WOODY SPECIES DIVERSITY AND TRADITIONAL MANAGEMENT PRACTICES OF ON-FARM TREES IN GOMBORA WOREDA, HADIYA ZONE, SNNPR, ETHIOPIA

M.Sc. THESIS

BY

TAMIRAT EGISO

JUNE, 2016

JIMMA, ETHIOPIA

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Submitted to the School of Graduate Studies, Jimma University, College of Agriculture and Veterinary Medicine Department of Natural Resource Management in Partial Fulfillment of the Requirements for the Degree of Master of Science (MSc.) in forest and nature conservation.

June, 2016

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THESIS SUBMISSION FOR EXTERNAL DEFENSE APPROVAL SHEET

JIMMA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

Name of Student: Tamirat Egiso Funduse ID No.MSc06014/06

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Title: Woody Species Diversity and Traditional Management Practices of On-Farm Trees In Gombora Woreda, Hadiya Zone, SNNPR, Ethiopia

I have incorporated the suggestions and modifications given during the internal Thesis defense and got the approval of my advisors. Hence, I hereby kindly request the Department to allow me to submit my Thesis for external Thesis defense.

Tamirat Egiso _____

Name and signature of student

We, the Thesis advisors have verified that the student has incorporated the suggestions and modifications given during the internal Thesis defense and the Thesis is ready to be submitted. Hence, we recommend the Thesis to be submitted for external defense.

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Signature Date

Decision/suggestion of Department Graduate Council (DGC)

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Chairperson, DGC Signature Date

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Chairperson, CGS Signature Date

DEDICATION

To my father Egiso Funduse and mother Tsehaynesh Eyob for their all-rounded and unconditional support in my life.

STATEMENT OF AUTHOR

First, I declare that this thesis is my own work and that all sources of materials used for the thesis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirements for M.Sc. degree at Jimma University, College of Agriculture and Veterinary Medicine and is deposited at the University library to be made available to users under rules of the library. I solemnly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate. Brief quotations from this thesis are allowed without special permission provided that accurate Acknowledgment of sources is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the Department of Natural Resource Management or the Dean of the School of Graduate Studies when in his or her judgment the proposed use of the material is in the interests of scholarship. In all other instances, however, permission must be obtained from the author.

Name: Tamirat Egiso
Place: Jimma University

Date of Submission: ----------

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BIOGRAPHICAL SKETCH

The Author, Tamirat Egiso, was born on 5th of November 1987 in Soro Woreda of Hadiya Zone, Southern Ethiopia. He attended his junior elementary school at Wachamo Junior and Secondary School (1996 to 2003), and his secondary school at Wachamo comprehensive secondary school from 2004 to 2007. He joined Wolaita Sodo University in 2008 and studied Geography and Environmental and awarded B.Ed. in Geography and Environmental in 2010. After graduation, he was employed in Bureau of Security and administration in Gombora Woreda of Hadiya Zone and he worked there until he joined the School of Graduate Studies at Jimma University, College of Agriculture and Veterinary Medicine in September 2014 to pursue his M.Sc. degree in Natural Resource Management specialization in Forest and Nature conservation.

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LIST OF ACRONYMS

CSA	Central Statistics Agency
DA	Development Agents
DBH	Diameter at Breast Height
EFAP	Ethiopian Forestry Action Plan
FAO	Food and Agricultural Organization
GW	Gombora Woreda
GWARDO	Gombora Woreda Agriculture and Rural Development Office
GWFEDO	Gombora Woreda Finance and Economy Development Office
HH	Household
IVI	Importance Value Index
KI	Key Informant
SNNPR	Southern Nations Nationalities and Peoples Region State
SPSS	Statistical Package for Social Sciences

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ABSTRACT

Woody species conservation is an issue of scientific, economic, ecological and political concern at global level. Farmland plays significant role in the woody species conservation. The study was conducted to investigate traditional woody species management practices on farmland in Gombora Woreda, Hadiya Zone, Southern Nations, Nationalities and Peoples Regional State, Ethiopia. Simple random sampling method was used to select representative kebeles in the woreda. Eight kebeles, a total of 24 key informants (KI) (3 from each) and a total of 134 households were selected for study and interview. A line transect was used to collect woody species data from a total of 80 plots with an area of 40m × 40 m which were laid at 300 m intervals on farmland. The result shows that a total of 32 woody species belonging to 22 plant families were identified and recorded. The Shannon diversity index and evenness of woody species on farmland were 2.70 and 0.42 respectively. The average basal area of woody species on farmland in study sites was 2.71 m^2. The important value index of individual woody species on farmland was assessed and Croton macrostachyus was ranked first with mean IVI of 70.99. In the study area, woody species that are preferred by farmers those species that have a value for fuel wood, timber, shade, construction. The most preferred tree species was Cordia africana (39.09%) followed by Croton macrostachyus (26.15%). The management practices employed includes coppicing, pollarding, Lopping and thinning. The socioeconomic factors like farm size, educational background, and wealth status had significant influence ($P < 0.05$) on the management of woody species diversity on farmland across the study sites. Therefore, based on this study it can be concluded that farmers have traditional management practices to wood species on their farmland but this practice has not been supported well by extension to solve the problem.

Key words: Woody Species, Preference, Management Practice, Wealth Status, Farmland

1. INTRODUCTION

1.1 Background Information

Woody species conservation is an issue of scientific, economic, ecological and political concern at global level primarily because of an increase in extinction rates caused by human activities (Ehrlich and Wilson, 1991). The conservation practices that exist include protection against damage, pruning, and raising tree species in crop fields, courtyard, homegarden (Okiror *et al*., 2012). Effective conservation of tree species needs local participation especially in decision making and it should focus on resources that are important to local economies (Rodrigo *et al*., 2007). This is because most woody species are found on private land owned by local farmers and have a key role in decision making as far as harvesting is concerned (NEMA, 2002; Dalle and Potvin, 2004). Woody species provide products such as fuelwood, timber, medicines and food that millions of people in developing countries depend on (Belcher and Schreckenberg, 2007).

Woody species also provides important environmental and cultural services, including the provision of shade to crops and people, soil improvement, erosion control and heritage values (Rönnbäck *et al*., 2007; Varghese and Ticktin, 2008). Despite the existing of those advantages, many woody species are threatened and declining (Martin *et al*., 2009). As result, there is a need to conserve the diversity of trees species as well as other plant species in natural ecosystem (Mishra, 1998). When the natural forests are in the verge of extinction, farmland plays significant role in the tree species conservation (Wickramasinghe, 1995). The main goal for woody species conservation is biodiversity protection (FAO, 2009).

Diversifying the composition of farmland tree species also enhances the stability and productivity of agro-ecosystems (Kindt and Coe, 2005) and combines the objectives of attaining gains in food security and in conservation of biodiversity (Atta-Krah *et al.*, 2004; Garrity, 2004). The diversification of trees in farmland could therefore result in improved woody species conservation, although the links between development and conservation goals need to be explored carefully (Kindt *et al*., 2005; Zewuge 2004).

Woody species in farmland also provide basic food products and variety of other products including traditional medicines, fodder, spices, gums, resins, fuel wood, construction wood and wood for making farm implements for a large number of people, in rural area (Zewuge 2004). An increase in the quality, number and diversity of woody species in farmland that provide a wide range of benefits enhance the capacity of the system to fulfil its ultimate potential, as a means of alleviating poverty (Cooper *et al.*, 1996).

The traditional conservation practices in highland areas of Ethiopia, have contribute to the conservation of forest genetic resources for centuries. Conservationists have focused their attention on the protection of natural forests (Schelas and Greenberg, 1996). But they have not given much attention to the dispersed tree species on farmland. Woody species diversity management can constitute a central part of the livelihood management strategies of farmers in different production systems (Rege *et al*., 2003).

Physical and socio-economic factors influence farm level woody species diversity (Zebene Asfaw and Hulten, 2003; Kindt *et al.*, 2004; Tesfaye Abebe, 2005). Altitude and temperature are important ecological factors that influence the diversity of woody species (Krebs, 1985). Moreover, socio-economic factors such as farm size, wealth status of the household, proximity to natural forest, access to a market, and availability of labour also determine the diversity of woody species (Kindt *et al.*, 2004).

In order to manage woody species in farmland for both conservation and production goals, it is important to understand the existing patterns of woody species, how farmers manage woody species within their farmland, and the roles that woody species play within production systems. Further more, understanding the roles of trees on farmland and diversification of the farmland in terms of species richness, as well as evenness through an increase in number of trees of rare species, or through replacement of more common species are the best options for preventing degradation of agroforest ecosystems on farmlands (Kindt *et al.*, 2005).

Some studies were reported on the Wood Production and Management of Woody Species in Homegardens Agroforestry in Gimbo District, South West Ethiopia (Yakob *et al.*,2014).

However, there is limited studies have been conducted on traditional woody species management practices, Woody species inventory and traditional management practices on farmland in Hadiya Zone Gombora Wareda. Therefore, this study aims to indicate the gaps which facter influence woody species diversity and to point out the potential role of farmland woody species. The investigation is crucial to provide baseline information on the woody species diversity and type of management practices of woody species on farmland in the Woreda.

1.2. Objectives of the Study

1.2.1. General objective

The General objective of this study is;

- To investigate Woody Species Diversity and Traditional Management Practices On-Farmland

1.2.2. Specific objectives

The Specific objectives of this study were;

- To assess woody species diversity on farmland in the study area
- To assess farmers' woody species management practices and their preference on farmland in the study area
- To identify factors that affects the woody species diversity on farmland in the study area

1.2.3. Research question

- What is the current status of woody species found on farmland?
- Which management practices farmers use to manage woody species and preference on their farmland?
- What are the factors that affect woody species diversity on farmland?

2. LITERATURE REVIEW

2.1 Woody Species on Farmland

In order to manage the woody species diversity in farmland for both conservation and production goals, it is important to understand the existing patterns of tree cover, how farmers manage the trees within their farmland and the roles that trees play within production systems (Kindt, *et al.*, 2005).

Woody species can be found in agricultural land in various forms of spatial and temporal arrangements. For instance, trees that contribute positively to agricultural crops are grown dispersed in crop fields while trees that compete with crops are planted separately in block arrangements. One of the features of on farmland tree management is that the biological characteristics of trees are often taken into account to determine where it should be grown (Tesfaye, 2005). Trees are planted on farms in different niches (Nair, 1993). Depending on the type of ecological settings, trees will be arranged in different patterns. For example, (Arnold and Dewees, 1995) have identified the following five different patterns of planted trees on farmland.

Trees planted on non-arable: This type of lower intensity management of naturally regenerated trees is likely to occur in more extensive farming and grazing system.

Trees grown in homestead areas: This type tree planting emerges when there is still plentiful tree cover to introduce fruit and other valuable species. Where protection against livestock or burning is still difficult, the homestead area can be the only niche where trees can be grown.

Tree growing along boundaries: Found where trees need to be separated from crops in areas of intensive land use, or where trees are the dominant means of boundary demarcation, where lines of trees serve a protective purpose (*e.g.* windbreaks and counter planting).

