegarden woody species management (Table 19), whereas in Beyemmo (midland) study area, 17 (32.69%), 17 (32.69%), 11 (21.15%), five (9.63%), two (3.85%), one (1.92%) of respondents agreed on men and women, all family members (men, women, boy and girls), men and boy, boy and women were respectively responsibile for woody species management (Table 17).

Table 17: No. of respondent for responsible for woody species management practices

	Responsible for woody species management practices								
Kebele	M	W	B	G	MW	MB	WG	MG	MWBG
Alari geta	24	-	2	-	1	15	-	-	9
%	46.15	0.00	3.85	0.00	1.92	28.85	0.00	0.00	17.31
Beyemmo	17	1	2	-	17	5	-	-	11
%	32.69	1.92	3.85	0.00	32.69	9.62	0.00	0.00	21.15

Key: M, Men; W,Women; B, Boy; G, Girl; MW, Men & women, MB, Men & Boys, WG, women & girl; MG, Men and girl; MWBG, Men, Women, boy and girl

4.4 Socio economic and Cultural roles

Socio economical roles

The present study result indicated that traditional knowledge of homegarden woody species management practices were influenced by socio-economic roles. Accordingly, *Hagenia abyssinica (15.51%), Millettia ferruginea* (*15.15%), Eucalyptus* spp. *(10.77%) Croton macrostachyus (10.04%)* and *Erythrina brucei (8.94%)* have high socio economic roles in Alarigeta (Highland) (Figure: 12a), and whereas *Coffea arabica (13.02%), Albizia gumifera (12.71%), Millettia ferruginea (11.88%), Cordia africana (8.21%) and Eucalyptus* spp. (*8.13%)* (Figure: 12b) are more retained and traditionally managed as compared to other species in Beyemmo (midland).

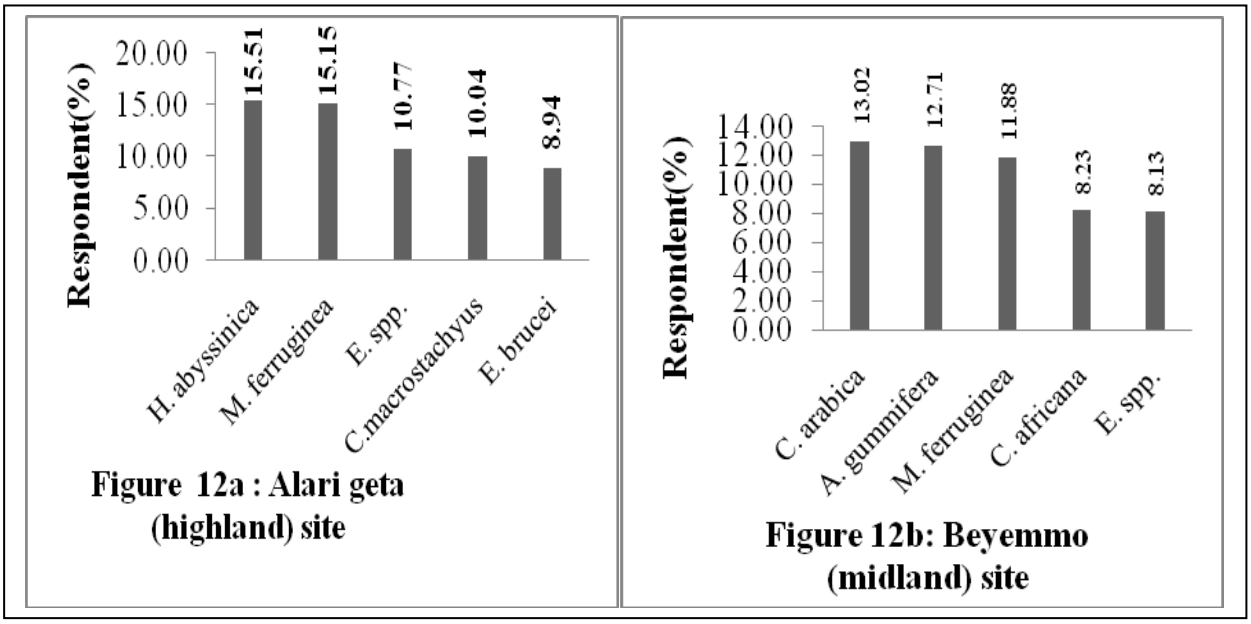

Figure 12: Socio economic roles on traditional homegarden woody species management (n=52)

Cultural values

In the two study sites, the assessment result indicated that farmers traditionally preserved and managed woody species in their homegarden for the purposely cultural value (Figure 13).

Figure 13: Woody species preserved in the homegarden for curtuaral value

Accordingly, *Prunus africana (48.78%), Erythrina brucei (17.07%), Ekebergia capensis (14.63%) and Buddleia polystachya (7.32)* were recorded in Alarigeta (highland) site (Figure:14a), whereas

Coffea arabica (63.41%), Prunus Africana (36.59%), Albiza gummifera(21.95%) and Erythrina abyssinica (7.32%) were recorded in Beyemmo(Midland) study site(Figure:14b).

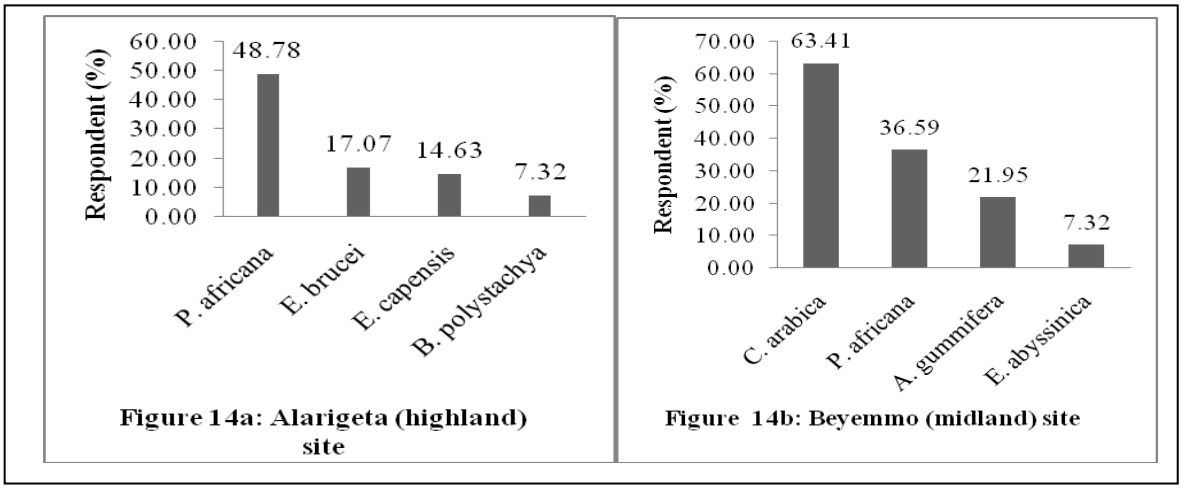

Figure 14: Cultural roles on traditional homegarden woody species management (n=52)

4.5 Trends of Homegarden Woody Species retention in home gardens

Traditionally, in the two study sites, households domesticated or grew woody species in their homegarden. According to woody species assessment, farmers were growing different woody species in their homegarden based agro-ecology. For example, household interview result indicated that 40 (76.92%) and 49 (94.23%) of respondent supported woody species increase, and 12 (23.08%) and three (5.77%) of respondents were agreed on woody species decrease in the homegarden of Alarigeta (highland) and Beyemmo (midland) respectively (Table 18). The chi-square test result indicated that the trends of the species growth in the household homegarden significantly dependent (P=0.0120) on agro ecological zone.

