ANALYSIS OF SOCIO-ECONOMIC AND ENVIRONMENTAL CONTRIBUTION OF AGROFORESTRY SYSTEMS TO SMALLHOLDER FARMERS AROUND JIMMA TOWN, SOUTHWESTERN ETHIOPIA

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ANALYSIS OF SOCIO-ECONOMIC AND ENVIRONMENTAL CONTRIBUTION OF AGROFORESTRY SYSTEMS TO SMALLHOLDER FARMERS AROUND JIMMA TOWN, SOUTHWESTERN ETHIOPIA

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DEDICATION

I dedicated the thesis to my father Ayele Feyisa and my mother Kumale Bekele for their love and support throughout my life.

STATEMENT OF THE AUTHOR

First, I declare that this thesis is my own work and that all sources of materials used for writing it have been duly acknowledged. This thesis has been submitted to Jimma University College of Agriculture and Veterinary Medicine in partial fulfillment of the requirements for the Degree of Master of Science and is deposited at the library of the University to be made available to borrowers under the rules and regulations of the library. I declare that I have not submitted this thesis to any other institution anywhere for the award of any academic degree, diploma, or certificate.

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Place: Jimma University College of Agriculture and Veterinary Medicine

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LIST OF ABBREVIATIONS /ACRONYM

AFS	Agroforestry System
AGRPS	Aggregate Relative Preference Score
ANOVA	Analysis of Variance
ARPS	Adjusted Relative Preference Score
BOFED	Bureau of Finance and Economic Development
CSA	Central Statistical Agency
DA	Development Agent
ETB	Ethiopian Birr
FAO	Food and Agricultural Organization
FGD	Focus Group Discussion
Ha	Hectare
HHs	Household Heads
MOARD	Ministry of Agriculture and Rural Development
MOFED	Ministry of Finance and Economic Development
MS	Mean Score
SNNPRS	South Nations, Nationalities and People Regional State
SPSS	Statistical Package for the Social Science
TLU	Tropical Livestock Unit

BIOGRAPHICAL SKETCH

The author, Endale Bekele, was born on June 5, 1986 in Adadi peasant association, Jibat district, West Shoa Zone, Oromia National Regional State, Ethiopia. He attended education at Lemman Mata Hora Primary School and Dejazmach Geresu Duki Secondary and Preparatory School. Endale has BSc. degree in Natural Resources Economics and Management from Mekelle University College of Dry Land Agriculture and Natural Resources on July 18, 2009. Endale has been working for Office of Agriculture and Natural Resources at Sokorru district, Jimma zone since 2009 at various positions; soil and water conservation expert, Natural Resources Management team leader and expert of economist. Endale has joined Jimma University in September 2015 to pursue his study in Master of Science in Natural Resource Management.

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ABSTRACT

Integration of trees into land use practices which is commonly known as agroforestry system is an old aged experience of smallholder farmers in Southwest Ethiopia. There is a tenet that tree-based land use approach has socio-economic and environmental contributions. The objective of this study was, therefore, to assess how the smallholder farmers appreciate agroforestry system from the perspective of socio-economic and environmental contributions around Jimma town, Southwest Ethiopia. A total of 199 households were calculated and proportionally distributed to three selected sites (Mazora, Waro kolobo, and Merawa). Semi- structured and structured questionnaires were employed to collect the data. Data were analyzed using descriptive and econometric model. The result shows that tree-based agroforestry land use practice is an integral part of smallholder farmers' livelihoods in the study sites. Tree has socio-economic, cultural and environmental benefits. An average household income from trees was estimated to be 2592 ETB, 4652 ETB and 1922 ETB in Mazora, Waro kolobo, and Merawa sites, respectively. Smallholder farmers appreciate trees more importantly from the socio-economic point of views in home garden; pasture land and woodlot, while highly appreciate from environmental point of views in farmland and coffee farm across sites. More trees were recorded in home gardens across the three sites. Generally, species preference was vary across the land uses and sites. Education level, tree planting experience and land holding were positively and significantly influencing income derived from tree products, while livestock possession and major livelihood activity were negatively and significantly affecting income in the study sites. In general, tree-based agroforestry land use practice is the most crucial for improving livelihoods of smallholder households and environmental quality. Therefore, Tree-based agroforestry land use practice should be encouraged in the study sites.

Keywords: Agroforestry system, socio-economic, environmental and income

1. INTRODUCTION

1.1 Background and justification of the study

Agroforestry system is an integrated approach in solving land use problems. According to Molua (2005) and FAO (2013) it is a form of sustainable land use systems that combine tree with crop or animal husbandry simultaneously and sequentially. Literature has shown that due to its economic, social and environmental benefits, agroforestry is the common experience that has been promoted throughout (Akinnifesi *et al.,* 2008; Mugure and Onio, 2013; Mbow *et al.,* 2014). Casey (2004) and Dwivedi *et al.* (2007) have stated that agroforestry system is a mechanism to diversify production from a single land unit.

The Federal Government of Ethiopia has strengthened the agroforestry extension package as one of the rural development strategies in the country (MOARD, 2005). As a result, the agroforestry practice has expanded throughout the country to maximizing production and maintaining livelihoods of farmers from fixed land use. For example, in Sidama, South Nations, Nationalities and People Regional State (SNNPRS), there are different types of agroforestry practices such as tree-enset-coffee, tree-enset, woodlot, scattered trees on farmland and pasture land, and boundary planting (Asfaw and Agren, 2007; Madalcho and Tefera, 2016).

Agriculture is the mainstay of Ethiopian economy which accounts 42-45% of the total gross domestic product of the country (Zenebe *et al.,* 2011). Climate change, land degradation, shortage of land and deforestation are adversely affecting agricultural production (Pender and Gebremedhin, 2008; Smith *et al.,* 2010). Literature shows, tree-based agroforestry systems significantly contribute in alleviating poverty (Garrity, 2004). Because, mixing trees with annual crops is an option for diversifying productions and increase the productivity of land use which in turn helps the farmer to overcome the crop failure due to climate change (Verchot *et al.,* 2007; Bishaw *et al.,* 2013; Mbow *et al.,* 2014). Therefore, tree–based agroforestry practice is more profitable than monocropping (Mcneely and Schroth 2006) as cited by Linger, 2014).