Intercropping on arable land: Such kind of arrangement generally takes the form of scattered trees, as part of sometimes complex agricultural crop production. This type of arrangement occurs where trees provide benefits to agricultural crops through shade, shelter or soil

improvement, or intercropping is mutually beneficial to both trees and crops because of shared water, soil nutrient and light resources. In its highly developed forms, as in multi-storied multiple species homegardens, tree/crop mixtures can represent an important component of the overall farm system. Homegardens represent land use systems involving deliberate management of multipurpose trees and shrubs in an intimate association with annual and perennial crops, and invariably, livestock within the compounds of individual houses (Fernandes, and Nair, 1986). Food production is the predominant role of most homegardens. A predominance of fruit trees and other food-producing trees is a conspicuous character of components of the homegardens. Traditional homegardening is a sustainable farming agricultural practice; it is environmentally friendly and also allows the cropping of diverse products to the satisfaction of farming families as well as urban dwellers (Zemede and Ayele, 1995).

In the tropics, conservationists have focused their attention on the protection of natural forests and until recently (Schelas and Greenberg, 1996) have not given much attention to the widely dispersed on farmland woody species. Woody species are often critical components of a farmers' environment being a source of products and environmental services to the farmers' livelihood and welfare. It has been recognized that the part played by the woody species in these landscapes play an important role in maintaining biological diversity (Schelas and Greenberg, 1996; Nikiema, 2005).

The integration of woody species into crop fields, has been proposed as one way of diversifying agro-ecosystems in a way that is beneficial to the environment and can maintain and perhaps enhance biodiversity (Sanchez *et al*, 1997). They could provide replacement of soil fertility and could also provide marketable forest products. The relevant services of woody species are those that increase the crop yields (nitrogen fixation, increased soil organic matter content, nutrient cycling, soil conservation, etc.), create environmental resilience (niche diversification, food-web complexity, reduced greenhouse emissions through carbon sequestration, etc.) and provide social benefits (Mugendi *et al.*, 2007).

Remnant woody species in crop fields may play an important role in conserving biodiversity within agricultural systems because they provide habitats and resources that are otherwise

absent from agricultural landscapes (Harvey and Haber, 1998). They also serve as critical nesting, feeding, and roosting sites for a variety of bird and bat species. They also provide transient habitats for many migratory birds. The presence of woody species in crop fields also favours the survival of native forest plants. In addition, on-farm trees often serve as a source of propagate for forest regeneration both because they produce seed locally, and because the birds that visit their canopies regurgitate or defecate seeds of forest plants while perched in the trees. As a result, the seed rain beneath on farmland trees is significantly higher than in open areas (Harvey and Haber, 1998).

2.2 Use of Farmland Woody Species

According to Nair (1990), there is now more than enough evidence to indicate that trees and shrubs on farmland, if managed properly, can make significant contribution in improving the livelihood of smallholder farmers. Farmers do have several reasons for growing trees on their farmlands. Farmland trees could be a viable resource to supplement the income of small and landless farmers. Trees provide firewood, which is the energy source in most developing countries. Furthermore, trees provide wood for various local uses, such as housing construction, fencing, furniture, etc. Trees are also left on farms for the multiple benefits they provide, *e.g.* to increase the total yield of mixed products, to diversify the range of products and to increase crop production. They often combine two or more of these objectives (Rocheleau *et al*., 1988). Diversification of products from trees may provide some insurance against uncertainties in market reliability for other products (Bayush, 1997).

The presence of farmland woody species diversity that serves different socio-economic and ecological functions could contribute to the sustainability of agricultural systems (Tesfaye, 2005). At the same time, the diversification of farmland trees provides biological assets for maximizing of farmland resources, thus lowering the cost of production. Trees on farmland, in the form of agroforestry, are uniquely suited to provide eco-agricultural solutions that successfully combine the objectives of increased food security and conservation gains, especially by promoting the greater use of native tree species (Atta-Krah *et al*., 2004).

Diversifying the composition of farmland tree species also enhances the stability and productivity of agro-ecosystems (Kindt and Coe, 2005) and combines the objectives of

attaining gains in food security and in conservation of biodiversity (Atta-Krah *et al.*, 2004; Garrity, 2004). For example, trees on farmland can reduce the exploitation of protected areas, increase biodiversity within working landscapes and the diversity of trees in farming systems, or all of them (Garrity, 2004).

Woody species in farmland provide basic food products and variety of other products including traditional medicines, fodder, spices, gums, resins, fuel wood, construction wood and wood for making farm implements for a large number of people, in sub-Saharan Africa (Zewuge, 2004).

The most direct connection between woody species on farmland and food security is the food items produced by trees. Fruits, nuts, leaves, roots and gums are just a few of the huge array of edible foods that are obtained from trees and shrubs, either growing naturally in the wild or cultivated on-farms and around the home. Woody species on farmland can have an important indirect influence on food production. By maintaining and improving soil fertility, trees grown on farmland can help sustain yields. Topsoil beneath canopies of *Cordia africana* and *Millettia ferruginea* in relation to open fields had higher pH, higher exchangeable base, increased total nitrogen, organic carbon and available phosphorus (Zebene and Hulten, 2003). As a result, higher productivity of crops was reported under relics of trees in crop fields (e. g. *Acacia albida*) as compared to open areas (Desta and Feyissa, 1994).

The socio-economic links between farmland trees and food security are those, which link the products and services of farmland woody species to the people who depend on them. From the point of view of individual households, farmland trees may affect their food security in several ways. Foods obtained from trees and forests make an important direct contribution to family foods, providing a tasty and nutritious supplement to otherwise bland staple foods. Although the quantities involved may be small, their nutritional contribution is critical, especially at certain times of the year, and during droughts or other emergency periods when cultivated foods are not available (FAO, 1998).

2.3 Woody Species Preference and Management on Farmland

2.3.1 Woody species Management

Diversifying the composition of farmland woody species also enhances the stability and productivity of agro-ecosystems (Kindt and Coe, 2005). Based on traditional and technical knowledge (Wojtkowski, 1998), there are known five basic management practices or harvesting methods for biomass, firewood, forage, poles, etc. which are defined as follows:

Coppicing

When a woody perennial is cut close to ground level and will sprout a multitude of new shoots. In addition, it is the process of cutting trees down, allowing the stumps to regenerate for a number of years and then harvesting the resulting stems. It involves cutting down the whole tree leaving a stump 10 – 30 cm above ground level. The cut should be angled so that re-growth of new shoots can take place. Preferably, this method should be used only on small trees and shrubs (Wojtkowski, 1998). This is useful for forage or biomass production.

Pollarding

It is similar to coppicing except that the main stem is cut about 2m above the ground. It is a method of encouraging lateral branches by cutting off the whole crown of the tree two meters or so above ground level. Involves cutting the whole of the tree's crown so as to encourage regeneration and the method applies to trees that can be easily climbed. It has also multiple uses of trees located on farmland or in pastures. Really, one of the main uses of pollarded trees was to provide grazing for domestic animals and, at the same time, pollarded stands constantly supplied stove wood for domestic consumption or wood for carving which, however, required a longer pruning cycle. For forage production, trees were cut back to allow them to produce new sprouts, which were then cut, and the foliage and bark stripped by animals. The woody remains were used as firewood and it encourages quick regeneration and still allows the branches to be used for various purposes (Ferrini, 2006).

Lopping

It is where the outer parts of the branches are cut. The primary use is to stimulate fruit production but, by controlling the canopy spread, lopping can also be used to regulate light reaching understory crops (Wojtkowski, 1998).

Branch pruning

This technique is unique to agroforestry. Selected branches are removed, either some of main branches from the stem and/or where the main branches are pruned. This management technique is performed to improve the growth rate or health of the remaining trees and pruning of indigenous species retain in crop fields is mean for; reducing the effect on crops, getting fodder for animals, and collecting wood to be used for fencing, constructing houses, firewood and also for sales (Motuma *et al*., 2008).

2.3.2 Woody species preference

The choice of tree species depends on the benefit that can be drawn from keeping the tree on a farm. The importance of trees in addressing the production and service function issues has been well understood by farmers through the centuries and has been clearly demonstrated in traditional tree-based agricultural farming and land-use systems, such as shifting cultivation in the humid tropics and grazing in the semi-arid savanna areas (Garrity *et al*., 2006). Well adapted trees have the potential to rehabilitate degraded lands and ecosystems, restructure the landscape, provide a range of benefits and products (wood and non-wood products for food and medicines), and render environmental and socio-economic services.

The presence of trees in part of contemporary farming systems has its origins in two attributes. One is their role in sustaining crop production and their impact on the physical environment, most notably through the restoration of soil nutrients, protection against wind and water. The other is the role that various tree products play in the household economy. This includes products used directly by the rural households, such as food, fuel, construction materials, *etc*.; inputs to agricultural implements and storage structures; and products or activities that provide household members with employment and income (Arnold and Dewees, 1999).

Tree and shrub species are likely to be managed for fodder on farmland. In subsistence agriculture on hill-slopes, there exists a complementary relationship among trees, crops and livestock, where trees and crops provide fodder (Neupane and Thapa, 2001). However, in many developing countries, sustained and high population growth rates, combined with limited and rapidly diminishing land for forage production, have created a need to intensify agricultural production in order to bridge the gap between requirement and supply of food and ensure proper human nutrition (Smith, 1992).

2.4 Factors Influencing Woody Species Diversity on Farmland

Farmers' efforts with regard to tree-species diversification and conservation on their farmlands are influenced by a number of socio-economic, biophysical environmental conditions, and by institutional and extension inputs (Zebene and Hulten, 2003; Tesfaye, 2005). For example, the traditional agroforestry systems of southern Ethiopia have been considered as a sustainable farming system during recent centuries, mainly owing to the diversification of products and services from diverse trees and other agricultural crops (Bayush, 1997). However, in recent years, the growing population has increased pressure on such traditional agroforestry systems, threatening their sustainability (Zebene and Hulten, 2003). Following are the major factors that influence on-farm tree species diversity and composition.

Wealth status

Wealth is one factor of interest that influences tree-species diversity on farmlands. Lack of capital may hinder a farmer from obtaining a preferred species or a large number of seedlings, although it does not prevent him from planting trees (Warner, 1993). A study by Tesfaye (2005) has indicated that wealth status in itself does not influence tree-species diversity. However, if the wealth status of farmers is highly correlated with farm size, the variation among different wealth groups is explained by farm size. Wealth could also make difference in the utilization of different tree species for various purposes.

Some households do not use a species for a particular product or service, although it is present on their farm and other farmers use it for that particular purpose. For example, richer households had fewer medicinal species, according to the survey conducted by (Kindt *et al*.

,2004) in Kenya, which could indicate that the richer households opt to purchase medicine from off-farm sources, and are not interested in having medicinal trees on their farms.

Farm size

Farm size is perhaps the most critical factor that limits tree-species richness and diversity on farmlands (Zebene, 2003; Tesfaye, 2005). There must be sufficient land available to make tree-growing possible, to cover the expense of tree-planting. In a study conducted by Muktar (2006), in the highlands of southern Ethiopia, the most widespread constraint to both the retention and addition of trees was probably that of the increasing competition for land under the pressure of an expanding population on a limited land base. Although the high population growth rate is increasing pressure on the relatively small amount of arable land, a decline in farm size does not necessarily mean a decline in tree-planting (Arnold and Dewees, 1995). A study from Kenya by Scherr (1995) indicated that the predominant reasons why farmers have been increasing the number and land area occupied by trees under conditions of increasing population and land scarcity, appear to have been to obtain critical consumption goods, to diversify their source of cash income, and to protect food security in the face of declining crop yield. On the other hand (Omati *et al*., 1999) indicated small farm size as the main hindrance to tree-planting and increasing of species diversity under central Ethiopian conditions.