Table 18: No. of respondent for woody species growing trends within ten year (n=52)

		Trends for homegarden woody species growing within ten year			
Site	Altitude	NCH	INCR	DECR	Sum
Alari geta	highland	-	40	12	52
	(%)	0.00	76.92	23.08	100.00
Beyemmo	Middle altitude	-	49	3	52
	(%)	0.00	94.23	5.77	100.00

Key: NCH, No change; INCR, Increases; & DECR, Decrease

5. DISCUSSION

5.1. Woody Species Diversity in the Homegarden

Homegarden was an important area to grow woody species. In the present study, homegarden woody species assessment result showed that, totally 77 woody species was recorded under 35 families from the two study sites in 104 homegarden plots. At site level, 39 and 63 woody species were recorded in Alarigeta (highland) and Beyemmo (midland) study areas respectively from each 52 home gardens. This result indicated that Beyemmo (midland) study site has more species richness as compare to Alarigeta (highland) study site. In the two study sites, the main reasons for species richness variation was the altitude variation and besides accessibility difference. For example, Beyemmo (midland) study site is found in accessible area like road, market and more extension services than Alarigeta (highland) site. It is similar to earlier study reports of Asfaw (2003) and Abebe (2005) in Sidama, Southern Ethiopia. Total woody species richness (77) of the study areas were found to be greater when compared to total of 36 woody species that were recorded in homegarden agro forestry in Shashemenne District (Jogora, 2011); 64 homegarden woody species in Arsi Negelle District, Ethiopia (Tolera, 2006), and smaller to trees and shrubs diversity of 120 woody species (Abebe, 2005) in Sidama and 108 tree and shrub species (Reshad, 2006) in Arbegona district (highland) of Southern Ethiopia.

During this study, the density of woody species was assessed in the two study sites. The assessment result showed that, the total stem density of woody species was higher in midland of Beyemmo study stite (1437 per ha) than highland of Alarigeta study site (894 per ha). This result as compared to other previous finding, 1020 stems per ha were recorded in homegarden agroforestry in Shashemenne District (Jogora, 2011). It is smaller density compared to in Beyemmo (midland) but higher in Alarigeta (highland) study site. The woody species density variation in the two study sites indicated that the role of altitude, accessibility and management variation. For example, the midland area is more suitable for coffee and fruit growth; therefore Beyemmo study site farmers grow coffee and fruit under shades of various trees than Alarigeta (highland).

The frequent occurrence of most valuable woody species was assessed to know the extent of species distribution on homegarden. The assessment survey result indicated that, *Coffea arabica* was the most frequently occurring species in the 49 homegardens of Beyemmo (midland) study site, where as

Vernonia auriculifera was the most frequently occurred in 39 homegardens of Alarigeta (highland) site. Accordingly, different woody species occurrences were recorded in the two study sites.The main reason was altitude variation. For example, Alarigeta (highland) study area is not suitable for coffee growing as compared to Beyemmo (midland) study area. But at individual study site level, the reason for highest frequent of woody species, *Coffea arabica* (Beyemmo) and *Vernonia auriculifera* (Alarigeta) study sites were their provision of multiple benefits for the households. The result of this study is similar to homegarden agroforestry of the study sites of Shashemenne District (Jogora, 2011) and in Sidama, Southern Ethiopa (Abebe, 2005).

In the present study, from the two each study site, five highest woody species with importance value index were indentified and recorded (Table 3). In Alarigeta (highland) study site, *Erythrinia brucei* had higher important value index than other woody species, followed by *Vernonia auriculifera*, *Eucalyptus* spp., *Euphorbia ampliphylla* and *Millettia ferruginea*, whereas in Beyemmo (Midland) study site *Coffea arabica* ranked the highest important value index (IVI) as compared to other woody species being followed by *Persea americana*, *Millettia ferruginea*, *Eucalyptus* spp., and *Albizia gummifera* which were retained and managed in the farmers homegarden of the two study sites. This study result showed that in each study site local communities ranked highly important valued woody species from their homegarden. The main reason for community preference was connected with multipurpose benefits of woody species for local. For example, in the highland agroecology, *Erythrinia brucei* might have high multipurpose uses for local communities such as life fence, lumber, shade and to prepare bee hive and *Vernonia auriculifera* also contributed soil fertility improvement, fuel wood and shade*; Eucalyptus* spp., were also used for construction purpose because of there are fast growing woody species and preferred for cash or income generation in the study site. The result agreed with Reshad (2006) study report in Arbegona District, highlands of Southern Ethiopia and in high and midland agroecology *Millettia ferruginea* had highly retained and preferred in the homegarden by its provision of soil fertility improvement, shade and construction material and its unique character of high capacity to self regenetaion and no need of intensive management. This result ageed with Yakob *et al*. (2014) previous study reported in Gimbo District, south west Ethiopia. Moreover, coffee is widely planted and grown in Beyemmo (midland) study site, because of the suitability of the agro ecology for coffee production, major cash crop in the study area and providing income for household expenditures. It agreed with previous study report of Abebe *et*

al. (2010) and an ethno botanical profile study report of Seta *et al* (2013) in Wolayita, Southern Ethiopia. Besides, in midland agro-ecology (Beyemmo) study site, the road and market accessibility, extension services and stakeholder intervention have contributed for coffee and avocado which had high importance value in the study area. The result agreed with previous reports of Reshad (2006) and Jogora (2011).

In the present study, the similarity in woody species composition was observed between the two study agro ecological zones and then result is 0.329. This result indicated that there was less similar type of woody species between the two study site homegardens. The reason for less similarity between the two agro ecological study sites indicated that there was the effect of altitude variation on woody species similarity.

Diameter at breast height (DBH) measurement result in class indicated that decreasing stem numbers from seedling to mature trees. The DBH class from below 10 cm for the result in Beyemmo (midland) site 3,008 stems and greater than 70 cm DBH 23 stems were recorded, whereas in Alarigeta (highland) site DBH class from below 10 cm 1,916 stem and greater than 70 cm DBH 16 stem were recorded. This result indicated that below 10cm DBH high number of seedling and sapling stems were recorded in Beyemmo as compared to Alarigeta sites. The main reason is high coffee population retained and planted in Beyemmo (Midland) study site as compare to Alarigeta (highland) site. Because, the suitability of agroecology and accessibility were encauraged more for homegarden agro forestry practices in midland area. In the two study sites the same trends were observed because the number of stems decreased as the DBH class increase. The reasons are farmers reduce and/or use young and mature woody species for construction, to intercrop annual crop and fuelwood purpose.

In the present study, the basal area of the two study sites were calculated, therefore the result indicated that 1.69 per plot and 33.87 m^2 per ha and 2.21per plot and 44.24 m^2/per ha for Alarigeta and Beyemmo study site, respectively (Table 4). This implies that there was high population or stems in the homegarden of Beyemmo (Midland) study site as compare to Alarigeta (Highland) site. In the two study sites, the altitude (agroecology) variation, accessibilily and management cultures were created difference in basal area.