Tree-based agroforestry system is developed either by planting or through naturally/protected trees under different land uses. Planting/protecting naturally regenerated trees on farmland contributes various benefits to the livelihood of the rural farmer (Gideon and Verinumbe, 2013). Farmers retains or planting different tree species on their farmland in order to obtain firewood and fodder for household consumption and income (Negash, 2007; Gebreegziabher *et al.,* 2010). All these points show the life of people relies on tree-based agroforestry products and environmental services. This reality is also similar in the Southwestern part of Ethiopia.

Smallholder farmers have an experience of AFS practice in Southwestern Ethiopia (Abebe *et al.,* 2010; Kebebew and Urgessa, 2011). Tree or shrubs based agroforestry practice is the most popular, particularly coffee-based agroforestry system is the dominant (Muleta *et al.,* 2007).

Tree-based agroforestry land use practice is playing a major role for improving and sustaining the livelihoods of smallholder farmers in Southwest, Ethiopia. Because it supports smallholder farmer through supplying various tree products and environmental benefits. For example, home garden agroforestry product offers income, which leads to increase the household income at the household level (Kebebew *et al.,* 2011). Tree-based agroforestry land use practice under different land use forms like in the home garden, coffee farm and farmland are accounted as a mainstay strategy because they help the farmers to maintain food security through buying cereal crops from local markets because they earned income from tree products (Kebebew and Urgessa, 2011). Further, they provide firewood, coffee shade and timber (Muleta *et al.,* 2007). Tree-based agroforestry lands use practice is the best approach for improving land productivity without imposing land degradation rather solving land degradation and reduce deforestation problems (Madalcho and Tefera, 2016).

Even though, many studies have been conducted in AFS in Southwestern Ethiopia but, most of them given a little or no emphasis on the socio-economic and environmental importance of AFS. As a result, there is a gap of information to policy makers, to the government and to smallholder farmers because they not have an equal understanding about the socio-economic and environmental benefits of agroforestry system. These show that there is an inadequate study of research in the study sites. Therefore, this research was conducted to fill a gap in the study sites.

1.2 Objectives

1.2.1 General objective

To assess how smallholder farmers appreciate the socio-economic and environmental contribution of agroforestry system around Jimma town, Southwestern Ethiopia

1.2.2 Specific objectives

- To assess and compare the benefits of agroforestry to smallholder farmers from socio-economic, cultural and environmental perspective;
- To assess and estimate the income contribution of tree products of AFS to smallholder farmers annual income;
- To assess and prioritize the most preferred agroforestry tree species in different land uses practices;
- To determine factors that influence income derived from tree products of AFS in the study sites

1.3. Research Question

This study was designed to address the following research questions:

- ✓ How do smallholder farmers appreciate the trees in land uses in view of socio-economic, cultural and environmental benefits?
- ✓ How much income from tree products contributes to smallholder farmer's annual income?
- ✓ Does agroforestry tree species preference varies with land uses and sites?
- ✓ What are the factors that affect income derived from tree products in AFS?

2. LITERATURE REVIEW

2.1 Concept and Definition of Agroforestry

Agroforestry is a dynamic, ecologically based natural resource management system through which the integration of trees/woody perennials in farm, diversifies and sustains production to increased social, economic and environmental benefits (Leakey, 1996). It is a new name for a traditional old land use practices, but late 1970 it emerged as modern improved land use systems. Some previous literature tried to show the relationship between land size and agroforestry practices. For instance, Ajayi and Kwesiga (2003) from Zambia and Oyewole *et al.* (2015) from Nigeria reported that land size is a basic one for enhancing agroforestry practice because the farmer who has a large size of land is willingly engaging in retaining/planting tree species on their land. Besides, the farmer who is holding a large size of land is more participating in the practice of agroforestry system in central Ethiopia (Sisay and Mekonnen, 2013). On other hand, a farmer who has small land size is less or not retaining naturally regenerated or planting trees on their land in Ghana (Kofi *et al.,* 2003).

In addition, the spreading and effectiveness of agroforestry system are different from place to place. This may be due to various factors like management (Negash, 2007), land ownership, size of land and gender equity (Mugure *et al.,* 2013), family size and numbers of livestock holding (Duguma, 2013) and in-depth understanding the benefits of trees, especial income (Kofi *et al.,* 2003).

2.2 Tree-Based Agroforestry Land Use System in Ethiopia

Agroforestry system is the ancient land use practice in Ethiopia. There are different types of agroforestry practice in the Ethiopia. For instance, Kidanu and Mekonnen (2006) identify three types of tree-based agroforestry land use practices such as pasture land, farm land and home garden in Northwestern Ethiopia as cited by (Ketsela, 2012). Besides, Abebe (2005) and Asfaw and Agren (2007) also noted that coffee shade tree, scattered trees on farmland, home garden, woodlots, farm boundary and grazing lands are types of traditional agroforestry land-use practices in Southern, Ethiopia. The enlargement of tree-based agroforestry land use practice under different landforms is the alternative method of increasing the efficiency of land because planting or maintaining of tree or shrub on farmland, roadsides, degraded land,

pasture land, and farm boundary use to minimize a shortage of wood products and improve the production ability of land simultaneously (Duguma and Hager, 2010). Coffee-enset-based agroforestry practice and parkland agroforestry practices are the most economical eye-catching. However, coffee-enset-based agroforestry practice is the best economical presentation than parkland agroforestry practices and accepted as the best strategy for improving the livelihood of smallholder farmers in Yirgachefe district of Gedeo Zone, Ethiopia (Ayele *et al.,* 2014). Woodlot of *Eucalyptus* is also the most agroforestry practice in Ethiopia because it plays a vital role in improving the livelihood of the farmer (Duguma and Hager, 2009; Kebebew and Ayele, 2010).

2.2.1 Home garden tree-based agroforestry system

Home garden agroforestry can be defined as a land use system involving deliberate management of multipurpose trees and shrubs in intimate association with annual and perennial agricultural crops and invariably livestock within the compounds of individual houses, the whole tree-crop–animal unit being intensively managed by family labor (Fernandes and Nair, 1986) as cited by (Das and Das, 2010). Tree, livestock and crops are the most commonly known as three stable ecosystems of home garden agroforestry, which is related to three scientific disciplines of forestry, animal rearing and agronomy, respectively (Abebe, 2005). As a result, it can improve the livelihoods of the farmer through providing multiple services like food/fruit, timber, firewood and fodder (Kumer and Nair, 2004 cited in Gebrehiwot, 2013).