Higher species-richness and abundance of trees per unit area of farms offer greater opportunities for tree-species conservation through their use in the farmland (Kindt and Lengkeek, 1999). Thus, the size of the landholding has an important influence on the choice of tree species and their diversity, arrangement and density, as well as on the overall management (Zebene, 2003). According to Tesfaye (2005), farm size is an important element in influencing the diversity and composition of trees species, but the density of persons per farm (number of inhabitant per ha of farmland) should also be considered since it indicates the magnitude of the pressure on land.

Free grazing

Livestock grazing is known as one of the major factors that influences management practice of woody species on farmland, throughout the world and it occupies 25% of the global land surface (Asner *et al*., 2004). Also multiple other physical and biological factors at various spatial and temporal scales of influencing woody species balance (Asner *et al*., 2004). Because of free grazing all trees seedlings that emerge in grazing, farming and communal lands are either grazed on and uprooted, or will be trampled on and die. Grazing animals can cause wide damage to trees, both young and old. Seedlings are removed and mature trees chewed, bunted and rubbed against by goats, sheep and cattle. Horses are particularly destructive animals and can ring bark a mature tree overnight or even completely remove it in a matter of days (Asner *et al*., 2004).

Lack of capital

As reported by Imo *et al*. (2001) one of the woody species management problem to nursery were lack of capital for the purchase of potting materials, tools and equipment (mainly watering cans, wheelbarrows and spades), pests and diseases, and livestock damage. The other problem was associated with seed procurement of certain species, mainly *Grevillea robusta, Hakea saligna, Olea africana* and *Terminalia mentalis*. Several studies have reported the influence of lack of capital on the tree density and tree species-richness on farmlands (Zebene, 2003; Tesfaye, 2005). There can also be more fundamental economic pressures that prevent or discourage farmers from managing trees into their agricultural practices.

Drought

Drought is defined as the absence of rainfall for a period of time long enough to result in depletion of soil water and injury to woody species. The drought stress is a very important limiting factor during early seedling growth and establishment (Jaleel *et al.,* 2009). It affects both elongation and expansion growth of woody species on farmland (Shao *et al.,* 2008). It indicates that water-deficit stress reduced the growth of woody species by restricting leaf formation. Furthermore, the effect of drought stress indicating that shoot growth is more sensitive to water availability than root growth (Ashraf and Foolad, 2007). Since drought is a

reoccurring phenomenon in these landscapes, management strategies aimed at facilitating regeneration of mature trees/shrub must include the influence of these decadal scale disturbances on the composition and structure of series woody species communities in tropical highland landscapes and its suppression has been implicated as a potential cause of reduced woody species regeneration (Johnson *et al.*, 2002).

3. MATERIALS AND METHODS

3.1 Study Area Description

Location

The study was conducted in Gombora Woreda, Hadiya Zone, Southern Nations, Nationalities and Peoples Regional State (SNNPRS) of Ethiopia. Gombora Woreda is located about 259 km south of Addis Ababa and 27km away from Hossana, the capital of Hadiya Zone and it is one of the 11Woredas of Hadiya Zone. It is geographically located between 7^0 49′, 7^0 70 N latitude and 37^0 45′, 37^0 77’ E longitudes (Figure 1). Gombora woreda is bordered in the North by Gibe woreda, in the North East by the Misha woreda, and on the South Soro woreda, in the East by the lemo woreda, and in the West by Omo River Yam special woreda and Oromiya National Regional States. This woreda has 23 rural Kebeles and 1 urban Kebeles. The administrative center of this Woreda is Habicho; other towns in Gombora Woreda include Bushana (GWFEDO, 2009).

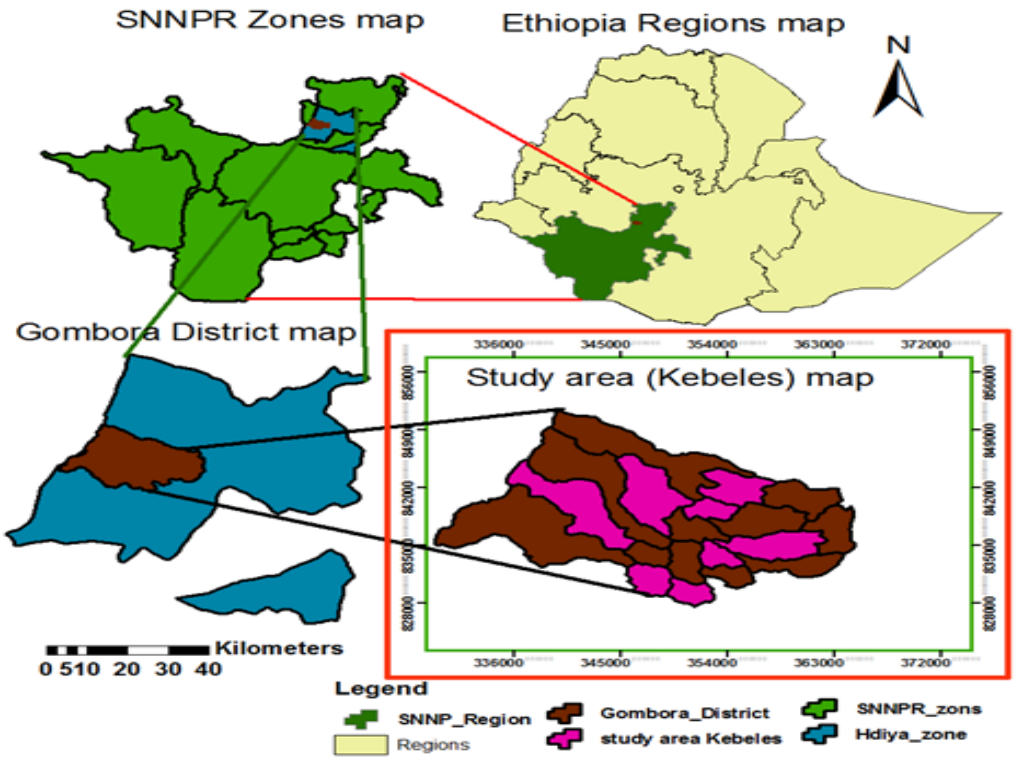

Figure 1: Location map of study area

Topography

Topographic features of the Gombora Woreda were mostly by flat and moderately gentle lands. This Woreda is characterized mostly by lowland altitude site (1600-2000m.a.s.l) 46.5%, and middle altitude site (2000-2400.m.a.s.l) 53.5% (GWFEDO, 2009).

Climate

Gombora Woreda has two agro-ecological Zones, namely *Kolla* (low land and warm) 46.5% and *woina-dega* (moderate) 53.5%. These agro-ecological zones differ in altitude and in rainfall distribution. The rainfall distribution is bimodal type, which occurs in two main rainy seasons *Belg* and *Maher*. *Belg* is a short rainy season from occurs from beginning January to April and that of *Maher* occurs long rainy season that May to the end September. The mean minimum and maximum annual precipitation varies between 500 - 2200mm. The mean minimum and maximum temperature are 15 - 25°C (GWFEDO, 2009).

Vegetation

Formerly, the woreda was covered by dense natural forests, but the distribution of natural forest is declining from time to time, due to human interference. Currently forest coverage of the woreda is only 10% of the total land area (GWARDO, 2009). Currently the common trees in the study area include *cordia africana, Croton macrostachyus, ficus sur, Podocar pusfalcatus, prunus africana, juniperus procera, Erythrina abyssinica* and *Millettia ferruginea* which are found as scattered in most farmland.

Soil

The soil is pale in color, generally coarse textured and freely drained. Most of the soils have low bulk density and weak structure, which render them vulnerable to erosion. Generally, Woreda has been identified by three types of soil, comprising of Red 20%, Brown 48% and Black 32%. The common soil types are Vertisol, Camisole, and Rigosol. The dominant soil type of the area is Vertisol (GWARDO, 2009).

Population

The demographic characteristics of the study area can be described as follows: Gombora Woreda has 23 Kebeles (KAs) with a total population of 92,332; with 46,225 males and 46,107 females (CSA, 2007). The population density of Gombora Woreda is 270 persons per square kilometer (GWARDO, 2009).

Economic Activities

The livelihood of the people in the Woreda depends mainly on mixed agriculture (crop-livestock production). It is characterized by mixed farming of rain-fed crops and livestock production associated with tree species on farmland. The most commonly cultivated crops in the study sites include enset (*Ensete venrtricosum*), teff (*Eragrostis tef*), wheat, maize (*Zea mays*), coffee (*Coffea arabica*), barley (*Hordeum vulgare*) and chat (*Catha edulis*) in order of their importance, respectively. Enset is the staple food crop for the majority of the community, while coffee (*Coffea arabica*) and chat (*Catha edulis*) are the dominant cash crops in some Peasant Associations (PA). Fruits such as avocado (*Persea americana*), banana (*Musa paradisiaca*), mango (*Mengefra indica*), White sapota (*Casimiroa edulis*), papaya (*Carica papaya*), and bullock's heart (*Annona reticulate*) are also cultivated for household consumption and to some extent income generation (GWARDO, 2009).

3. 2 Methods

3.2.1. Study site selection

For the selection of the study sites, reconnaissance survey was made with help of Development Agents and Agricultural Office of the Woreda. From the Woreda, eight Kebeles/sites were selected randomly and the study was conducted.

3.2.2 Woody Species Inventory and Sampling Design

In this study inventory of woody species such as trees and shrubs were used on farmland. A quadrat size of 40m x 40m (1600m^2) was used (Abreha and Gebrekidan.,2014). The tree is scattered over large areas, these large number of plots help to collect representative and sufficient data. The distance between transects line was 1km and between quadrate 300 meters (Nikiema, 2005). Sixteen (16) transect line and eighty (80) quadrate was laid out in

eight selected kebele (two transect line and ten plots in each kebele). The first transect line and plot was set randomly. In each plot, all woody species was identified; diameter at breast height (DBH, measured 1.3m above the ground) for all woody species≥ 5 cm measured according to Abed and Stephens, (2003). Development Agents were employed as enumerators (assumed as a professional who assist the researcher by counting, listing, and naming woody species besides to involving in formal surveying of HHs) for the purpose of data collection.

Woody species identification was done in the field by using local names with the help of key informant and field guide book Flora of Ethiopia and Eritrea (Edwards *et al*. 1995; Hedberg *et al*. 2004; Hedberg *et al*. 2006; Azene, 2007). However, for those species type which was not easily identified in the field by all above techniques, the code was given, and specimens collected, attached, labeled and submitted to the Jimma University College of Natural science Biology Department Herbarium for identification and documentation.

3.2.3 Socio-economic data collection

For socioeconomic study both primary and secondary data sources were used. Primary data collection was conducted on the sample households with the structured open ended and close ended questionnaires in each selected kebele. The secondary data source was gathered from Woreda's administration Office and Rural and Agricultural development Office. Thus, information related to woody species management concerns; woody species preference (by species preference matrix), factors influence woody species diversity data were collected by using structured open ended and close ended questionnaires, family size, age, educational status wealth stats, farmland size and others were gathered by questionnaires.