In the present study to know the extent of woody species diversity, different diversity indices were employed which include Shannon and Evenness indices for the two study sites. The highest Shannon diversity index was recorded at Alarigeta (Highland) study site but the species richness is low as compared to Beyemmo (Midland) study sites (Table 5). The reason for this is Shannon diversity index accounts more for equal abundance and eveness of the species in the same community. For example, in Beyemmo there was high species richness but low diversity due to high abundance of few species including *coffea arabica* in the area. High eveness result recorded in Alarigeta site, which has the same trends observed with the Shannon diversity index. Because, the evenness is also accounts more for homogeneous distribution of woody species on the homegarden.

5.2 Traditional Knowledge on Homegarden Woody species Management

Traditionally, local communities manage woody species in their homegarden depending on their preference. According to household interview result the seedlings of woody species were obtained from different sources. In the two studies sites, most local communities managed self raised seedlings in their own nursery site, but in Beyemmo (midland), few farmers obtained *Coffea arabica* seedlings free from locally available a source that is self regenerated from natural wild coffee forest, most likely this opportunity was available to forest adjacent communities. The result is also similar to earlier report of Yakob *et al*., (2014) in Gimbo District. In addition to self regenerated they plant woody species in their homegarden from agricultural nursery site sources, but no provision of agricultural nursery site access in Alarigeta study area, Adiyo district (Table 11). During homegarden woody species assessment, from each site 52 household interviews result indicated that 2 and 1 respondents from Beyemmo and Alarigeta study sites respectively households did not planted seedling their homegarden (Table 11). The reason for none planting woody species in household garden is connected with lack of extension services and access of woody species in their adjacent natural forest.

Households in the study area traditionally managed woody species in their homegarden to get multiple benefits from homegarden woody species. Purpose of homegarden woody species management in the two study sites was to reduce competition, provide shade, enhance growth and increases productivities of intercropped plant and understory crops, and to obtain sufficient construction and fuel wood. According to interview result thinning, composting and weeding are

most commonly used woody species management practices in the study area (Table 10). Traditionally, thinning and weeding are common management practices in the two study sites. The result agreed with that of Jogora (2011) who previous study reported in Shashemene District Oromia Region. Compost application was also observed in Beyemmo site (midland) but it was insignificant in the two sites as compared to other management practices. The result is similar to Yakob *et al*. (2014) earlier work report in Gimbo District. But, the homegarden woody species management intensification was different in the two study sites. The reason is that it depends on the purpose of woody species and socio economic culture local communities. For example in Beyemmo study site, local communities relatively managed intensively as compared to Alarigeta site. Because, in Beyemmo site the diversity of ethnic group, accessibility to market and road and extension services may have created management intestification than from Alarigeta study site.

In the present study, different factors affected homegarden woody species management. Household interview result showed that, in Alarigeta (highland) area 67.31% reported animal damage as a serious problem, whereas in Beyemmo (midland) study site 53.85% reported disease as a relatively high problem. Out of those, others were insignificant problems (Table 14). According to household and key informant information, Rodent, Colobus monkey and browser domestic animals were serious problems in Alarigeta (highland) study sites. For example, Rodent cuts the root part of seedlings in the ground, Colobus monkey eats bark of sapling tree especially young *Eucalyptus* spp. and domestic animals like sheep, goat, cattle etc., browsed and grazed tree saplings and seedlings respectively. Contrarily, in Beyemmo (mid altitude) study site disease was serious as compared to other problems in the area. According to household and key informant interview result coffee berry disease (CBD), coffee wilt disease (CWD) and avocado plant drying disease were common problems in the area, especially CBD and CWD were severe problems in coffee species production. But, 17.31% and 19.23% of respondents from Alarigeta (highland) and Beyemmo (mid land) respectively were informed none homegarden woody species management problems (Table 14). The reason for this result implied that household survey incorporated none coffee producer farmers in their garden. Because, the farmers who lived t adjacent of natural forest, they used forest coffee production, and they did not plant coffee in their garden.

To overcome the above mentioned problems, local communities traditionally use different practices such as fencing, guarding and application of insecticides to solve the problems (Table 15). Fifty two respondents were asked from each study site, the result showed that fencing and guarding (57.69%) were highly used by highland site (Alarigeta) farmers; whereas in midland (Beyemmo) study site farmers relatively used fence only (19.33%) as the solution to protect their woody species damage from animals. In addition to that, two study sites, 9.62% and 1.92% of household respondents from Alarigeta (highland) and Beyemmo (midland) were used guarding solution to reduce woody species losses in the homegarden (Table 15). The remaining respondents not used any solution in the two sites. The reason for this was in the two study sites, weak extension services, and weak emphasis for homegarden woody species, lack of anti bacterial and fungal treatment for coffee producer. The effect weak solutions were influenced on woody species richness and diversity. It is similar to previous work report of Yakob *et al*., (2014).

The present study was assessed at different levels all household members' involvement in homegarden woody species management practices. For example, according to household interview result, in Alarigeta (highland) study sites, men are more responsible for homegarden woody species management from all family members, whereas in Beyemmo (Midland) study site, household interview result indicated that men and women are more responsible for woody species management practices from all family members (Table 16). The above results indicated that others household members (boy and girl intervention) in homegarden woody species management in two study sites were insignificant. Even women participation in management practices differ in the two study sites. The reason was in the two different agroecology socio economic and cultural factors limited all household intervention in homegarden woody species management practices.

5.3 Factors for Sustainability of woody species diversity

In the present study, altitude is a major factor for woody species diversity in homegardens. The two study sites are laid in different altitude ranges, for example Alarigeta study site (highland) altitude ranges from 2300 to 2450 m.a.s.l, whereas Beyemmo study site (Midland) it ranges from 1750 to 1900 m.a.s.l. Due to altitude variation the high woody species were recorded in the homegarden of Beyemmo (midland) study site whereas low in species number but high species diversity recorded in Alarigeta (highland) site (Figure 10). This result is similar to Abebe (2005) study report in Sidama

Zone, Southern Ethiopia. Because, his report indicated that based on his personal observation, if we go up to another agro-ecological zone, locally called *Dega*(high land) where the altitude is above 2300 m.a.s.l the temperature is low and plant diversity is generally low.

In the present study, the result shows that in Alarigeta (highlnad) study site 90.38% farmers used their homegarden for trees with annual crop. From this land use type, the result indicated that low and high woody species richness and diversity recorded respectively, whereas in Beyemmo (Midland), more (86.54%) farmers used their homegarden land for coffee with tree fruit agroforestry system. In this site, the assessment result indicated that there was high woody species richness but low species diversity was observed. Accordingly, in Beyemmo study site the community is intensively introducing different woody species in homegarden including exotic species, different fruit trees, cash crops and some species were brought from other localities the planting of various exotic and native woody species. Similar to Tolera (2006) previous study report in Arsi Negelle District, Ethiopia and Gebrehiwot (2013) previous study report also indicated that land use change was found in the homegarden agro forestry, as a consequence of the expansion of cash crops since 1990s in Gemmeto Galle, Southern Ethiopia. In Alarigeta (highland) site the exotic species including *Euclapytus* spp. was introduction observed rarely but land use type significantly converted to annual crop in the study area. Therefore, the land use type has significant role on woody species diversity.