However, home garden agroforestry land use practice has varied from place to place depending on its goal and types of tree species, farmer's interest and management system. For example, Abebe (2013) stated that home garden agroforestry in the SNNPRS was recognized by a unique combination of two native major perennials enset and coffee which grow in association with food crops, various trees species and livestock in a multilayer story agroforestry system.

Additionally, Gebrehiwot (2013) proclaimed some driving forces which lead the transition of home garden agroforestry to a mono-cultivation of cash crop and its result affecting the

people in SNNPRS. According to his finding population pressure, reduction of land size, poverty and the market situation were some of the driving forces which push home garden agroforestry land use practice to monoculture production of Khat and *Eucalyptus* species. He also found that this shift toward monoculture of crop production has affected the economic gain and the socio-cultural benefits derived from the traditional home garden agroforestry system in the region. The study conducted on functional identification and analysis, differentiated three functional groups in agroforestry system such as ecological, conservation and livelihoods functional groups (Huang *et al.,* 2002). Accordingly, they found that under functional group they not only include food, cash, and vegetable but also fruit trees. A fruit tree is the mainstay home garden agroforestry, which assists the smallholder household as subsistence and cash in Ethiopia. According to CSA (2012) *Mangifera indica, Carica papaya, Citrus sinensis* and *Persea americana* are a common fruit tree species in Southern Ethiopia. Furthermore, Yeshitela and Nessel (2004) also pointed out *Mangifera indica* is helping the farmer through providing additional income to the smallholder farmer in Eastern, Southern and Southwestern Ethiopia.

2.2.2 Farmland tree-based agroforestry System

It is a type of tree-based agroforestry land use system whereby a tree is always growing associated with a cereal crop such as maize, teff, sorghum. It's known a parkland farming system (Ayele *et al.,* 2014). This practice involves the growing of individual trees or shrubs in wide spaces or scattered and distributed on the farmland and without preventing other crops grown. Such types of tree species growing dispersed on cropland may be based on protection and careful managing of either naturally regenerated or planting new trees. Tree planting on farmland does not have any specific pattern, for instance, *Acacia albida, Croton macrostachyus* and *Ficus* species are the most common tree species on farmland in central Highlands of Ethiopia (Duguma and Hager, 2009). Besides, *Croton macrostachyus, Ficus sure, Albizia gummifera, Cordia africana, Acacia abyssinica, Rosa abyssinica, and Erthrina abyssinica* are also the most common tree species available on farmland in Jabithenan district, Northwestern Ethiopia (Linger, 2014) while *Eucalyptus spp.* and *Grevillea robusta* are grown as live fences, boundaries and small-scale woodlot.

According to Duguma and Hager (2009) around half (42%) of farmers are interested in scattered tree planting on farmland in central Highlands of Ethiopia. The intercropping of maize with *Cordia africana* in western Ethiopia, *Acacia albida* in Hararghe Highlands and Debrezeit area are common practices (Hoekstra *et al.,* 1990). The deliberate tree species on farmland is an agroforestry practice which has multiple values such as windbreak, firewood, shade, fodder, soil improvements, medicine, herbs, and construction materials in Nigeria (Jamala *et al.,* 2013). They also forwarded all these advantages have initiated the farmer to engage in agroforestry practices gladly through retaining naturally regenerated or planting trees on their farmland.

Currently, integrating of tree species with annual crops practice is accounted as the modern ways of increasing the production capacity of single land through diversifying the production with higher yields. Because of their multipurpose benefits the farmer is purposefully retaining or planting different tree species on their farmland. Some of their benefits are conserving soil erosion, enhance the water holding capacity of soil and improving soil fertility through nitrogen fixation (Yadessa *et al.,* 2001; Gideon and Verinumbe, 2013). Additionally, Asfaw (2006) also reported that tree available on the farmland provides socio-economic benefits like medicinal, fodder and fuel wood in Southeast Langano of Ethiopia.

2.2.3 Coffee farm tree-based agroforestry system

Coffee farm is the types of agroforestry land use in which various tree species used as a coffee shade are combined with coffee planting (Abebe, 2005). In Ethiopia, the farmer has experience of cultivating coffee crop under different shade trees. *Albizia schimperiana, Albizia gummifera, Millettia ferruginea, Cordia africana and Erythrina abyssinica* are the most compatible trees for coffee shade in Southwestern Ethiopia. In addition to shade services, they also offer various tree products like firewood, timber, construction materials and lastly improving soil fertility and reduction of soil erosion (Nigussie *et al.,* 2014; Hundera *et al.,* 2015). Besides, *Acacia abyssinica* are also the most favorable tree species for coffee shade in Southwestern Ethiopia (Muleta *et al.,* 2011).

2.2.4 Woodlot tree-based agroforestry

A woodlot is a piece of forest land which is developed for various purposes like firewood and construction (Duguma and Hager, 2009). They also verified that many farmers are separately planting tree on a small-scale woodlot as the best alternatives to land use practices. Because, it provides firewood, construction materials, and financial benefits, which reversely help smallholder farmers to meet their family's needs in Eza district of Ethiopia (Zerga, 2015). In India the farmers planting *Eucalyptus* woodlot for income purpose (Ravindran and Thomas, 2000).

In Ethiopia, particularly in rural areas, woodlot tree-based agroforestry land use is cultivated by smallholder farmer (Duguma and Hager, 2009; Kebebew and Ayele, 2010). The main purpose of *Eucalyptus* introduced into Ethiopia is to improve the supply of tree products and to reduce natural forest degradation. But, current time this perception is gradually changed to more benefits market-oriented (Pohjonen and Pukkala, 1990). Planting of *Eucalyptus* woodlot is the best strategy for improving the livelihoods of smallholder farmer, because it offers income and woody products for house consumption in Arsi Zone of Oromia, Ethiopia (Mekonnen, 2010). According to Kebebew and Ayele (2010) *Eucalyptus* woodlot contributes more income than income obtained from cereal crops and livestock. They also added that relatively *Eucalyptus globulus* contribute 50% of income to smallholder household in the central Highland of Oromia, Ethiopia. Due to this reason the farmers are allocated their land for Eucalyptus cultivation.