3.2.4 Key Informant (KI) selection

These key informants are individuals who are assumed to have adequate knowledge of their locality and who have lived continuously in the area for 30 years. Local elder, chief principal of kebele and development Agents (DA) were selected from the community as key informants from each kebele and a total of 24 KI were selected. The key role of KI is to categorize

sample household into the wealth categories to provide information about traditional woody species management practices on farmland.

3.2.5 Sample size determination of household

The list of names of all HHs living in the kebele was obtained from the kebele's office and cross checked with key informants at each kebele. As a consequence, this study was carried out by categorizing households into different wealth groups at each site. The purpose of wealth ranking in relation to this study was investigate how HHs' wealth, status relates with management practices of woody species on farmland. The techniques of Crowley (1997) were adapted and used by the key informants for the sampled HH wealth ranking. The criteria for differentiating HHs into different wealth classes were set by key informants. Based on number of cattle (particularly the number of oxen and cows), amount of annual crop production, land holding size and type / standard of housing were among the criteria used for classification of HHs into different wealth categories (Appendix 1). Then, HHs living in the kebeles was categorized into three wealth classes of rich, medium and poor according to the set criteria (Table 1).

Table 1: Sample households in wealth categories

No	Kebeles	Sample HHs	Sample HH in wealth category		
			Rich	Medium	Poor
1	Ade-ana	18	4	6	8
2	Bole	16	5	8	3
3	Misa	17	3	6	8
4	Oridebobicho	18	7	4	7
5	Sage	16	5	5	6
6	Wabo	17	4	6	7
7	Weera	18	4	4	10
8	Wondo	14	6	4	4
	Total	134	38	43	53

Based on Daniel (1999) formula, a total of 134 sample households were selected from the total households of 3912. The allocations of the number of sample households to each Kebeles were proportional to the number of households.

The number of sample households for the interview were selected based on simple random sampling techniques

$$n = \frac{z^2 p(1-p)}{d^2} \quad - n' = \frac{n z^2 p(1-p)}{d^2(n-1) + z^2 p(1-p) n}$$

Where:

n = sample size,

n'= sample size with finite population correlation

N = Population size,

Z = Z statistic for a level of confidence for 95% at 1.96

P = expected prevalence or proportion of population to be included in sample i.e. 10%) and

d = degree of accuracy desired (0.05)

3.3 Data Analysis

3.3.1 Woody Species Diversity Indices

Woody species diversity was analyzed by using different diversity indices. Shannon diversity index (*H*), Shannon equitability/evenness index (*E*) and species richness (*S*) were calculated per kebele and over all total of species which obtained from 80 plots . Then the collected data was analyzed. These diversity indices provided important information about the rarity and commonness of species in a community. Species richness is the total number of species in the community (Krebs, 1999).

3.3.1.1. Shannon diversity

The Shannon-Weiner Index is the most commonly used diversity indicator in woody species, communities, and it takes a value of zero when there is only one species in a community, and a maximum value when all species are present in equal abundance (Shannon and Wiener, 1949). The values of the Shannon diversity usually lie between 1.5 and 3.5, although in exceptional cases, the value may exceed 4.5 (Kent and Coker, 2011). The Shannon diversity index was calculated as follows:

$$H' = - \sum_{i=1}^{S} (P_i \ln P_i)$$

Where:

H’ = the Shannon diversity index,

S= number of species

ln = natural logarithm of pi

Pi = the proportion of individuals or abundance of the i^{th}species expressed as Proportion of the total abundance

3.3.1.2. Evenness (Equitability) index

Evenness (Shannon equitability) index (E) was calculated to estimate woody species distribution in plot on farmland. It measures have attempted to quantify unequal representation against a hypothetical community in which all species are equally common (Krebs, 1999). The Shannon-Wiener’s equitability or evenness (J) Index (Krebs, 1985) was quantified as follows:

$$E = \frac{H'}{H'max} = \frac{H'}{\ln S}$$

Where:

E = Evenness;

H’ = Shannon-Wiener Diversity Index;

Hmax = lnS;

S = total number of species in the sample.

The value of evenness index falls between 0 and 1. The higher the values of evenness index, the more even the species are in their distribution within the given area (Rocky and Mligo, 2012).

3.3.1.3 Important Value Index (IVI)

The importance value index (IVI) indicates the importance of species on farmland and it was calculated with three components according to Kent and Coker, (1992) as follows:

$$1.\ \text{Relative Abundance} = \frac{\text{Number of individuals of a species}}{\text{Total number of individuals}} * 100$$

$$2.\ \text{Relative dominance} = \frac{\text{Dominance of a species}}{\text{Total dominance of all species}} * 100$$

$$3.\ \text{Relative frequency} = \frac{\text{Frequency of a species}}{\text{Sun of frequency of all species}} * 100$$

Importance value of each woody species was the sum of Relative Abundance, relative dominance and relative frequency. The importance value index was estimated to evaluate the importance of woody species (Jose *et al.*, 1994).

3.3.1.4 Frequency

Frequency is defined as the probability or chance of finding a species in a given sample area or quadrant (Kent and Coker, 1992). Thus, it shows the presence or absence of a given species within each sample plot. The frequency of each woody species in the study area was calculated by determining the proportion of quadrants in which that species were found. Absolute frequency, which is the number of quadrants in which the species recorded and relative frequency of a species, computed as the ratio of the absolute frequency of the species to the sum total of the frequency of all species (Tadesse, 2003).

$$\text{Frequency of a species} = \frac{\text{the number of plot in which that species occurs}}{\text{Total number of plots}}$$

$$\text{Relative frequency} = \frac{\text{frequency of species A}}{\text{Tota frequency of all species}} \times 100$$

3.3.1.5 Density

The density of woody species is one of the most important structural parameters to be considered during data analysis. The density of a species reflects the numerical strength of species in a given community (Dissanayake and Hettiarachchi, 2013). Density was calculated by summing up all stems across all sample plots and converted to hectare basis.

$$\text{Density} = \frac{\text{Total number of indviduals}}{\text{Sample area in hectare(ha)}} \times 100$$

$$\text{Relative Abundance} = \frac{\text{Number of individuals of species}}{\text{Total number of individuals}} * 100$$

3.3.1.6 Basal area

The other most important structural parameter was basal area. It is the cross-sectional area of tree stems at breast height. It measures the relative dominance (the degree of coverage of a species as an expression of the space it occupies) of a species (Suratman, 2012). It was calculated as follows:

$$BA = \frac{\pi \times DBH^2}{4}$$

Where,

BA = basal area (m^2),

DBH= diameter at breast height (cm);

$\pi = 3.14$

$$\text{Dominance} = \frac{\text{Total Basal Area of Species}}{\text{Area Sampled}}$$

$$\text{Relative Dominance} = \frac{\text{Dominance of species A}}{\text{Total Dominance of all species}} \times 100$$

3.3.2 Data analysis

Quantitative data concerning Woody species inventory, traditional management practices and factors influence woody species diversity from farmland survey was analyzed. The result of the woody species inventory and questionnaire survey on farmland were analyzed by using the SPSS-20 Statistical Software and Microsoft Office Excel 2010. In relation to woody species preferences, relative score was calculated by multiplying the number of respondents in each rank by its proportion and factors influence woody species diversity data were analysed. By means of descriptive statistics, the mean, range, frequencies, percentages, minimum as well as maximum values of variables were calculated.

4. RESULTS AND DISCUSSION

4.1 Socio-Economic Characteristics of Households

Farmers in different socioeconomic characteristics affect the management of woody species diversity in their farmland. In this study, the socioeconomic features of the sampled households were presented (Table 2). The average ages for the respondents were 43 which ranged from 23 to 71 years. The sampled households were characterized as 87.3% males headed households and 12.7% females headed households. Females were family headed when their husband have been died or migrated from their original residence to South Africa. The greater percentage of respondents 'religion was Protestant (99.3%) and only 0.7% were Orthodox. With regard to educational level, 38.1% of respondents were illiterate while 26.9% can read and write, 23.1% was belonged to primary 1st cycle (1-4) and 11.9% was primary 2nd cycle (5-8). In the study area, about 41.2%, of the household family size were in the range of 8–10, 38.6% were within the range of 5-8, 10.4% was within the range of 3-5 and9.8% was >10 members. Agriculture was the major occupation for most of the households which covers 91.0% and only 9.0% of them are involved in other informal income generating activities. In terms of wealth status 39.6% of HHs were poor, 32.1% was medium and 28.4 % were rich wealth categories.

Table 2: Respondents socio-economic characteristics in study area

Socio-economic characteristics		Frequency	Percent (%)
Sex	Male	117	87.3
	Female	17	12.7
	20 – 40	32	23.9
	41 – 55	57	42.4
	56 – 70	42	31.4
	> 70	3	2.2
Religion	Orthodox	1	0.7
	Protestant	133	99.3
Education	Illiterate	51	38.4
	Read and write	36	26.9
	Primary 1st cycle (1-4)	31	23.1
	Primary 2nd cycle (5-8)	16	11.9
Family size	3 –5	13	9.8
	5– 8	51	38.6
	8 –10	56	41.2
	> 10	14	10.4
Marital status	Married	123	91.8
	Unmarried	4	3.0
	Widowed	7	5.2
Occupation	Agriculture	122	91.0
	Agriculture and other	12	9.0
Wealth status	Medium	43	32.1
	Poor	53	39.6
	Rich	38	28.4

Eighty four percent (84.3) of the respondents own land and land certificate with an average farmland size of 1.54 ha (ranged from 0.25 to 3.5 ha). The rest 15.7% stay on the land they rent or that is acquired from their parents. The richer households had the highest average farmland size 2.26 ha followed by medium 1.54ha and the poorer HHs had the least average farmland size 1.02 ha Figure 2. The sizes of farmland differ significantly between the wealth categories ($P< 0.05$). It showed that declining trend from the rich to the poor wealth categories. They are the deciders of themselves on how to use land. In study area almost all households had the right to use tree species which is found on their farmland and they used trees without permission which might affect tree species diversity.

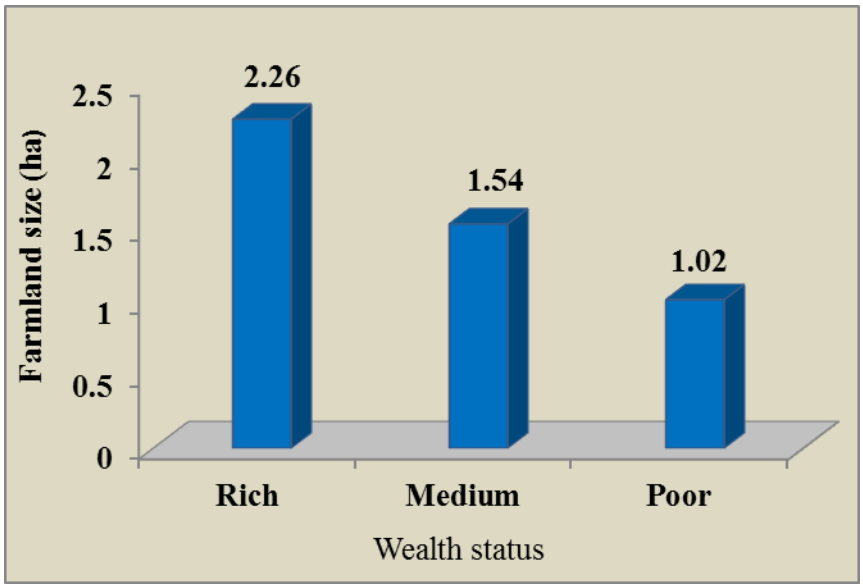

Figure 2: Average farmland size (ha) of households of the three wealth categories at study

4.2 Farmland Woody Species Diversity

4.2.1 Woody Species richness and Diversity Indices

A total of 32 trees/shrub species belonging to 22 plant families were recorded on the farmland at study sites. Among the plant families, the most frequent family was Fabaceae 6 (18.2%) followed by Euphorbiaceae family 3 (9.4%) whereas; the least frequent families were Boraginaceae, Moraceae, and Myrtaceae represented by 2 (6.3%) each. The remaining 16 families were represented by only one woody species (Appendix 1). The average Number of individuals species per plot was (7.6) obtained on farmland and the least average number of individuals species per plot was (5.6) recorded in the study area (Table 3). These results were in line with the previous findings (Dissanayake and Hettiarachchi, 2013; Mulugeta *et al.* 2005; Nikiema, 2005; Motuma *et al*, 2008).