During the present study, the role of wealth status affected woody species diversity. In the two study sites the landholging system and species diversity in three wealth categories, the result indicated that in Beyemmo (Midland) and Alarigeta (highland) study sites, the average land size was showed significant difference but the average species richness was not indicate significant variation between the three wealth categories (Table 8). The wealth status significantly influenced land holding system between wealth categories, poor farmers hold small land size as compare to rich farmers. The result is similar that of Reshad (2006) in Arbegona District, highland of Southern Ethiopia. But wealth categories did not significantly influence the three weath categories (poor, medium and rich) in the two study sites. The reason is poor households intensively grow in their small sized garden. This result agreed with the earlier report of Gebrehiwot (2013) and diffent from the previous study report of Reshad (2006).

In the present study the stakeholder's interventions in homegarden woody species management were assessed in the two study sites. The households (farmers) interview respondent result showed that, Alarigeta (highland) study site only government institution intervention was recorded in woody species management activities by providing awareness creation whereas in Beyemmo (midland) study site there were different stakeholders involved in homegarden woody species management including government, sustainable land management project (SLMP), etc. who supported homegarden woody species production and management (Figure 11). Because stakeholders intervene and none intervene sites Beyemmo and Alari geta respectively were observed significantly different woody species diversity and richness. Therefore, the stakeholder's intervention had significantly affected woody species diversity in the two study sites. The reason for stakeholder intervention difference in the study sites was the accessibility problem. Because, Beyemmo (midland) study site to more accessible than Alarigeta (highland) study site for stakeholder interventation.

During this study, in the two study sites the roles of different opportunities were assessed on the diversity of woody species in homegarden (Table 9). The two study sites, household interview result showed that, different opportunities played vital role for the farmers to plant and manage woody species in the homegarden. In Beyemmo (midland) study site, there were high opportunities like road accessibility, market price, seedling access, and extension service and stakeholder interventation than in Alarigeta (highland) site. The result agreed with earlier report of (Asfaw, 2006; Abebe, 2005; Jogora, 2011). The result of these opportunities contributed to species richness in Beyemmo site but not species diversity. Whereas in Alarigeta (highland) study site low species diversity. The reason was there were none of the above mentioned opportunities in the Alarigeta (highland) site. Therefore, presence or absence of opportunities affected woody species diversity in the homegarden.

In the present study, the two agro-ecological study area households (respondent) were asked to rank the important woody species among the homegarden species which was they retain or plant on their homegarden. According to the respondent interview result the woody species richness and diversity were influenced by preference of households (Table 10). The result agreed with previous study report of Yakob *et al*. (2014). Basically, household woody species preferences were depended on its use or purpose of woody species and varied due to altitude and socio cultural factors**.** In Alarigeta (highland) study site, most householder woody species preference was mainly indigenous

multipurpose trees species which were incorporated into the homegardens, commonly nitrogen fixers or soil fertility improvement species were preferred in this study area. This result agreed with Asfaw (2003) and Yakob *et al. (*2014) studies earlier report, but in Beyemmo (midland) study area households mainly preferred cash and fruit woody species. The reason for woody species preference was depending on altitude and socio economic culture of local communities. Therefore, household woody species preference is the factor for woody species diversity and richness, in addition to the agro-ecological suitability.

5.4 Socio economic and cultural roles

In the present study, the assessment report indicated that, farmers retained and domesticated woody species in their homegarden for the reason of socioeconomic and cultural benefits (Table 10). For example, *Coffea arabica* species dominantly planted and managed in the homegarden in Beyemmo kebele, Gimbo district, because it had socioeconomic and cultural roles in the area. The result agreed with Abishkar *et al.* (2004) and Abebe (2005). It also contributed to the livelihood of communities and for household consumption, and it also increases social value with in communities. For example, strength neighbor and family relationship called social capital, and even it is culturally symbol for household respect from the local communities. The result is similar with earlier study report of Linger (2014). In the same study site, *Persea americana* had contributed for house food, cash and shade, *Millettia ferruginea* for construction and soil fertility improvement; *Eucalyptus* spp. for cash, fuel and construction; *Albizia gummifera and Cordia africana* have contributed shade, construction and cultural value etc., were dominantly planted and retained in farmers homegardens, whereas *Erythrina brucei, Vernonia auriculifera*), *Eucalyptus* spp., *Euphorbia ampliphylla, Millettia ferruginea, Bersama abyssinica* and etc woody species in also Alarigeta (High altitude) planted and retained as basic components of their homegardens structure. Because all woody species have socio economic roles for local communities by providing shade and soil fertility, wood and other products, and it supplements for household as food and income sources (Table 10).

Homegarden woody species richness and diversity varied between the two study sites and households due to socio-economic and cultural factors, particularly farm size, access to the road and market (Table 7), and different socio-cultural settings and multiple necessities. According to household and key informant information all woody species richness and diversity were connected with socio

economic and cultural benefit related preference of communities (Table 10). Basically, socio economic and cultural difference created different woody species system in the two study sites. For example, due to accessibility and host communities were intensive management and exotic woody species introduction culture shared from "*Amahara*" community in Beyemmo study as compare to Alarigeta site. Due to socio economic and cultural factors *Coffea arabica* has high relative density in Beyemmo study site.

5.5 Trends of homegarden woody species retention in homegarden

Traditionally, in the two study sites, households were domesticated or grown woody species in their garden. According to woody species assessment result, farmers growing different woody species in their homegarden based agro-ecology. For example, household interview result indicated that 76.92% and 94.23% of respondents agreed on woody species increases, in contrast 23.08% and 5.77% of respondents agreed on woody species decrease in the homegarden of Alarigeta (highland) and Beyemmo(middle land) respectively (Table 17). Similarly in the two study sites, woody species survey result showed that the household who lived closer to forest said decrease, unlikely the respondents who lived far from forests where they said increase woody species in the homegarden. The key informants also agreed on the above mentioned result. The reason was farmers who lived adjacent to forest area did not plant or manage woody species in their garden because they had opportunity to get any benefit from the forest, whereas farmers far from forest, they domesticated (planted) and managed woody species in their homegarden, because there was no other opportunities for them. Therefore, woody species growing trends were signicantly affect by the forest distance from homegarden.

6. CONCLUSION AND RECOMMENDATION

Traditionally, both midland and highland agro ecology local communities' carried out woody species domestication and management in their homegarden in the two kebeles. This is because of the fact that farmers have accumulated indigenous knowledge in managing homegarden woody species and management knowledge gained by experience and transferred one generation to next generation. Most local communities managed self raised woody species in their own homegarden, besides, in Beyemmo (midland) study site seedling obtained free from locally available sources that is self regenerated from natural wild coffee forest. In the two study area, traditional management system was thinning, composting, weeding, hoeing, pruning and protecting from animals damage are most commonly used woody species management practices in the two study area. But the management intensity and culture were differing between two study areas.

The present study also assessed that the reason for household woody species management was it's the multiple benefits and/or socio economics and cultural roles was a key factors. Because it a means of satisfying their needs for ensuring food security or home consumption and also as a means for income generation. Moreover, homegarden represents an important reservoir of diversity of woody species and have immensely contributed to in-situ conservation of woody species and provide a multiple contribution for household.