2.3 Benefits of Tree-Based Agroforestry System

2.3.1 Socio-economic benefits

The income earned from tree products is calculated from both non-timber forest products (NTFP) and timber forest products (TFP) such as fruit, firewood, honey, spices, timber, pole and charcoal (Kebebew *et al.,* 2011; Melaku *et al.,* 2014). Income obtained from tree produts is varying from place to place. For example, a farmer who participated in agroforestry practice is more advanced in extra income than a non-participated farmer in Tanzania (Charles *et al.,* 2013). This extra income obtained from tree products improve livelihoods of

farmers', especially during some risks occurred related to crop production due to climate changes (Kebebew and Urgessa, 2011).

According to Ndalama (2015) agroforestry practice is basic one for improving livelihoods of the farmer through various purposes; among them, it increases the income of farmer by 51.7% in Malawi. Besides, Emukule *et al*. (2013) also stated that total HHs annual income is increased by 40% due to the presence of agroforestry practice in Rwanda. Furthermore, the farmer obtains 47% income from NTFPs in Kaffa Zone, Southwest Ethiopia (Melaku *et al.,* 2014).

However, the amount of income derived from tree product is influenced by various factors. For example, socio-economic characteristic of the household farmers are the main factors. According to some literature experiences of tree planting, age of farmer, household wealth status, land size and education level are positively influencing the income of households (Jama and Zeila, 2005; Gebreegziabher *et al.,* 2010; Bwalya, 2013; Ahmed, 2015; Oyewole *et al.,* 2015).

According to Dwived *et al.* (2007) agroforestry practice is increasing because it contributes various advantages to the livelihoods of the household through the shade, fuel wood and income in Western Uttar Pradesh. Tree products contribute about 90% energy for cooking through fuelwood and charcoal in the rural population, especially for low-income households in Malawi (Malakini *et al.,* 2014). Tree-based agroforestry products contribute very high, high, very low and low and which account about 22.5%, 50%, 15% and 12.5%, respectively, with a products of food/fruit, fodder, and medicine 50%, 30%, and 20%, respectively in Karim-Lamido of Taraba State (Gideon and Verinumbe*,* 2013). Finally, all various advantages of tree-based agroforestry products which the farmer collected are evaluated through socio-economic and environmental importance (Anderson and Sinclair, 1993).

In Kenya, the most popular tree species that provides timber, poles, construction and firewood are *Grevillea robusta, Makhamia lutea, Cassia spectabillis* and *Eucalyptus* and again *Mangifera indica, Persea americana* and *Carica papaya a*re also the most common fruit tree species which assisted a farmer for house consumption or cash (Mugure and Oino, 2013). In

Karim-Lamido local Government, tree species like *Borassus aethiopium, Vitellaria paradoxa, Vitex doniana, Annona senegalensis, Ziziphus mauritiana, Ficus capensis, Balanates aegytiaca, Sychronus innucua, Psidium guajava* and *Mangifera indica* are retaining/planting on farmland. These tree species are playing a vital role in improving the farmer livelihoods through providing fruit/food, fodder, medicine, seeds, fibre and oil (Gideon and Verinumbe, 2013). Jamala *et al.* (2013) stated that the farmer retaining/planting different trees species on their farmland for the purpose of socio-economic and environmental services in Southeastern Nigeria.

The World Health Organization estimated that at least 80% of the populations of most developing countries rely for their primary health care on traditional medicine (WHO, 2001) as cited by (Gidey *et al.,* 2015). There are various works of literature which shows the benefits of tree or shrubs for traditional medicine in different parts of the Ethiopia. Fisseha (2007) identified various tree species which helped a local people as a medicine. For instance, *Croton macrostachyus* for malaria, diarrhea, epilepsy, ringworm and skin rush, *Cordia africana* to cure evil eyes, *Euphorbia candelabrum* for ringworm, *Millettia ferruginea* for fungal infection, *Vernonia amygdalina* for diarrhea and stomach ache. Hunde (2006) identified 52 medicinal plant species in Boosat district central Eastern Ethiopia and Abera (2014) also differentiated 39 medicinal plants used for the treatment of various diseases in Jimma zone, Southwestern Ethiopia.

Tree-based agroforestry land use practice provides a shade service in Kenya, it is considered as a socio-culture benefit (Jamala *et al.,* 2013; Mugure and Oino, 2013). Different tree species services as a shade for animal and human, especially during dry and heavy rainfall season (Zubair and Garforth, 2006). Besides, Negash (2007) also stated that people are assembled under a shade tree for social issues and praying in Southwestern Ethiopia.

2.3.2 Environmental benefit

Agroforestry is the basic alternative land use system in which tree growing in various land uses which provides numerous services. For example, it increases the environmental health quality, control soil and water erosion and improve soil fertility and enhance the moisture

holding capacity of the soil (Okigbo, 2003; El Tahir and Vishwanath, 2015). The farmer adopts agroforestry on their farmland by considering socio-economic and environmental benefits in Northern Rwanda (Emukule *et al.,* 2013). The integration of tree with annual crops is the best alternative for enhancing the productivity of land through diversifying agriculture and sustains production of land use (ICRAF, 1997). Ndalama (2015) pointed out that agroforestry serves for improving soil fertility, water retention, and soil and water conservation which in turn increase the crop yields in Malawi. Kalaba *et al.* (2010) also noted from Southern Africa Regions that agroforestry practices is playing a major role in environmental protection through reducing the soil erosion and raising the water holding capacity of the soil, especially on farmland.

Agroforestry can mitigate climate change through various techniques. According to Mbow *et al.* (2014) agroforestry practice is playing a major role in mitigating the negative impact comes due to climate change to agricultural production. Because agroforestry practice is a combination of tree with crop or animals within a specific land unit and sustains the productivity of land. This consequence will enhance the rural farmer to cope with the climate change. Agroforestry systems also tend to have increased crop diversity within the agroforestry systems such that a greater diversity of food, fuel and fodder items is produced for the smallholder farmer (Mendez *et al.,* 2010). Kebebew and Urgessa (2011) reported that tree-based agroforestry land use practice is strength for attaining food security, especially to subsistence agricultural farming system through providing cash to smallholder farmer, then the farmer can purchase cereal crop for house consumption.

2.4 Preference of Tree Species

According to Emukule *et al.* (2013) and Gideon and Verinumbe (2013) all tree-based agroforestry land use practices provide multiple benefits to the rural farmer. Even if they provide different advantages, it does not mean that the distribution of each tree species is the same in different land uses. For example, landscapes, topography, agro- climate are some factors which influence the distribution of tree species.