Table 3: Woody Species on farmland in the study area

Kebele	Number of individuals	Min	Max	Average
Adeana	56	4	10	5.6
Bole	87	6	14	8.7
Misa	82	7	11	8.2
Ordebobcho	68	5	10	6.8
Sage	73	4	13	7.3
Wabo	92	6	13	9.2
Weera	61	4	11	6.1
Wondo	86	7	12	8.6
Average	76			7.6

Woody species Shannon diversity and evenness index was also studied in the study sites. The overall mean values of species richness and Shannon diversity index of woody species on farmland were 32 and 2.70 respectively (Table 4). The mean values of the evenness index of woody species on farmland were 0.42. The finding supported by Motuma *et al*. (2008) who reported that, the value of the Shannon diversity index of crop field was 2.22.

Table 4: Diversity indices of woody species on farmland in the study sites

	Species diversity index		
Kebeles	**Species richness**	**Shannon**	**Evenness**
Ade-ana	21	2.51	0.62
Bole	22	2.53	0.57
Misa	20	2.38	0.54
Ordebobcho	19	2.17	0.51
Sage	17	2.15	0.5
Wabo	18	2.19	0.48
Weera	16	2.24	0.54
Wondo	22	2.17	0.49
Overall	32	2.70	0.42

4.2.2 Important value index (IVI)

Importance value index was calculated for those tree/shrub species with a (DBH) of 5 cm. in the farmland. The result of the analysis of importance value index indicated that *Croton macrostachyus, Cordia africana, Albizia gummifera*, *Syzygium guineense* and *Olea africana* were the top five most important tree species on farmland in the study area (Table 5). The important value index shows that the importance of woody species on farmland helps to evaluate the important woody species. Accordingly, the IVI on farmland in study area *Leucaena leucocephala* and *Casimiroa edulis* were the least important tree species.

In this study the result of importance value index (IVI) indicated that the species that have uses as well as higher frequency or occurrences in the study sites were the most important tree species. *Croton macrostachyus* had the highest important value index with IVI of 70.99. For this reason, *Croton macrostachyus* was the most important trees in study sites for farmers by providing different uses like fuelwood, medicinal, shade, timber and fencing purposes. The current finding is in line with Nikiema *et al*. (1997) who reported that important species had been ranked as perceived by farmers themselves in different places. In the same way, the trees in the crop fields are seen as a source of income to the household. And also, the practice of managing this species in farmlands might be a positive contribution to the crops. Similarly, Tesfaye (2005) also reported that *Croton macrostachyus* was among the most important tree species in southern Ethiopia for its popularity as woody species.

Cordia africana is also a very important tree on farmland in the study sites. *Cordia africana* was a good and durable quality timber that is used for the manufacture of furniture, doors, beehives, farm tools and widely marketed tree species. It is also used to provide fuel wood, shade, soil fertility and fencing purposes. *Cordia africana* is one of the fast growing native tree species. The current finding is in agreement with Negash (1995) and Tesfaye (2000).

Those species, which had highest IVI, were highest valuable species across study sites. This result is in agreement with findings of (Das and Das, 2005) who reported that the species with multiple uses showed higher IVI value. Similarly, Tesfaye (2005) also who reported that species used for HHs income generation with the highest importance value indices. Animportance value index was calculated for those woody species inventoried with a DBH of ≥ 5 cm.

Table 5**: Importance value index of woody species in the study area**

No	Scientific name	IVI	Rank
1	*Croton macrostachyus* A.Ric	70.99	1
2	*Cordia africana* Lam.	35.84	2
3	*Albizia gummifera* (G.F.Gmel.).	23.30	3
4	*Syzygium guineense* (Wild.) DC.	21.94	4
5	*Olea africana* Mill.	14.43	5
6	*Ficus vasta* Forssk.	13.62	6
7	*Podocarpus falcatus* (Thunb.) Mirb	12.31	7
8	*Acacia abyssinica* Hochst ex Benth.	12.30	8
9	*Eucalyptus camaldulensis* Dehnh	10.00	9
10	*Sapium ellipticum* (Krauss) Pax	8.86	10
11	*Persea americana* Mill.	7.99	11
12	*Ekebergia capensis* Sparm	7.25	12
13	*Grevillea robusta* R. Br.	6.08	13
14	*Bersama abyssinica* Fresen.	6.02	14
15	*Juniperus procera* Hochst.	5.46	15
16	*Ficus sur* Forssk.	5.20	16

4.2.3 Basal area

The average basal area of woody species on farmland of the eight study Kebeles was (2.71 $m^{2)}$. The highest mean basal area per kebele was obtained at Wondo kebele (3.84m^2) followed by Bole (3.45 m^2) and the least mean basal area was obtained at Weera kebele (1.03 m^2) (Table 6).

Table 6: Mean basal area (m^2) of woody species on farmland in the study areas

No	Kebeles	Basal area per kebele
		Mean
1.	Wondo	3.84
2.	Bole	3.45
3.	Orde	3.26
4.	Ade-ana	2.76
5.	Misa	2.56
6.	Sage	2.43
7.	Wabo	2.35
8.	Weera	1.03
	Overall mean	2.71

4.2.4 Stem diameter distribution

In the study area woody species diameter distribution was recorded. The proportion of individuals of woody species in higher diameter classes was the smallest on farmlands which were indicated as follows: 46-55cm (6.54%), 56-65cm (5.47%) and 66-75cm (2.42%). On the other hand, the number of individual woody specie with lower diameter classes was highest which were indicated as DBH class interval of 5-15cm (26.57%), 16-25cm (20.69%) and 26-35cm (18.69%) (Figure 3). These diameter distributions of woody species figured out a declining trend from lower DBH class to higher DBH class. The results showed that, high utilization of woody species for different purpose. This work is in agreement with the finding of Dissanayake and Hettiarachchi, (2013) who reported that, due to the fact that farmers have used the trees with higher DBH for their timber purposes. (Tabuti *et al*., 2003) also who reported that, exploitation of woody species continues because of experiencing a rising demand in wood products for both domestic and commercial purposes. (Motuma *et al*., 2008) also further reported that, the regeneration of young trees in crop fields is almost non-existent on farmland.

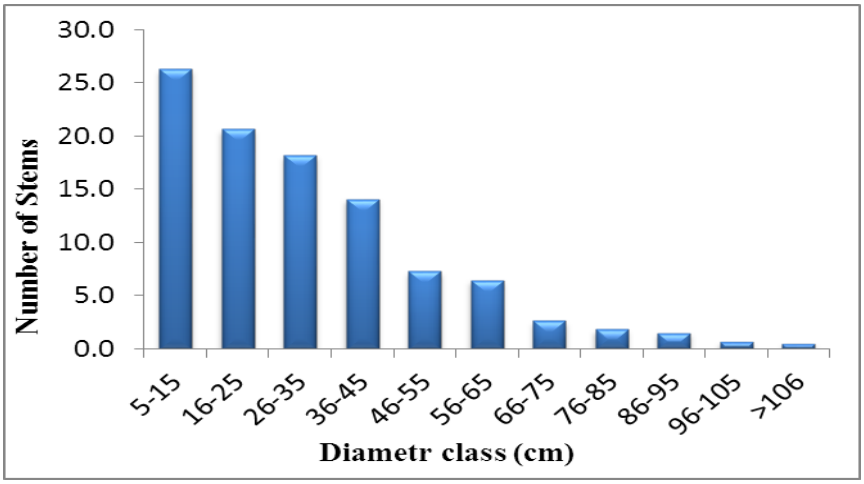

Figure 3: Diameter class distribution of woody species on farmland in study area

4.3 Frequency of Woody Species on Farmland

In the study area the frequency of woody species occurrence on farmland was recorded. *Croton macrostachyus, Cordia africana, Albizia gummifera, Olea africana, Syzygium guineense* and *Podocarpus falcatus* were among the most frequent tree species (Figure 4). On the other hand, *Maese lanceolata* and *Prunus africana* was the least frequent woody species. The frequencies of the woody species were variable on farmland in study sites. Some of species frequencies occurrence were very low as compared to other sites (Appendix 5). This might be due to trees species are threatened due to over-utilization by humans and also lower regeneration rates as compared to other woody species. However, *Croton macrostachyus* was the most frequent woody species followed by *Cordia africana.* The current finding is in agreement with Motuma *et al*. (2008) who reported that *Croton macrostachyus* is the most frequent tree species encountered in the plots of the crop field at Beseku, in Arsi Negelle. Mulu (2010) also who reported that *Cordia africana* as the most frequent tree species in sampled farms in Bahir Dar Zuriya District. Whereas, some of the species like *Schefflera abyssinica, Leucaena leucocephala and Prunus africana* were the least frequent woody species in study sites. This indicated that the species in farmland was infrequently existed. The reason behind is local community did not wish to retain or plant this woody species in moment of trees cut for agricultural land expansion.