Under this present study, the altitude variation in homegarden woodyy species diversity was thoroughly assessed and indentified in the two agro-ecologies. In the present study conducted in the two specific study sites laid in different altitude ranges. Alarigeta study site (the highland) laid the altitude ranges from 2300 to 2450 m.a.s.l, whereas Beyemmo study site (midland) laid the altitude ranges from 1750 to 1900 m.a.s.l, and as result, the woody species were recorded in the homegarden 39 and 63 respectively and 25 common woody species were identified from the two study sites. The result implies that the altitude variation created the species richness difference between two agro-ecologic zones of the two kebeles.

Different opportunities like, road and town accessibility also significantly contributed for exotic species introduction and wody species diversity variation in study area household garden. Hence, the assessment result shows that 18 and 3 exotic woody species introduced and domesticated in

Beyemmo and Alarigeta study sites respectively. For example, during woody species survey exotic species like *Eucalyptus* spp., *Persea americana* (Avocado) and other exotic species were highly introducing (planted) in Bayamon (Midland), and whereas *Eucalyptus* spp. and *Cupressus lusitanica* also relately introducion in Alarigeta (Highland) were observed in two study sites. This indicated that it has a big threat for endemic or indeginous woody species diversity in the homegardens. Moreover, due to the increasing cash crop (like coffee plant) in Beyemmo (Midland) and annual crop agricultural expansion in Alarigeta (highland) was woody species diversity under threat.

Thus, homegardens provided opportunities for the growth of woody species in and around them; it is one of strategiy for climate change mitigation. Based on the results of the study the following recommendations were given:

- Encourage homegardening for woody species diversity conservation and management as well as for ecological intervention in the two kebeles.
- Awareness raising for lacal communities on the factor of the exotic woody species on the species diversity in the two study kebeles.
- Needs quantifying homegarden woody species and intebrating with payment for ecosystem service (PES) and/or payment for carbon program, because it has role in balancing carbon emission.
- Needs stakeholders' involvement and strong extension services in homegarden woody species management practices in highland area, because land is being converted to annual crop.
- Awareness raising of the local communities and training on the sustainable utilization and management of homegarden woody species.
- Prividing training for responsible local government expertise on homegarden woody species management
- Research focusing on livelihood contribution of homegarden woody species in this area.
- Needs further depth investigation on traditional or indigenous homegarden woody species management knowledge based on two agro ecological zone.

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8. APPENDICES

Appendix 1: Woody species frequency, relative frequency, relative density, relative dominance, important value index and basal area

Site(Agro-ecology)	S.N	Scientific name	Family	Local name		Life form	F	RF	RD	RDO	IVI	BA (M^2)
				Kefigna	Amharic							
Beyemmo(Midland)	1	*Acacia abyssinica*	Fabaceae	Graaro	Graro	T	5	0.9381	0.5355	2.2746	3.7481	1.0064
	2	*Albizia gummifera*	Fabaceae	Caatto	Sasa	T	33	6.1914	3.0790	11.436	20.7062	5.0598
	3	*Albizia schimperiana*	Fabaceae	Koyo		T	2	0.3752	0.2410	1.6147	2.2309	0.7144
	4	*Allophytus abyssinicus*	Sapindaceae	She'o/xupho		T	1	0.1876	0.1606	0.3331	0.6813	0.1474
	5	*Azadirchta indica*	Meliaceae	Neemo	Neem	T	1	0.1876	0.0268	0.0064	0.2208	0.0028
	6	*Bersama abyssinica*	Melianthaceae	Booqqo		T	2	0.3752	0.0803	0.0114	0.4669	0.0050
	7	*Brucea antidysenterica*	Simaroubaceae	Nuqesho		T	4	0.7505	0.1874	0.3277	1.2656	0.1450
	8	*Buddleia polystachya*	Loganiaceae	Ataaro		ST	5	0.9381	0.3213	0.2262	1.4856	0.1001
	9	*Carica papaya*	Caricaceae	Papaayo	Papaya	S	6	1.1257	0.5355	1.1965	2.8576	0.5294
	10	*Casimiroa edulis*	Rutaceae	Kazimiiro	Kazimir	S	5	0.9381	0.4284	0.2358	1.6022	0.1043
	11	*Casuarina cunninghamiana*	Casuarinaceae	Shishiwo	Shishiwe	T	4	0.7505	0.1339	0.7446	1.6289	0.3294
	12	*Catha edulis*	Celastraceae	Caato	Chat	S	10	1.8762	0.6693	0.1403	2.6858	0.0621
	13	*Celtis africana*	Ulmaceae	Uufo		T	3	0.5629	0.0803	0.5898	1.2330	0.2610
	14	*Citrus sinensis*	Rutaceae	Birtukaano	Birtukan	S	1	0.1876	0.1339	0.0579	0.3794	0.0256
	15	*Clausena anisata*	Rutaceae	Imicho	Limich	S	6	1.1257	0.1606	0.0133	1.2997	0.0059
	16	*Coffea arabica*	Rubiaceae	Bunoo	Buna	S	49	9.1932	55.689	2.2920	67.1747	1.0141
	17	*Cordia africana*	Boraginaceae	Di'o	Wanza	T	28	5.2533	2.6506	14.923	22.8265	6.6025
	18	*Croton macrostachyus*	Euphorbiaceae	Waagoo	Bisana	T	20	3.7523	1.4190	5.4015	10.5728	2.3899
	19	*Cupressus lusitanica*	Cupressaceae	Tsido	Tsid	T	7	1.3133	0.6426	0.7900	2.7459	0.3495
	20	*Dracaena steudneri*	Dracanaceae	Yuddo		ST	1	0.1876	0.0535	0.1296	0.3708	0.0573
	21	*Ehertia cymosa*	Boraginaceae	Wogaammo	Game	ST	6	1.1257	0.4819	0.3890	1.9966	0.1721
	22	*Entada abyssinica*	Fabaceae	Geello		T	3	0.5629	0.0803	0.2445	0.8876	0.1082
	23	*Erythrina abyssinica*	Fabaceae	Beroo		T	11	2.0638	0.6426	7.2001	9.9065	3.1857