Many studies have been pointed out that tree preference depends on numerous factors. Among them farmer interest and characteristics of tree species take the first position in central Highland of Ethiopia (Duguma and Hager, 2010). According to them, *Cupressus lusitanica* is a least preferred tree species for house construction because it is damaged by insects and easily decomposed when contact with moisture. *Eucalyptus camaldulensis* and *Eucalyptus globulus* are highly favorable for constructions (both iron roof and thatch house). Besides, Aladi and John (2014) also reported that the farmer preferred growing of fruit tree on their farmland by considering their income, fruit/food and firewood contribution in Kogi State. They also added that 40% of the respondents are involved in growing fruit trees for food, while 30% grow trees for lumber, 12% and 10% grow trees for fuel wood and environmental protection, respectively.

Some agroforestry tree species get more acceptance by farmers, for instance, *Erythrina abyssinica* (100%), *Alnus acuminate* (94%), *Grevillea robusta* (77%) and *Iboza liparia* (72%) are the most preferred tree species for improving the livelihoods of rural farmers in Northern Rwanda (Emukule *et al.,* 2013). *Eucalyptus camaldulensis* is the most preferred tree species to smallholder farmers in Northern Ethiopia (Mekonnen, 2009). Besides, Mushtaq *et al.* (2012) also revealed that *Acacia nilotica* and *Dalbergia sissoo* are the most preferred tree species for firewood because they had better characteristic for ease in combustion, better fuel quality, low smoke emission, while *Mangifera indica* are the least preferred tree species for fuelwood in India. On other hands, identifying the most important tree species is helping the farmer to focus on more benefits tree species than less benefit one (Gausset, 2004; Duguma and Hager, 2009). According to Mulugeta and Admassu (2014) *Eucalyptus camaldulensis* is the most preferred tree followed by *Rhamnus prinoides, Catha edulis* and *Cordia africana,* respectively in Bahir Dar Zuriya of Amhara region, Ethiopia. They also concluded that understanding the farmer's notions and experiences they have on woody species diversity and preference are a key input for developing a future plan for tree species to be implemented on land use. *Cordia africana* and *Millettia ferruginea* can be managed on farmland and pasture land abundantly for different purposes (Bekele *et al.,* 1993; Yadessa *et al.,* 2001). Many time the farmer planting *Eucalyptus* solely as woodlot (Asfaw and Agren, 2007; Kebebew and Ayele, 2010).

3. MATERIALS AND METHODS

3.1 Description of the Study Sites

3.1.1 Location and topography

The study was conducted around Jimma town of Oromia Regional State within 20km radius, at Mazora, Waro kolobo, and Merawa sites, in Southwest Ethiopia. Jimma town is located at 352 km distances to Southwest from Addis Ababa, the capital city of Ethiopia (Tefera *et al.,* 2014). Geographically, it lies between latitude 7°40´N and 36°50´ E longitude with an average of elevation of 1750 meters above sea level (https://en.wikipedia.org/wiki/Jimma, 2017) (Figure 1). Temperature fluctuates between 6 °C and 31 °C. An average annual rainfall ranges from 1138 mm to 1690 mm (Alemu *et al.,* 2011).

Table 1 shows a detail description of the study sites. Almost Oromo is the dominant inhabitants in the area because of this Afan Oromo language is the most common spoken language.

Table 1: Description of the study site

S.N^{o}	**Variables**	**Mazora site**	**Waro kolobo site**	**Merawa site**
1	Total population size	9540	15281	18665
	Male	4660	7616	10262
	Female	4880	7665	8403
	Household head	1908	2204	2559
2	Area (Ha)	3403.5	3516.5	7932
3	Direction from Jimma town	Northwest	Southeast	Northeast

Source: WANRMO (Woreda Agriculture and Natural Resource Management Offices, 2016)