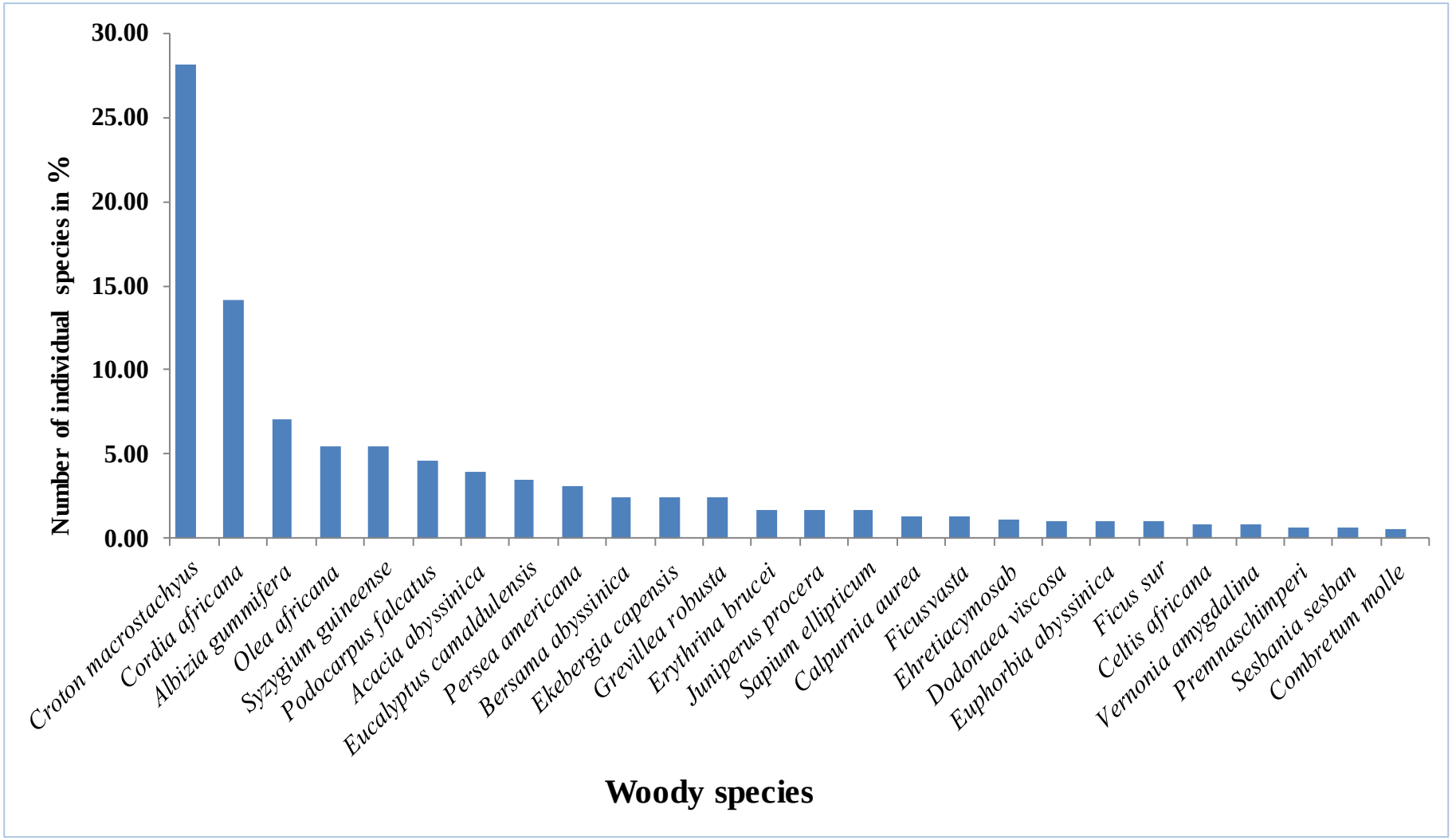

Figure 4 Frequency occurrences of woody species in the study sites

4.4 Woody Species Preference, Uses and Management

4.4.1 Woody species Preference

In the study area, woody species which were either planted or retained on farmland provide different types of uses. In the study area the respondents have preferred different woody species in their farmland (Appendix 4). To evaluate farmers' species preferences, respondents were asked to rank the five most important woody species. The most preferred species by respondents was *Cordia africana* followed by *Croton macrostachyus* and the least preferred species were *Celtis africana* and *Juniperus procera* (Table 7). The respondents' major reasons for preferences of woody species were based on different purpose like: timber, fuel wood, shade, construction, fence and boundary, agricultural implements, soil fertility, beehive making, source of income. This finding is in agreement with (Garrity *et al*., 2006) who reported that the importance of trees in addressing the production and service function issues has been well understood by farmers through the centuries and has been clearly demonstrated in traditional tree-based agricultural farming and land-use systems.

Table 7: Respondents' preference of some selected species at the study sites

No	Species scientific name	Total Relative score
1	*Cordia africana*	39.09
2	*Croton macrostachyus*	26.15
3	*Albizia gummifera*	12.97
4	*Eucalyptus camaldulensis*	11.94
5	*Acacia abyssinica*	6.88
6	*Olea africana*	2.44
7	*Podocarpus falcatus*	1.59
8	*Persea americana*	1.16
9	*Erythrina brucei*	0.21
10	*Vernonia amygdalina*	0.17
11	*Prunus africana*	0.13
12	*Syzygium guineense*	0.07
13	*Ficus sur*	0.06
14	*Celtis africana*	0.04
15	*Juniperus procera*	0.01

4. 4. 2 Uses of farmland woody species

Based on respondents, different types of woody species use were identified on farmland in study sites (Figure 5). Some of the major uses obtained from farmland woody species includes, fire wood (32%), timber (19%), construction material (13%), shade (11%), cash generation (6%) soil fertility improvement (5%), and others. Almost all the identified farmland woody species provide more than one use. *Croton macrostachyus, C. africana, Albizia spp* and *Olea africana* were the most important tree species which generate different purposes for farmers living in that study area. Since, these trees were identified, depending on their multipurpose uses as compared to other woody species across the study sites. The present finding is supported by Kindeya, (2004) who reported that woody species can protect wind erosion and provides fuel wood, charcoal, shade, construction materials; farming implements and fodder for livestock. Biruk (2006) also reported that farmers in South East Langano, Ethiopia maintained trees/shrubs on their farms for different socio-economic purposes including medicinal products, provision of shade and shelter, fodder, fuel wood and the like.

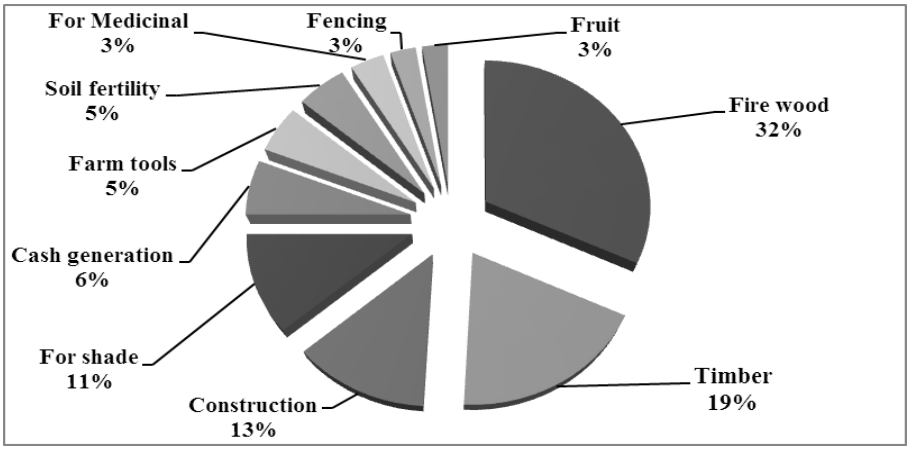

Figure 5 Different uses of farmland woody species in study area

4.4.3 Woody Species Management Practices

Sample Households in study sites employ various management practices of woody species on either farmland. Out of them the most common management activities that exercised in the study area were coppicing, pollarding and lopping. Whereas, the least common management

practice was thinning this was practiced by some farmers (Figure 9). The result is in agreement with finding of Abebaw (2006) who suggested that, coppicing, pollarding, lopping and thinning are among the most important tree management practices. Similarly Agidie *et al.*, (2013) also further reported that, Coppicing, pollarding, pruning, and lopping are among the most important tree management practices.

Across the study sites, one of woody species management practices used by respondent was coppicing (Figure 6). Farmers used this practice to harvest tree species for timber, for construction, for pole, for fuel wood and in small amounts to regenerate trees. The majority of respondent were practicing coppicing and thinning for *Eucalyptus camaldulensis* planted in their road side and river side woodlot.

Figure 6: Tree managed by coppicing practice

The other most important management practice was lopping. The trees managed by this practice were *Croton macrostachyus, Cordia africana, Albizia gummifera, Olea africana, Erythrina brucei* (Figure7). Survey results indicated that most of the farmers under study sites used lopping for those trees species. Farmers used this method to reduce shade, for fencing, fuel wood, growth and regeneration. The present finding is in agreement with Workneh (2002) who figured out that pruning of trees on croplands by farmers is common to reduce competition and to obtain fuel wood and construction wood.

Figure 7: Tree managed by lopping practice

The other management practice exercised in the study sites was pollarding. Pollarding is cutting of tree above two meters from the ground to reduce the shade of other crop, for regeneration of tree **(**Figure 8).

Figure 8: Tree managed by pollarding practice

Farmers used this management technique because it promote normal growth of the trees, control its interaction with crops, encourage regeneration and construction purpose. The trees managed by this practice were *Olea africana, Grevillea robusta* and *Acacia abyssinica*. This finding was supported by Abebaw (2006) who reported that, pollarding of trees was evident for *Acacia abyssinica* and *Olea africana* and FAO (2006) in the highlands of Kenya, the pollarding of *G. robusta* growing on agricultural lands is common.

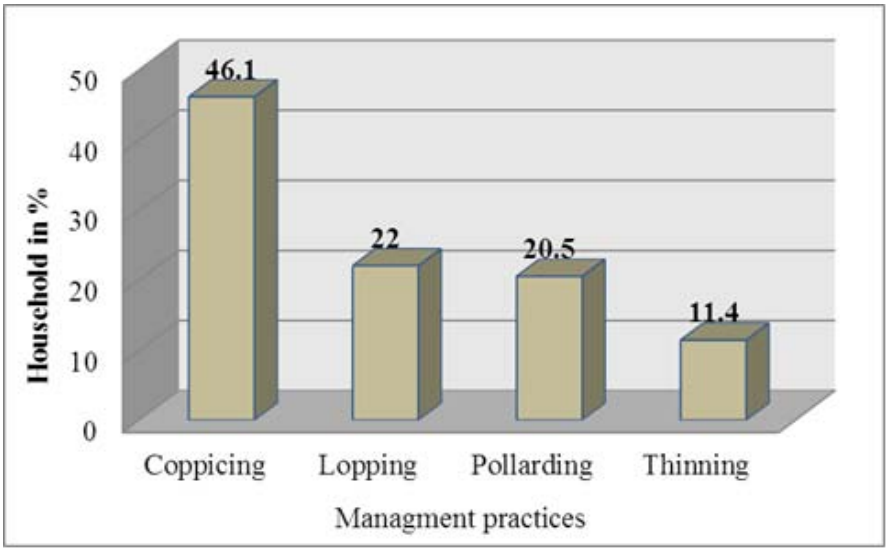

Figure 9: Woody species management practices

4.5 Socio-Economic Factors to Manage Woody Species

The present results from the study of socio-economic factor showed that, farm size, wealth status and educational background of the households were the most important factors that affect management practice of woody species on farmland. The households' farm size was one of the important factors that affect woody species management. In the study area the variation among different wealth groups is explained by farmland size. There was a significant positive correlation ($P<0.05$) between wealth category and total farm size. Wealth status of household is highly correlated with farm size. As farmland size of household increase the woody species management increased. Farmers with larger land sizes plant/retain more species on their farmland as compared to farmers with small size of land. This is because those farmers with larger land sizes wish to plant/retain more species on their farmland as compared to farmers with small size of land holdings. Small size land owner farmers explained that they want to plant or retain trees but much of their land was already allocated for crop production to feed their families and they do not have extra land to retain trees. The current work is supported by Omati *et al*. (1999) who reported that, small farm size is the main hindrance to tree-planting, managing and increasing of species diversity under central Ethiopian conditions.