24	*Erythrina brucei*	Fabaceae	Kollaco	Korch	T	9	1.6886	0.4819	0.3726	2.5431	0.1649
25	*Eucalyptus species*	Myrtaceae	Bahirzaafo	Bahirzaaf	T	22	4.1276	6.8005	4.4636	15.3917	1.9749
26	*Euphorbia candelabrum*	Euphorbiaceae	Gacho	Kulikual	T	4	0.7505	0.1874	0.7258	1.6636	0.3211
27	*Fagaropsis angolensis*	Oleaceae	Yaayo	Siglu	ST	1	0.1876	0.0268	0.0044	0.2188	0.0020
28	*Ficus exasperata*	Moraceae	Shottoppo		ST	1	0.1876	0.2410	0.2661	0.6947	0.1177
29	*Ficus lutea*	Moraceae	Meelo	Warka	T	6	1.1257	0.2142	2.0595	3.3994	0.9112
30	*Ficus Ovata*	Moraceae	Caaro	Shola	T	6	1.1257	0.3213	0.7856	2.2326	0.3476
31	*Ficus thonningi* Blume	Moraceae	Xigago		ST	5	0.9381	0.1606	0.3215	1.4202	0.1423
32	*Ficus vasta*	Moraceae	Caphero		T	4	0.7505	0.3213	2.4207	3.4924	1.0710
33	*Galiniera saxifraga*	Rubiaceae	Diido		ST	6	1.1257	0.3213	0.0128	1.4598	0.0057
34	*Grevillea robusta*	Proteaceae	Gravilla	Gravila	T	5	0.9381	0.2410	0.4254	1.6044	0.1882
35	*Jacaranda mimosifola*	Bignoniiaceae	Jacarando	Y/zaf	T	1	0.1876	0.0535	0.1287	0.3699	0.0569
36	*Leucaena leucocephala*	Fabaceae	Lucina	Lusina	ST	4	0.7505	0.3213	0.2491	1.3208	0.1102
37	*Maesa lanceolata*	Myrsinaceae	Caggo	Kelewa	ST	10	1.8762	0.7764	0.2970	2.9496	0.1314
38	*Mangifera indica*	Anacardiaceae	Mango	Mango	ST	17	3.1895	1.4726	1.0431	5.7051	0.4615
39	*Maytenus addat*	Celastraceae	Oberoo		T	6	1.1257	0.1874	0.0348	1.3479	0.0154
40	*Millettia ferruginea*	Fabaceae	Bibero	Bibira	T	37	6.9418	5.6760	9.4282	22.0460	4.1715
41	*Morus mesozygia*	Moraceae	Injoori	Enjori	ST	3	0.5629	0.2677	0.2478	1.0784	0.1097
42	*Olea welwitschii*	Oleaceae	Yahoo	Woyira	T	4	0.7505	0.1874	1.6578	2.5957	0.7335
43	*Persea americana*	Lauraceae	Avokado	Avukado	ST	37	6.9418	3.8554	8.0328	18.8300	3.5541
44	*Phoenix reclinata*	Arecaceae	Yebboo	Zembaba	ST	1	0.1876	0.0268	0.0348	0.2492	0.0154
45	*Pittosporum viridiflorum*	Pittosporaceae	Sholloo	Kefeta	ST	5	0.9381	0.1874	0.1667	1.2922	0.0738
46	*Polyscias fulua*	Araliaceae	Karesho		T	1	0.1876	0.0268	0.0513	0.2657	0.0227
47	*Premma schimperi*	Lamiaceae	Cocoo		ST	3	0.5629	0.1606	0.0309	0.7544	0.0137
48	*Prunus africana*	Rhamnaceae	Oomo	T/enchet	T	19	3.5647	0.8568	5.5869	10.0084	2.4719
49	*Prunus persica*	Rosaceae	Kooki	Koki	ST	6	1.1257	0.2410	0.0643	1.4309	0.0284
50	*Psidium guajava*	Myrtaceae	Zeitona	Zeyitona	ST	11	2.0638	0.7229	0.5749	3.3616	0.2544
51	*Rhamnus prinoides*	Rhamnaceae	Geesho	Gesho	ST	3	0.5629	0.1339	0.0158	0.7125	0.0070

	52	*Rhus natalensis* Kraw	Rubiaceae	Qammo		ST	2	0.3752	0.0803	0.1245	0.5800	0.0551
	53	*Ricinus communis*	Euphorbiaceae	Xecho	Gulo	S	9	1.6886	0.6426	0.2082	2.5394	0.0921
	54	*Sapium ellipticum*	Euphorbiaceae	Shedo		T	13	2.4390	0.4819	5.2820	8.2030	2.3370
	55	*Schefflera abyssinica*	Araliaceae	Buto	Geteme	T	2	0.3752	0.0803	0.8033	1.2589	0.3554
	56	*Schinus molle*	Anacardiaceae	Chinase mole		ST	1	0.1876	0.0268	0.0859	0.3003	0.0380
	57	*Sesbania sesban*	Fabaceae	Sasibaano	Sasbania	ST	18	3.3771	2.9719	1.2133	7.5623	0.5368
	58	*Syzigium guineense*	Myrtaceae	Yino	Dokima	T	1	0.1876	0.0803	0.0257	0.2937	0.0114
	59	*Teclea nobilis*	Rutaceae	Shengaaro		ST	1	0.1876	0.0268	0.0044	0.2188	0.0020
	60	*Trichilia madagascariense*	Moraceae	Gaboo		T	1	0.1876	0.0268	0.0675	0.2819	0.0299
	61	*Vepris dainelli*	Rutaceae	Mengirexo		ST	1	0.1876	0.0268	0.0215	0.2359	0.0095
	62	*Vernonia amygdalina*	Asteraceae	Grawoo	Girawa	ST	17	3.1895	1.5261	1.6930	6.4086	0.7491
	63	*Vernonia auriculifera*	Asteraceae	Dangireto		ST	17	3.1895	1.1245	0.3906	4.7046	0.1728
		Total					533	100	100	100	300	44.245
Alarigeta (Highland)	1	*Albizia gummifera*	Fabaceae	Caatto	Sasa	T	1	0.2571	0.0430	1.2386	1.5386	0.4196
	2	*Allophytus abyssinicus*	Sapindaceae	She'oo		T	2	0.5141	0.4301	0.0995	1.0438	0.0337
	3	*Apodytes dimidiata*	Icacaeinace	Wundifo		T	13	3.3419	2.8817	3.1149	9.3386	1.0552
	4	*Bersama abyssinica*	Melianthaceae	Booqqo		T	32	8.2262	7.0108	2.2428	17.4798	0.7597
	5	*Brucea antidysenterica*	Simaroubaceae	Nuqeshoo		T	9	2.3136	1.1183	0.3130	3.7450	0.1060
	6	*Buddleia polystachya*	Loganiaceae	Ataaro		ST	15	3.8560	2.9247	1.2189	7.9997	0.4129
	7	*Canthium oligocarpum*	Rubiaceae	Xiixi dibbo		ST	2	0.5141	0.2581	0.0000	0.7722	0.0000
	8	*Clausena anisata*	Rutaceae	Imbiricho	Limich	ST	1	0.2571	0.3871	0.0000	0.6442	0.0000
	9	*Clerodendrum myricoides*	Lamiaceae	Agiyoo		S	17	4.3702	2.5806	0.0148	6.9657	0.0050
	10	*Coffea arabica*	Rubiaceae	Bunoo	Buna	S	3	0.7712	2.7957	0.0000	3.5669	0.0000
	11	*Croton macrostachyus*	Euphorbiaceae	Waago	Bisana	T	18	4.6272	2.1505	4.5387	11.3165	1.5375
	12	*Cupressus lusitanica*	Cupressaceae	Tsido	Tsid	T	5	1.2853	1.4194	1.3459	4.0506	0.4559
	13	*Dombeya torrida*	Sterculiaceae	Shawuko		ST	22	5.6555	4.1290	3.3758	13.1604	1.1435
	14	*Ekebergia capensis*	Malliaceae	Ororoo	Somb	T	12	3.0848	2.5806	3.3993	9.0648	1.1515
	15	*Erythrina brucei*	Fabaceae	Kollacho	Korch	T	37	9.5116	10.581	27.5142	47.6064	9.3202