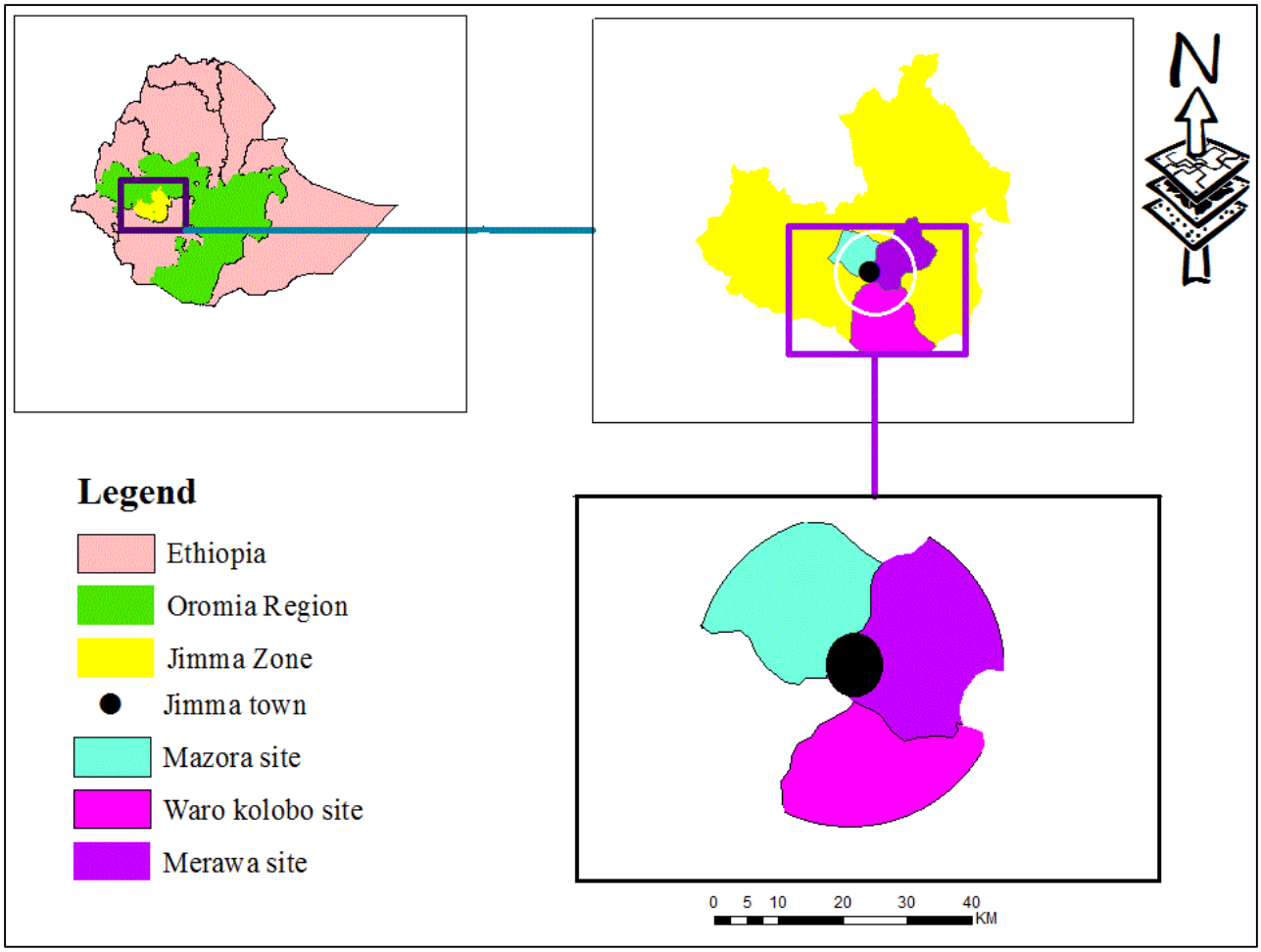


Figure 1: Map of the study sites

3.1.2 Socio-economic activity

A socio-economic livelihood of smallholder farmers depends on the mixed crop-livestock system on a subsistence scale. Teff, maize, sorghum, coffee, fruit crops, vegetables, potato, pulse, and enset are the dominant crops grown in the study sites (Kechero *et al.,* 2013). Maize is the most staple food crop in the study sites. Cows, oxen, goats, sheep, and poultry are a livestock commonly known in the study sites. Tree-based agroforestry land use practice is commonly known in the sites. Smallholder farmers have an experience of the home garden, farmland, coffee farm, and woodlot land uses agroforestry practices (Kebebew and Urgessa, 2011). Among them, coffee-based agroforestry practice is the main one in sites. The area is still known with a few remaining natural forests (Woldemariam, 2003).

Smallholder farmers obtain their annual income from crops, livestock, trees products and off-farming activity. Coffee and khat are the most important cash crops in the study sites.

3.2 Sampling Techniques

3.2.1 Study site selection

Reconnaissance field survey was conducted before the actual survey to capture information about the agroforestry practice coverage surrounding of Jimma town within 20 km radius. During this, the intensity and extent of tree-based agroforestry practice and accessibility of road were identified. Consequently, four districts: Mana, Seka chekorsa, Dedo and Kersa of Jimma Zone with eight sites such as Mazora, Yabu, Somoddo, Doyyo, Waro kolobo, Bore, Kachama and Merawa were identified.

A multistage technique was applied for the selection of the study sites. At first stage, Jimma zone was selected purposively. In second stage three districts Mana, Dedo, and Kersa were purposively selected based on reconnaissance result (extent and intensity of tree-based agroforestry practices, accessibility of road and 20km radius). In the third stage, three sites, namely Mazora from Mana, Waro kolobo from Dedo and Merawa from Kersa districts were selected purposively. Based on the same result the three kebeles (lower administrative) were purposively selected from each site at fourth stage. Namely Gubbe Muleta, Gudeta Bula, and Buxure from Mazora, Ofole Dewa, Waro Kobolo and Bilo Adijo from Waro kolobo site and Ankasso, Babo and Merawa from Merawa site. On the final stage, household head were selected through simple random sampling.

3.2.2 Sample size determination

The sample sizes of HHs were determined by Yemane (1967) formula. Table 2 shows a detail of total population size of each site along with their kebeles.

$$n = \frac{N}{1+N(e^2)} \quad \text{.....eq. 1}$$

Where: n= sample size

N= size of population

e= the desire level of precision

According to Yemane (1967), the margin of error varies between 5% and 10%. The marginal error of 7%, the confidence level of 95% and tabulated $Z_{0.25}$= 1.96 were used. Accordingly, total 199 sample sizes were selected from 6671 of total households in the study sites. Then the proportional size samples in each kebele was determined by (Eq. 2) formula and finally sum up the total sample size of each site which brings the entire sample of the study sites as well.

$$ni = \frac{Ni*n}{N} \text{..eq.2}$$

Where: ni= the sample size proportional determined, Ni= represents HHs size of the i^{th} strata, n= the sample size determined in equation 1 and N= the total HHs.

Table 2: Number of households and sample size proportional determined across the study sites

Sites	Kebeles	Numbers of households	Sample size determined proportional
Mazora	Buture	564	17
	Gudeta Bula	465	14
	Gubbe Muleta	879	27
	Total	**1908**	**58**
Waro kolobo	Woro kolobo	706	21
	Ofole Dawa	702	21
	Bilo Adijjo	796	23
	Total	**2204**	**65**
Merawa	Merawa	716	21
	Babo	902	27
	Ankasso	941	28
	Total	**2559**	**76**
	Total of HHs	**6671**	**199**

3.3 Data Collection Methods

Both primary and secondary data were used. Primary data was collected from sampled households through semi-structured and structured questionnaires, key informant interview, focus group discussion and field observation. Secondary data was collected from different source publications such as books, report, journal article and website and unpublished sources.

3.3.1 Households survey

Data was collected through a semi- structured and structured questionnaire from individual HHs through face to face contact. The questionnaire was developed in English language and then translated to local language Afan Oromo for the purpose of avoiding an information impurity during data collection and enhancing the validity of the data (Appendix 1). Before going to the main survey, the questionnaire was pre-tested using 30 farmers from three sites. Then, a questionnaire was modified through incorporating the result obtained in order to collect accurate data for this study site.

Information about socio-economic and demographic characteristics of HHs; name, age, family size, level of education, numbers of livestock, total land size and major livelihood activity were collected from the sampled HHs.