Wealth status was the other important factor that influences woody species management on farmland. A sample household who had well enough of basic necessity (rich) had managed the species diversity on farmland in proper manner. However, those farmers whose living status was lower didn't manage tree because they cut tree to generate income to survive. The wealth status of farmers was highly correlated with farm size and the variation among the different wealth categories was determined by the size of the farmland. The wealth status of households in the study site was positively correlated with the woody species management practices (Table 8). The other socio economic factor that influences the woody species managements on farmland in the study sites was educational status. Literate farmers manage tree appropriately as compared to illiterate one because they know the advantage of managing tree.

This study showed that illiteracy was also the main reason for non-managing of woody species on farmland. Uneducated farmers considered this practice as harmful for their agricultural crops due to lack of awareness. They recognize management practices as it compete with their crop and take long time to be productive than agricultural crops. The present finding is in line with Amir. (2003) who reported that, education was the main and vital weapon for bringing a positive change in the behavior of individual, farmer who develops knowledge and other desirable qualities of mind and general competence. The illiteracy among the farmers was much influencing their behavior to manage woody species on farmland.

Table 8: Correlation of number of woody species diversity with the socio-economic factors

	Socioeconomic factors	**Woody Species management**
1	Land size	0.41**
2	Educational status	0.28*
3	Wealth status	0.37**

Correlation is significant at ($P<0.05$).

4.6 Constraints to Manage Woody Species on Farmland

The different kinds of constraints for woody species management in the study areas were listed in (Table 9). Among the constraints land shortage, drought, free grazing or animal damage, theft and seedling shortage were the most frequently replied constraints by respondents.

Among constraints, the most important factors that affect woody species management was land shortage (23.1%) followed by drought (21.6%) and the least important constraints was labour shortage (3.7%). These findings showed that land shortage was a serious constraint to manage woody species in the study sites. The other most important constraint was drought across the study sites. Observation from sample households revealed that it was factor during early seedling growth and establishment. According to the respondents, drought was one of the most seriously threaten constraints in the study sites, which could affect the diversity of woody species in the farmland. Current study is supported by Abiyu *et al*. (2015) who reported that, the most important limitations for tree growing is drought, free grazing, and limited availability of seedlings.

Table 9: Major constraints to manage woody species on farmland

Constraints to manage woody species	**Household Respondents**	
	Frequency	**Percent**
Land shortage	31	23.1
Drought	29	21.6
Free grazing	26	19.4
Seedling shortage	15	11.2
Lack of awareness	11	8.2
Lack of capital	9	6.7
Thief	8	6
Labour shortage	5	3.7
Total	134	100

5 SUMMARY AND CONCLUSION

The results of this study have shown that woody species inventory on farmlands provided baseline information on existing situation of woody species frequency, importance value index, richness, diversity, evenness and basal area. To manage the diversity of woody species on farmland across the study sites, farmers were applying different types of traditional management practices. Coppicing, pollarding and lopping were the most common management practices. *Croton macrostachyus*, *Cordia africana* and *Acacia abyssinica* trees are lopped for elimination of negative effect in crops and its re-growth in the area. *Cordia african* and *C. macrostachyus* and *Eucalyptus* species are coppiced, with which the stem is harvested close to the ground to use for different purpose. *Acacia spp and Olea africana* trees are pollarded, all the branches are removed for utilization and more branches will re-grow or the amount of spines on the branches will increase. Farmland woody species in the study area provide both product and service benefits. From these benefits, about 12 diverse use types were identified. Out of which, fuel wood accounted for the largest number of contributes, followed by timber purposes. Many woody species such as *Cordia africana, Croton macrostachyus, Albizia gummifera, Acacia abyssinica, Podocarpus falcatus etc*, are most important woody species provides different purposes for the community. A number of constraint related in managing farmland woody species were draught, free grazing, and seedling shortage, among the others were occurred in study sites. Accordingly farm size, educational back ground and wealth status of the households were the most important socio economic factors affecting woody species management practices on farmland in the study sites. Finally, based on this study it can be concluded that farmers have local traditional management practices to wood species on their farmland but this practice has not been supported well by extension to solve the problem.

6 RECOMMENDATIONS

Based on these findings, the following future line of work is recommended.

- Raising the amount of woody species diversity on farmland at the study sites, awareness of local people in diversifying, conserving and sustainability using of woody species should be done. This could be by introducing and expansion of multipurpose woody species of farmlands, which help in improving the product as well as service value of the woody species. Therefore, diversification of farmlands with multipurpose woody species with the aim of enhancing productivity needs to be an important priority

- Farmers have traditional management practices for the farmland woody species diversity, but this practice has not been supported well by extension (Extension is a series of embedded communicative interventions that are meant, among other goals, to develop and/or induce innovations which help to resolve (usually multi-actor) problematic situations.) to solve the problem. Therefore, intervention should be required to develop farmers' in sustainable management and utilizations of woody species in the farmlands of the study sites.

- Since water shortage, free grazing and drought were the major factors which hinders woody species diversity management. So govermental organization should set a rule to prevent free grazing or animal damage and there should be a means to overcome the problem of shortage of water.

- Even though the contributions of farmland woody species in the study area were various, the present research focused on traditional management practices and the woody species diversity. Therefore, further research should have to be done.

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8. APPENDIX

Appendix 1: Sample household wealth ranking criteria in the study sites

Social classes	**Sample household wealth ranking criteria**
Poor	Owns less than 1.05 hectare of land
	Do not have oxen and but only one cow
	Owns only chicken
	Sell charcoal and fuel wood
	Owns not more than 3 sheep
Medium	Owns greater than 1hectare and less than 2.15 hectare of land
	Owns a pair of oxen
	Owns up to three cattle
	Owns not more than five sheep
Rich	Owns more than 2.15 hectare of land
	Owns more pair of oxen
	Owns more than 6 cattle
	Owns more than 6 sheep

Appendix 2: Sample households in wealth categories.

	Kebeles	Number of HH	Sample HHs	Sample HH in wealth category		
				Rich	Medium	Poor
1	Ade-ana	454	18	4	6	8
2	Bole	487	16	5	8	3
3	Misa	527	17	3	6	8
4	Oridebobicho	544	18	7	4	7
5	Sage	465	16	5	5	6
6	Wabo	408	17	3	6	8
7	Weera	531	18	3	4	11
8	Wondo	496	14	6	4	4
	Total	3912	134	38	43	53

Appendix 3: List of woody species recorded in the study sites

No	Local Name	Scientific .Name	Family Name	Plant form	Frequency
1	Girara	*Acacia abyssinica* Hochst ex Benth.	Fabaceae	Tree	24
2	Mande	*Albizia gummifera* (G.F.Gmel.).C.A.Sm.	Fabaceae	Tree	43
3	Koraqqa	*Bersama abyssinica* Fresen.	Melianthaceae	Tree	15
4	Senna	*Calpurnia aurea* (Ait.) Benth	Fabaceae	Shrub	8
5	Kazmira	*Casimiro aedulis* Llave&Lex.	Rutaceae	Tree	2
6	Qamalhaqa	*Celtis africana* Burm.F.	Ulmaceae	Tree	5
7	Habule	*Combretum molle* R.Br. ex G.Don	Combretaceae	Tree	3
8	Wedeshsha	*Cordia africana* Lam.	Boraginaceae	Tree	86
9	Massan	*Croton macrostachyus*A.Ric	Euphorbiaceae	Tree	171
10	Megara	*Dodonaea viscosa* (L.) Jacq	Sapindaceae	Shrub	6
11	Ulaga	*Ehretiacymosab* Thonn.	Boraginaceae	Tree	7
12	Ollolla	*Ekebergia capensis* Sparm	Meliaceae	Tree	15
13	Wora'a	*Erythrina brucei* Schweinf	Fabaceae	Tree	10
14	Bahirzafa	*Eucalyptus camaldulensis* Dehnh	Myrtaceae	Tree	21
15	Adaama	*Euphorbia abyssinica* Gmel.	Euphorbiaceae	Tree	6
16	Oda'a	*Ficus sur* Forssk.	Moraceae	Tree	6
17	Qilxxoo	*Ficusvasta* Forssk.	Moraceae	Tree	8
18	Giravila	*Grevillea robusta* R. Br.	Proteaceae	Tree	15
19	Abash Homa	*Juniperus procera* Hochst.	Cupressaceae	Tree	10
20	Bilawahaqa	*Leucaena leucocephala* (Lam.) de W	Fabaceae	Tree	1
21	Kowada	*Maesa lancelata* Forssk	Myrsinaceae	Shrub	3
22	Weera	*Olea africana* Mill.	Oleaceae	Tree	33
23	Abokkado	*Persea americana* Mill.	Lauraceae	Tree	19
24	Dimbaba	*Phoenix recilnata* jacq.	Arecaceae	Tree	3
25	Digiba	*Podocarpus falcatus* (Thunb.) Mirb	Podocarpaceae	Tree	28
26	Xoxanqe	*Premnaschimperi* Engl	Verbenaceae	Tree	4
27	Arara	*Prunus africana* (Hook.f.)Kalkm	Rosaceae	Tree	1
28	Shaqama	*Sapium ellipticum* (Krauss) Pax	Euphorbiaceae	Tree	10
29	Gatama	*Schefflera abyssinica* Harms.	Araliaceae	Tree	2
30	Sasbanya	*Sesbania sesban* (L.) Merr.	Fabaceae	Shrub	4
31	Dubana	*Syzygium guineense* (Wild.) DC.	Myrtaceae	Tree	33
32	Heeba	*Vernonia amygdalina* Mesfin	Asteraceae	Shrub	5

Appendix 4 : Respondents' woody preference ranking in the study sites

No	Name	No. of respondents in each rank					Relative score					Total Rel.score
		1st	2nd	3rd	4th	5th	1st	2nd	3rd	4th	5th	
1	*Cordia africana*	48	51	22	8	4	17	17.19	3.69	0.71	0.3	39.09
2	*Croton macrostachyus*	37	38	22	10	7	10	10.22	3.69	1.11	0.91	26.15
3	*Eucalyptus camaldulensis*	20	20	25	9	4	3	2.99	4.77	0.9	0.3	11.94
4	*Albizia gummifera*	18	4	13	17	14	2.4	2.42	1.29	3.21	3.63	12.97
5	*Persea americana*	4	4	5	8	1	0.1	0.12	0.19	0.71	0.02	1.16
6	*Podocarpus falcatus*	4	2	12	4	2	0.1	0.12	1.1	0.18	0.07	1.59
7	*Syzygium guineense*	2	1	1	0	0	0	0.03	0.01	0	0	0.07
8	*Acacia abyssinica*	1	5	22	15	6	0	0.01	3.69	2.5	0.67	6.88
9	*Prunus africana*	0	1	1	3	1	0	0	0.01	0.1	0.02	0.13
10	*Vernonia amygdalina*	0	0	0	0	3	0	0	0	0	0.17	0.17
11	*Juniperus procera*	0	0	0	1	0	0	0	0	0.01	0	0.01
12	*Celtis africana*	0	0	1	1	1	0	0	0.01	0.01	0.02	0.04
13	*Ficus sur*	0	0	2	1	1	0	0	0.03	0.01	0.02	0.06
14	*Olea africana*	0	2	5	11	7	0	0	0.19	1.34	0.91	2.44
15	*Erythrina brucei*	0	0	0	2	3	0	0	0	0.04	0.17	0.21
		134	134	131	90	54						