16	*Eucalyptus species*	Myrtaceae	Bahirzaafo	Bahirzaaf	T	21	5.3985	10.323	6.7556	22.4767	2.2884
17	*Euphorbia candelabrum*	Euphorbiaceae	Gacho	Kulikual	T	18	4.6272	5.7204	7.2412	17.5888	2.4529
18	*Ficus Ovata*	Moraceae	Caaro	Shola	T	3	0.7712	0.6452	0.5857	2.0021	0.1984
19	*Ficus vasta*	Moraceae	Caphero		T	1	0.2571	0.0860	0.1192	0.4623	0.0404
20	*Galiniera saxifraga*	Rubiaceae	Diidoo		ST	2	0.5141	0.3871	0.0000	0.9012	0.0000
21	*Hagenia abyssinica*	Rosaceae	Kooso	Koso	T	13	3.3419	2.6667	3.0291	9.0377	1.0261
22	*Ilex mitis*	Aquifoliaceae	Qetoo		ST	1	0.2571	0.0430	0.0114	0.3114	0.0038
23	*Macaranga capensis*	Euphorbiaceae	Shakero		ST	1	0.2571	0.0860	0.7272	1.0703	0.2463
24	*Maesa lanceolata*	Myrsinaceae	Caggoo	Kelewa	ST	16	4.1131	4.7312	1.3749	10.2192	0.4657
25	*Maytenus addat*	Celastraceae	Oberoo		T	4	1.0283	0.4301	1.0771	2.5355	0.3649
26	*Millettia ferruginea*	Fabaceae	Bibero/yaago	Birbira	T	27	6.9409	10.452	12.5503	29.9428	4.2513
27	*Olea welwitschii*	Oleaceae	Yahoo	Woyira	T	1	0.2571	0.0430	2.0490	2.3490	0.6941
28	*Oncoba spinosa*	Flacourtiaceae	Shuretoo		S	1	0.2571	0.2581	0.0000	0.5151	0.0000
29	*Pavetta abyssinica Fresen.*	Rubiaceae	Tushimo		S	2	0.5141	0.9462	0.0000	1.4604	0.0000
30	*Persea americana*	Lauraceae	Avocado	Avukado	ST	2	0.5141	0.3871	0.0000	0.9012	0.0000
31	*Pouteria adlolfi-friederici*	Sapotaceae	Sha'o/Kerero		T	2	0.5141	0.3871	0.0000	0.9012	0.0000
32	*Prunus africana*	Rhamnaceae	Oomo	T/ enchet	T	23	5.9126	4.3011	9.8221	20.0357	3.3271
33	*Rytigynia neglecta*	Rubiaceae	Naxaacho		ST	9	2.3136	3.0538	0.0000	5.3674	0.0000
34	*Schefflera volkensi*	Araliaceae	Komo	D/ geteme	T	2	0.5141	0.0860	1.0131	1.6133	0.3432
35	*Sesbania sesban*	Fabaceae	Sasibania/Nechi	Sasbania	S	1	0.2571	0.1290	0.0762	0.4623	0.0258
36	*Solanecio manni (hook f.)*	Asteraceae	Amitiballo		S	2	0.5141	0.1290	0.1271	0.7702	0.0430
37	*Syzigium guineense*	Myrtaceae	Yinoo	Dokima	T	1	0.2571	0.1720	0.0184	0.4475	0.0062
38	*Vernonia amygdalina*	Asteraceae	Giraawo	Girawa	ST	8	2.0566	1.1613	0.4780	3.6958	0.1619
39	*Vernonia auriculifera*	Asteraceae	Danagerito		ST	39	10.026	12.086	4.5279	26.6396	1.5338
	Total					389	100	100	100	300	33.874

Key: T, Tree; ST, Shrub-Tree; S, Shrub

Appendix 2: Common homegarden woody species in two study sites

S.N	Scientific name	Family	Local name	
			Kefigna	Amharic
1	*Albizia gummifera*	Fabaceae	Caatto	Sasa
2	*Allophytus abyssinicus*	Sapindaceae	She'o/xupho	
3	*Bersama abyssinica*	Melianthaceae	Booqqo	
4	*Brucea antidysenterica*	Simaroubaceae	Nuqesho	
5	*Buddleia polystachya*	Loganiaceae	Ataaro	
6	*Clausena anisata*	Rutaceae	Imicho	Limich
7	*Coffea arabica*	Rubiaceae	Bunoo	Buna
8	*Croton macrostachyus*	Euphorbiaceae	Waagoo	Bisana
9	*Cupressus lusitanica*	Cupressaceae	Tsido	Tsid
10	*Erythrina brucei*	Fabaceae	Kollaco	Korch
11	*Eucalyptus species*	Myrtaceae	Bahirzaafo	Bahirzaaf
12	*Euphorbia candelabrum*	Euphorbiaceae	Gacho	Kulikual
13	*Ficus Ovata*	Moraceae	Caaro	Shola
14	*Ficus vasta*	Moraceae	Caphero	
15	*Galiniera saxifraga*	Rubiaceae	Diido	
16	*Maesa lanceolata*	Myrsinaceae	Caggo	Kelewa
17	*Maytenus addat*	Celastraceae	Oberoo	
18	*Millettia ferruginea*	Fabaceae	Bibero	Bibira
19	*Olea welwitschii*	Oleaceae	Yahoo	Woyira
20	*Persea americana*	Lauraceae	Avokado	Avukado
21	*Prunus africana*	Rhamnaceae	Oomo	T/ enchet
22	*Sesbania sesban*	Fabaceae	Sasibaano	Sasbania
23	*Syzigium guineense*	Myrtaceae	Yino	Dokima
24	*Vernonia amygdalina*	Asteraceae	Grawoo	Girawa
25	*Vernonia auriculifera*	Asteraceae	Dangireto	

Appendix 3: Questionnaire Format Sheet for Interview

Date…../…. /……

Household code number_____ Name of interviewer_____ sign _____

Date of interviewee day _____ month _____ year _____

Name of supervisor _____signature _____date _____

I. Background information of household characteristics

1. Interviewee name_____ Village_____

2. Age _____year

3. Sex M_____ F_____

4. Marital status A) Single B) Married C) Divorced D) Widow

5. Level of education A). Illiterate B) Primary (grade 1-4) C). Primary (grade 5-8) D). Secondary (grade 9-12) E). Diploma F) University degree and above

6. Religion A) Orthodox B) Muslim C) protestant D) others specifies_____

7. Ethnic group A) Kaffa B) Amhara C) Oromo D) others, specify_____

8. Occupation type A) Farmer B). Village council leader C). Self employed D). Others (Specify) _____

9. What is your primary livelihood means? A) Agriculture B) daily labor work C) Trading D) off-farming activities like selling of fire wood, collecting of wild Honey, D) other ____

10. What is the total size of your cultivation land in hectare if farmer? A) <0.5 B) 0.5-1 C) 1-2 D) >2) E No

11. Wealth category: A/Rich B/Medium C/Poor

12. Family size and composition by age and sex

Age group	Male	Female	Total
1-5			

6-15			
16-29			
30-64			
>65			
Total			

II. Woody species in homegarden

1. Is there different stakeholder intervention on homegarden woody species development and management? A/ Yes B/No

If yes describe Stake holder and type of intervention.

S.N	Name of stakeholder	Type of Intervention	Remark
1	Government office		
2	University		
3	Religious institution		
4	NGO		
5	Others		

Type intervention, by providing: 1/ Development fund 2/Awareness and technical training 3/Seed 4/Seedling 5/ Experience sharing visit 6. Management Material 7.Others

2. Have you ever plant woody species on your homegarden? Yes…….. No……

a) If yes, indicate the species name, the preference with its rank?