The total annual HHs income was quantitatively collected from individual HHs in the study sites. In this case, any products (tree, livestock and crop) used for house consumption is not included in cash. The amount of income estimated was only a one year (January 1, 2015 – December 30, 2016). Data about annual household income from tree products (timber, fruit, firewood, pole and charcoal) was collected from individual farmers by asking the amount of actual cash they obtained. An annual household income from crop products (coffee, khat, maize, teff) was collected from sampled household. Income from livestock products (egg and milk) and animal sales (cattle, donkey, mule, horse, sheep, goats and poultry) was collected from individual households. The name of each tree species existed in the study sites were recorded through interviewed KI and FGD. After the local name of each tree species was known, their scientific names were identified using useful trees and shrubs for Ethiopia and Eretria (Bekele, 2007) and honey bee flowers of Ethiopia (Fichtl and Adi, 1994). Top ten tree species were selected by two systems. At first, sixteen trees were selected depending on their importance value index (Appendix 3). In second, KI was asked to rank these tree species depending on their multipurpose uses by considering the numbers of tree species recorded per land use. Finally, top ten tree species were selected for the purpose of preference (Appendix 4). The qualitative information about the benefit of tree-based agroforestry land use practice such as socio-economic and environmental was collected from sampled HHs.

3.3.2 Key informant interview

Data about the current situation of the tree-based agroforestry land use practices, the name of tree species present in the study sites related to land use types, and the socio-economic contribution of the tree to the farmer was collected through KI. KI is an individual person who accounted as an elder, a knowledgeable person and constantly lived in the study sites for more than 35 years were selected by adapting the snowball method (Bernard, 2002). At each site level, two farmers were randomly asked to give the names of six key informants. Out of the 36 total KI mentioned; the top eight ranked were selected at each site level which makes 24 and totally 30 KIs with DA and admistrative body for the entire study. Wealth status of the farmer was ranked depend on the wealth status of Kebeles' criteria (land size, numbers of livestock and annual income) and cross-checked through KI. The information obtained from the KI was assisted as keywords in preparing the survey questionnaire.

3.3.3 Focus group discussion

This focus group discussion (FGD) was conducted to strength the information collected from KIs and HHs interviewed. Totally, six focus group discussions, two FGD per sites were arranged; in which one member consists 8 members per groups. The group consisted of a male and female headed household. Qualitative data was collected through FGD.

3.3.4 Field observation

Field observation carried out in the study sites to assess the existing situation of agroforestry systems and various tree species present on farmland, coffee farm, woodlot, grazing land and around home gardens. This was used to cross-check and enhances the reliability of information collected from selected HHs and key informant interview and FGD. Besides, documentation involving photographing of some of the agroforestry system association with the land use system, tree types, intercropping of the crop with the tree and the products of tree species was also used.

3.4 Data Analysis

Both quantitative and qualitative data were first summarized, categorized and coded then interred into Microsoft excel 2007, then copied into SPSS Version 20 (USA, 2013).

Socio-economic and demographic characteristics of HHs such as ages, family size, a level of education, land holding size, wealth status and the contribution of AFS to HHs were analyzed through descriptive statistics such as frequency, percentage, mean, maximum and minimum then presented in the form of table and bar chart. Finally, chi-square test was used to test the significance of some categorical variables while compared mean was tested by one-way ANOVA. The data obtained from FGD, key information and field observations were expressed in narrative forms.

Both pair-wise and matrix ranking were used for ordering the most preferred tree species per land use based on the criteria (income, fruit, firewood, construction, timber and coffee shade). Through these method each tree species was compared and their score value was obtained by the accounting the redundancy of tree species within the matrix box (Appendix 5). The scored value of tree species was ranged from 1 to 9 respective land use types. The highest score (9) refers the most preferred tree species and score (1) refers the least preferred tree species respective land use.

Then the most preferred tree species per land use types across the sute sites were calculated through adopted (Duguma and Hager, 2010) formula, who already used for preference of tree and shrub in Welmare and Alemgana districts in Oromia Regional State, Ethiopia.

Accordingly, at first, the mean score of each tree species was calculated by dividing the summation a score value of each tree species for a given use to a number of sampled households per the study site (Eq. 3). Adjusted relative preference score (ARPS) is essential for the relative preference ranking of tree species on the same use or in this paper on the same criteria. In the second, adjusted relative preference score (ARPS %) of a tree species was calculated by dividing the mean score of each tree species to a given use by the summation of the mean scores of all tree species listed for the same use then multiplied by hundred percent (Eq. 4).

Lastly, to get the preferred tree species in the study sites relative to land use types, aggregate relative preference score of tree species (AGRPS %) were calculated by dividing the summation of adjusted relative preference scores of each tree species for single use to the summation of adjusted relative preference scores of all use tree species (Eq. 5). If a species are not used for a given criteria, it gets an ARPS equal to 0%. The AGRPS is very suitable for differentiating the priority tree species across all user types for the studied households. Moreover, in smallholder household like in Southwestern Ethiopia, where tree-based agroforestry practice is common and many remained or planted tree species were available in different land uses for socio-economic and environmental benefits. It is good to see which agroforestry tree species is the most preferred across land use types in the study sites.

$$\mathbf{MS}_{\text{Spp (x), Use(y)}} = \frac{\sum \text{Scores}_{\text{spp(x),Use(y)}}}{\mathbf{n}} \quad \text{.....Eq. 3}$$

$$\mathbf{ARPS}_{\text{Spp (x), Use (y)}} = \frac{\mathbf{MS}_{\text{spp(x), Use (y)}}}{\sum \mathbf{MS}_{\text{spp(all),Use(y)}}} * 100 \quad \text{.....Eq. 4}$$

$$\mathbf{AGRPS}_{\text{Spp(x)}} = \frac{\sum \mathbf{ARPS}_{\text{Spp(x)}}}{\sum \mathbf{ARPS}_{\text{spp(all),Use(all)}}} * 100 \quad \text{.....Eq. 5}$$

Where,

$\mathbf{MS}_{\text{Spp (x), Use}}$ stands for mean score of species x to use type y; n stands for the number of sampled households per the study site. $\mathbf{ARPS}_{\text{Spp (x), Use (y)}}$ stands for the adjusted relative preference score of tree species x to use types y in percentage and **AGRPS** Spss (x) stands for the aggregate relative preference score of a species across all use types in percentage. Factor affecting income derived from tree products was analyzed by multiple linear regression models. It was developed to envisage whether or not the dependent and independent variables were significantly related or not. The dependent variable is annual HHs income obtained from tree products and nine independents variables. The general model used in multiple linear regressions was here as follows:-

Yi= Bo+B1X1+B2X2+……B9X9 + Ɛi

Where,

Yi= the **i**$^{\mathbf{th}}$ total annual income obtained from tree products

Bo=intercept

B1 to B9 = Coefficients of independent variable

X1 to X9 independent or explanatory variables which influence (Yi) and Ɛi= error.This study hypothesizes that these independent variables have effect on the income derived from tree products in the study sites. These, explanatory variables are expressed in (Table 3).