*Relative score was calculated by multiplying the number of respondents in each rank by its proportion (e.g. (48x48/134) =17.19)

Appendix 5: Species richness in the study sites

No	Local Name	Scientific Name	Name of Kebele/sites								
			Weera	Sage	Wondo	Misa	Orde	Wabo	Bole	Adena	Total
1	Girard	*Acacia abyssinica* Benth.	1	6	0	5	1	3	5	3	24
2	Mande	*Albizia gummifera* C.A. Sm.	3	12	5	4	6	7	2	4	43
3	Koraqqa	*Bersama abyssinica* Fresen.	3	1	2	0	0	1	5	3	15
4	Senna	*Calpurnia aurea* (Ait.) Benth	3	0	2	1	0	2	0	0	8
5	Kazmira	*Casimiroa edulis* L lave & Lex.	0	0	0	0	0	2	0	0	2
6	Qamalhaqa	*Celtis africana* Burm. F.	0	0	0	1	1	2	1	0	5
7	Habule	*Combretum molle*R.Br. ex G.Don	0	0	0	0	3	0	0	0	3
8	Wedeshsha	*Cordia africana* Lam.	12	7	1	15	1	28	18	4	86
9	Massan	*Croton macrostachyus*A.Ric	12	24	36	15	28	19	20	15	169
10	Megara	*Dodonaea viscosa* (L.) Jacq	3	0	0	0	0	0	0	3	6
11	Ulaga	*Ehretia cymosab*Thonn.	0	0	2	3	0	0	1	1	7
12	Ollolla	*Ekebergia capensis* Sparm	0	2	1	2	4	2	3	1	15
13	Wora'a	*Erythrina brucei* Schweinf	0	0	0	3	0	5	2	0	10
14	Bahirzafa	*Eucalyptus camaldulensis* Dehnh	5	2	3	0	1	4	2	4	21
15	Adaama	*Euphorbia abyssinica* Gmel.	0	0	0	1	0	1	3	1	6
16	Oda'a	*Ficus sur* Forssk.	0	2	1	1	1	0	0	1	6
17	Qilxxoo	*Ficusvasta* Forssk.	1	0	2	3	0	1	0	1	8
18	Giravila	*Grevillea robusta* R. Br.	0	0	2	9	1	0	3	0	15
19	Homa	*Juniperus procera* Hochst.	0	1	1	1	1	2	3	1	10
20	Bilawahaqa	*Leucaena leucocephala* (Lam.) de W	0	0	1	0	0	0	0	0	1
21	Kowada	*Maesa lancelata* Forssk	0	1	0	1	0	0	0	1	3
22	Weera	*Olea africana* Mill.	2	7	0	4	0	6	7	7	33
23	Abokkado	*Persea americana* Mill.	3	0	1	7	1	5	2	0	19
24	Dimbaba	*Phoenix recilnata* jacq.	2	0	0	0	0	0	0	1	3
25	Digiba	*Podocarpus falcatus* (Thunb.) Mirb	4	0	12	2	6	1	3	0	28
26	Xoxanqe	*Premnaschimperi* Engl	0	0	1	1	1	0	1	0	4
27	Arara	*Prunus africana (*Hook.f.) Kalkm	0	1	0	0	0	0	0	0	1
28	Shaqama	*Sapium ellipticum* (Krauss) Pax	0	0	3	2	3	0	2	0	10
29	Gatama	*Schefflera abyssinica* Harms.	0	0	0	0	1	1	0	0	2
30	Sasbanya	*Sesbania sesban* (L.) Merr.	0	0	1	1	1	0	1	0	4
31	Dubana	*Syzygium guineense* (Wild.) DC.	7	3	8	0	7	0	3	5	33
32	Heeba	*Vernonia amygdalia* Mesfin	0	4	1	0	0	0	0	0	5
	Total		61	73	86	82	68	92	87	56	605

Appendix 6: IVI of woody species on Farmland in the study area

No	Scientific name	Rel, dens	rel.freq	Reldom	IVI
1	*Croton macrostachyus*A.Ric	30.307	17.224	23.461	70.992
2	*Cordia africana* Lam.	14.953	10.026	10.860	35.839
3	*Albizia gummifera* (G.F.Gmel.).C.A.Sm.	6.809	8.226	8.264	23.299
4	*Syzygium guineense* (Wild.) DC.	5.340	6.427	10.174	21.941
5	*Olea africana* Mill.	5.073	5.398	3.953	14.425
6	*Ficus vasta* Forssk.	1.602	3.085	8.931	13.618
7	*Podocarpus falcatus* (Thunb.) Mirb	3.872	3.599	4.838	12.309
8	*Acacia spp*.	3.471	4.627	4.203	12.301
9	*Eucalyptus spp*	3.204	4.884	1.912	10.000
10	*Sapium ellipticum* (Krauss) Pax	1.602	3.085	4.174	8.861
11	*Persea americana* Mill.	2.804	3.599	1.583	7.986
12	*Ekebergia capensis* Sparm	1.869	3.085	2.294	7.248
13	*Grevillea robusta* R. Br.	2.270	1.285	2.528	6.083
14	*Bersama abyssinica* Fresen.	2.136	2.828	1.051	6.015
15	*Juniperus procera* Hochst.	1.869	2.571	1.018	5.458
16	*Ficus sur* Forssk.	0.935	1.799	2.461	5.195
17	*Calpurnia aurea* (Ait.) Benth	1.736	2.828	0.517	5.080
18	*Erythrina brucei* Schweinf	1.335	1.799	1.569	4.704
19	*Ehretia cymosab* Thonn.	1.335	2.057	1.010	4.402
20	*Vernonia amygdalina* Mesfin	1.335	1.799	0.345	3.480
21	*Celtis africana* Burm.F.	0.801	1.542	0.816	3.159
22	*Combretum molle*R.Br. ex G.Don	0.668	1.028	0.950	2.645
23	*Euphorbia abyssinica* Gmel.	0.801	1.285	0.469	2.555
24	*Dodonaea viscosa* (L.) Jacq	0.801	0.514	0.602	1.918
25	*Sesbania sesban* (L.) Merr.	0.534	1.028	0.264	1.826
26	*Premnaschimperi* Engl	0.534	1.028	0.120	1.682
27	*Phoenix recilnata* jacq.	0.534	0.771	0.246	1.551
28	*Maesa lancelata* Forssk	0.401	0.771	0.280	1.451
29	*Schefflera abyssinica* (Hochst.ex.A.Ric) Harms.	0.267	0.514	0.451	1.232
30	*Prunus africana* (Hook.f.)Kalkm	0.267	0.514	0.450	1.231
31	*Leucaena leucocephala* (Lam.) de W	0.267	0.514	0.173	0.954
32	*Casimiroa edulis* L lave & Lex.	0.267	0.257	0.035	0.559

1. Woody species inventory on sample plots

1.1 Plot number _____

1.2 Area or data recorded 1600 m^2 for woody species

1.3 Altitude of the plot in meter _____

1.4 The slope in degree_____

1.5 Latitude_____ ^{0}_____ ’_____” and Longitude _____ ^{0}_____ ’_____”

Appendix 7: Woody species inventory sheet on sample plots

No	Species Name		No per plot	DBH (cm)	Growth habit	Uses
	Local	Scientific				

Appendix Table 10: Household data collection sheet

1. Questionnaire for Household

1.2. Sex: _____

1.3 Age: _____

1.4. Marital status 1. Married 2. Unmarried 3 Widowed 4. Divorced

1.5. Family size person's _____

1.6. Religion 1. Protestant 2. Orthodox 3. Muslim 4 others

1.7 Education 1. Illiterate 2. Read and write 3 Primary 1st cycle (1-4) 4. Primary 2nd cycle (5-8) 5/ (grade 9-10) 6/ grade 11-12) 7/ diploma and above

1.8. Occupation 1: Farmer 2: other

1.9, Wealth status 1: Rich 2: Medium 3: Poor

1.9. Total land size by ha. _____

List total land holding size	Hect
home garden	
Cultivated	
Grazing	
Others	

1.10. Who decides for you how to use your land? 1) Me 2) DA

1.11. Is there any restriction how to use your land? 1) yes 2) no

1.12. If yes, what is the restriction to use your land in relation to trees?

1.13. Who is the owner of the land? 1) Me 2) Parent 3) government

1.14. Do you have land certification for your own land? 1) yes 2) no

1.15. Who is the owner of the tree on your land? 1) Me 2) Parent 3) government

1.16. Do you have the right to use tree on your land? 1) yes 2) no

1.17. If yes, how do you use it? With permission or without permission

2. Woody species diversity on farmland

2.1 Do you have the right to plant trees on farmland?_____

2.2 Do you want to plant trees on your farmland? Yes/ no

Where do you plant?	
Which species do you permitted to plant?	
Which species do you want to plant?	
Why?	

2.3. Have you maintained trees on your farmland?

1) Yes 2) No

2.4. If yes, specify the purpose of trees on your farmland?

Code for niche): n_1= Homestead, n_2=Crop filed, n_3= Woodlots, n4=Grazing land,n5= (Farm boundary, n_6= (others)

Code for reason:r_1= firewood; r_2 = lumber; r_3= construction r_4= for cash generation, r_5= for fruit, r_6= for shade, r_7= for social purpose, r8 = for soil fertility r9= for soil and water conservation 10= medicine 11= bee keeping 12= farm implements 14=for fodder 15= (Others)

3 Tree species preference and management related knowledge

3.1 How do you see trends of trees on your farmland? 1, Increasing 2,decreasing 3, No change

Reason for increasing_____

Reason for decreasing 1= increased market value; 2= increased fuel wood demand 3= cutting of tree without replacement; 4= increased demand for construction wood; 5= increased demand for timber; 6= land shortage; 7= seed/seedlings shortage; 8= land and tree tenure problem; 9= Lack of tree planting tend 10=other /specify/

3.10. Species preference

Species preference matrix

List species	A	B	C	D	E
A					
B					
C					
D					
E					

What is major problem with tree planting/ maintaining? _____

Farmer's woody species management on farmland

4.1 What type of management practices do you use for farmland tree species?

No	Species	Management	Niches	Reason

***Code* for management**: m_1= Thinning, m_2= Pruning, m_3= pollarding, m_4= fertilizing, m_5= Coppicing, m_6= Lopping m_7= cultivation

***Code* for niches**: n_1= Homestead, n_2= Crop filed, n_3= Woodlots, n_4= Grazing land, n5= Farm boundary, n_6= Road side, n7 =River side

***Code* for reason**: r_1= for growth, r_2= to reduce competition, r_3= to reduce shad, r_4= for fuel wood, r_5= for fodder, r_6= for fencing, r7= for construction, r8= for timber

4.2. Have you managed trees?1) Yes 2) No If yes, lists the species where and why?

No	Tree species	Niches	Reason

Code for niche: n_1= Homestead, n_2= Crop filed, n_3= Woodlots, n_4= Grazing land),n_5= Farm boundary, n_6= others

Code for reason: r1= firewood; r_2 = lumber; r_3= construction r_4= for cash generation, r_5= for fruit, r_6= for shade, r_7= for social purpose, r8 = for soil fertility r9= for soil and water conservation 10= medicine 11= bee keeping 12= farm implements 14=for fodder 15= (Others)