Species type	Ranking score and use diversity	
	Reasons for preference	Rank

Reasons for preference: r1=firewood; r2= construction; r3= sale; r4=fruits; r5= medicine; r6=farm implements; r7=shade; r8= bee keeping; r9= soil fertility improvement; r10=fodder; r11= amenity; r12=lumber; r13 = fumigation;r14 =washing household materials ;r15=charcoal; r16 =others/specify/

3. Where do you get the seedlings? Self raised ------- Self regenerate -------- Wildling ------

ARDO nursery ------- Others----------

4. What type of management practices do you use for homegarden woody species?

No	Types of Woody Species	Management	Reason

Key for management: 1=Thinning, 2= Pruning, 3= Composting, 4=, Weeding 5= irrigating,

6= hoeing, 7= Others

Key for reason: 1= for growth, 2= To reduce competition, 3= To reduce shade, 4= For fuel wood, 5= For fodder, 6= Others ……

5. What problems did you encounter in managing woody species and how did you solve them?

No	Species	Problem	Solution

Key for problems: 1- Animal, 2- Insect-pest, 3- Disease, 4- Thieves, 5- Others

Key for solutions: 1- Fence, 2- Insecticides, 3- Guarding, 4- Others

6. For what purpose do you need woody species in your homegarden most?

No	**Woody species**	**Purposes**										
		1	2	3	4	5	6	7	8	9	10	11

Key for purposes: 1- Fuel 2- Construction 3- Household tools 4- Fodders 5- Shade 6- Fencing 7- Soil fertility 8- Fruit 9- Timber 10- cultural value 11-Other

7. How do you describe the tree-growing practices in homegarden the last ten years?

1. Yes--2. No---

Increase		Decreases	
Species	Reason	Species	Reason

Key: **Reasons for increase:** r1= increased market value; r2= increased fuel wood demand; r3=increased fodder demand; r4=Decreased market value; r5=decreased demand for construction wood; r6=increased demand for Lumber; r7= increased demand for handles of tools; 8=other /specify/

Reasons for decrease: d1= increased market value; d2= increased fuel wood demand d3=increased fodder demand; d4=Decreased market value; d5=decreased demand for construction wood; d6=increased demand for Lumber; d7= increased demand for handles of tools; 8=other /specify

8. If trees on your homegarden are used to improve soil fertility, indicate the species and parts of the tree used?

Tree species name	Tree part	Criteria	Rank *

Key: Trees in order of importance to soil fertility improvement

Tree part Code: t1= root; t2=bark; t3= leaves; t4= new shoot; t5=flower; t6=pod/fruits

Criteria to use tree species to soil fertility improvement Code: f1=fast Decomposition; f2=competition; f3=Deciduous; f4=Vigorous Growth; f5=availability of soil animals; f6= other /specif

9. Who take tree management practices at household level?

Preferred tree species	Niche	Management practice	Who manages/division of labor/	Who makes decision	Reasons for managing

Key: Who manages: w1=Men; w2=Women; w3=Boys; w4=Girls; w5=men and women; w6=other /specify

Who makes decision: d1=men; d2=women; d3=both

10. What are good opportunities in your managing woody species practices?

Woody Species	Opportunities	Rank

Key: **Opportunities:** o1= market; o2=price; o3=water harvesting; o4= seedlings; o5=credi

12. Could you describe species that contribute to increase yield in homegarden?

woody species	Type of Crop	Tree part used for	Reasons	Rank

Key: Reasons: r1= light shade; r2=high biomass; r3=late decomposing; r4=early decomposing; r5=combination (1,2,4); r6= Other/specify

Tree part: p1= root; p2= flower; p3= leaves; p4=fruits/pods/; p 5=stem; p6= other/specify

Appendix 4: Key Informant Interview Guide Lines

I. Background information of key informant

1. Interviewee name_____ Village_____
2. Age _____year
3. Sex M_____ F_____
4. Marital status A) Single B) Married C) Divorced D) Widow
5. Level of education A). Illiterate B) Primary (grade 1-4) C). Primary (grade 5-8) D). Secondary (grade 9-12) E). Diploma F) University degree and above
6. Religion A) Orthodox B) Muslim C) protestant D) others specifies_____

7. Ethnic group A) Kaffa B) Amhara C) Oromo D) others, specify_____

8. Occupation type A) Farmer B). Village council leader C). Self employed D). Employed either in NGO or government institutions. E) Others (Specify) _____

9. What is your primary livelihood means? A) Agriculture B) daily labor work C) Trading

D) off-farming activities like selling of fire wood, collecting of wild honey, D) other ___

II Guideline questioners for key informant

1. What are the benefits of homegarden woody species?
2. What was the main reason for woody species diversity and domestication in homegarden?
3. What trend was observing in homegarden woody species production in the study area?
4 What are the government and non government intervention in homegarden woody species production?
5. What are the main constraints for woody species production?
6. Which woody species have high market demand?
7. What are the great challenges of natural resources degradation in your kebele?
8. What types of intervention needs to sustain the homegarden woody species and benefits from it?
9. What is the homegarden woody species management knowledge between eldest and youngest?

Appendix 5: Woody species data collection format sheet

Woreda_____ Kebele_____ Name village_____

Name of HH _____ Land size:_____

Wealth category:_____ Distance from Forest:_____

Distance from road:_____ Distance From town:_____

Name of recorder _____ Date_____ Plot No_____

Plot size_____m^2

GPS coordinate (x/y) _____, _____ Altitude_____ Slope_____

No	Code no. plant	Tree species			DBH (cm)	Height (m)	Species layer	Remark
		local name(1)	local name(2)	scientific name				
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								

Appendix 6: Household background information in two study result

Household information		Alari-geta		Beyemmo	
	Class	Sum	%	Sum	%
Age	20-30	11	21.15	7	13.46
	31-40	15	28.85	10	19.23
	41-50	9	17.31	11	21.15
	51-60	6	11.54	16	30.77
	61-70	8	15.38	5	9.62
	Above 70 y/r	3	5.77	3	5.77
	Sum	52	100	52	100
Sex	Male	52	100	46	88.46
	Female	0	0	6	11.54
	Sum	52	100	52	100
Marital status	Single	0	0	0	0
	Married	52	100	47	90.38
	Divorce	0	0	0	0
	Widon	0	0	5	9.62
	Sum	52	100	52	100
Religion	Orthodox	52	100	52	100
	Muslim	0	0	0	0
	Protestant	0	0	0	0
	Others	0	0	0	0
	Sum	52	100	52	100
Ethnic group	Kafecho	51	98.08	44	84.62
	Amhara	0	0	8	15.38
	Oromo	1	1.92	0	0
	Others	0	0	0	0
	Sum	51	100	52	100
Education status	Ill	23	44.23	29.00	55.77

	1 to 4	9	17.31	10.00	19.23
	5 to 8	16	30.77	12.00	23.08
	9 to 12	4	7.69	1.00	1.92
	Sum	52	100.00	52.00	100.00
Land size	<0.5	3	5.77	2.00	3.85
	0.5-1.00	17	32.69	8.00	15.38
	1.00 - 2.00	4	7.69	14.00	26.92
	> 2ha	28	53.85	28.00	53.85
	Sum	52	100.00	52.00	100.00
Wealth category	Rich	17	32.69	18.00	34.62
	Medium	21	40.38	17.00	32.69
	Poor	14	26.92	17.00	32.69
	Sum	52	100.00	52.00	100.00