Table 3: Description of independent variable

Independent variable	**Unit**	**Description**	**Hypothesis**
Sites (X1)	Categorical	0=Mazora site 1=Waro kolobo site 2=Merawa site	Positive relationship
Sex (X2)	Dummy, takes the value of 1if female and 0 otherwise		Male head HHs positive relationship and other negative
Age (X3)	Year	Continuous	Negative relationship
Family size (X4)	Number	Continuous	Negative relationship
Education level (X5)	Grade	Continuous	Positive relationship
Total land size (X6)	Hectare	Continuous	Positive relationship
Experience of tree planting (X7)	Year	Continuous	Positive relationship
Livestock (X8)	TLU	Continuous	Positive relationship
Major sources of livelihoods (X9)	Dummy, takes the value of 1if agriculture and 0 otherwise (agriculture and off-farm)		Agriculture and off-farm activity is negative relationship

4. RESULT AND DISCUSSION

4.1 Socio-economic and Demographic Characteristics of Household in the Study Sites

The socio-economic and demographic characteristics result showed that among the sampled households 86.2% were male head households in Mazora and Waro kolobo, whereas 88.2% were male headed households in Merawa site (Table 4).

The age of respondent in Mazora site was minimum 20 and maximum 70 and in Waro Kobolo minimum 22 and maximum 75 age, while in Merawa site minimum 21 and maximum 75 age. The average age of respondents was 43.40, 47.77 and 42.63 years in Mazora, Waro Kobolo, and Merawa sites, respectively. The average age of HHs was a statistically significant difference ($p \leq 0.05$) between the study sites.

The average family size of the sampled HHs in Mazora, Waro kolobo and Merawa were 6.6, 6.2 and 6.1 persons per household, respectively; with minimum three and maximum ten family size in each the study site. A number of family sizes were relatively less than an average family size of Ethiopia National (7.4) but greater than Sub-Sahara average (5.6) (USAID, 2009).

The minimum and maximum education levels of respondents were estimated to be zero and ten (10) with the mean of 3.9, 2.74 and 2.66 in Mazora, Waro Kobolo, and Merawa sites, respectively. Education level was a statistically significant difference ($p<0.05$) between the study sites.

Among the sampled HHs 22.4 %, 38.5 %, 11.8%, were rich in Mazora, Waro kolobo, and Merawa sites, respectively. Similarly, 37.9%, 29.2%, and 47.4% of sampled HHs were medium in Mazora Waro kolobo, and Merawa sites, respectively. The chi-square ($\chi 2$) test result shows that there was statistically significant difference ($\chi 2 = 14.305$, $p=0.006<0.05$) between the study sites regard to wealth status of the household.

Table 4: Socio-economic and demographic characteristics of household farmer per the study site

Household characteristics		Mazora	Waro kolobo	Merawa	Average	Chi-square (χ^2)
Sex	Female	13.8%	13.8%	11.8%	13.1%	0.922
	Male	86.2%	86.2%	88.2%	86.9%	
Major sources of livelihoods						
Agriculture only		93.1%	92.3%	94.7%	93%	0.837
Agriculture and off-farm		6.9%	7.7%	5.3%	7%	
Wealth status	Rich	22.4%	38.5%	11.8%	24%	0.006*
	Medium	37.9%	29.2%	47.4%	38%	
	Poor	39.7%	32.3%	40.8%	38%	
						P-value
Ages (years)	Minimum	20.0	22.0	21.0	21	0.012*
	Maximum	70.0	75.0	75.0	73	
	Mean	43.40	47.77	42.6	44.6	
Family size (Numbers)	Minimum	3.0	3.0	3.0	3	0.325
	Maximum	10.0	10.0	10.0	10	
	Mean	6.6	6.2	6.1	6.3	
Education level (Grade)	Minimum	0.0	0.0	0.0	0	0.032*
	Maximum	10.0	10.0	10.0	10	
	Mean	3.9	2.74	2.66	3.1	
Tree planting experience (years)	Minimum	2.0	2.0	3.0	2	0.003*
	Maximum	32.0	39.0	32.0	34	
	Mean	13.26	14.92	12.9	14	

* The mean difference is significant at the 0.05

Source: Field survey (2016)

The assessment result shows that most 93% of smallholder farmers depend on agricultural activities, while only 7% are dependent on both agricultural and off - farm activities in the study sites. Therefore, agricultural activity is accounted as the mainstay for smallholder farmer livelihood in the study sites which includes crop production, livestock husbandry, and tree planting. This in line with Agize *et al.* (2016) who reported that in Ethiopia about 85% population's livelihood depends on agriculture activity. The mean experiences age of tree

planting of respondents were 13.26, 14.92 and 12.93 in Mazora, Waro Kobolo, and Merawa sites, respectively. The avegare of tree planting experience was mi in the minimum 2 and maximum 34 in the study sites. The experience of tree planting was a statistically significant difference ($p \leq 0.05$) between the study sites.

4.2 Land Use Types and Recorded Tree Species

In the study site, land use types were known as in the form of home garden, farmland, coffee farm, pasture land and woodlot (Table 5). The total average of home garden landholding size per HHs was 0.19 ha, 0.34 ha and 0.76 ha in Mazora, Waro kolobo and Merawa sites, respectively. Kebebew *et al.* (2011) reported that the size of home garden ranged from 0.01-1 ha with an average 0.15 ha from Southwestern, Ethiopia. The size of the home garden was statistically significant difference ($P \leq 0.05$) between the study sites.

The study result revealed that the land classified as a form farmland estimated to be about 34.6 ha, 52.4 ha and 60.3 ha in Mazora, Waro kolobo and Merawa sites, respectively. From these figure farmland size was occupied the largest portion of land use in the study sites. Similarly, Misana *et al.* (2003) from the Kilimanjaro region, Kebebew and Ayele (2010) from central Highland of Ethiopia revealed that land allocated for crop production is larger in size than for other land use.

Table 5: Land use types across Mazora, Waro Kobolo, and Merawa sites

Land use types	Mazora site		W/kolobo ste		Merawa site		Average values (ha)	P- value
	Area (ha)	%	Area (ha)	%	Area (ha)	%		
Home garden	10.8	13	21.8	18	25.9	20	19.5	0.000*
Farmland	34.6	41	52.4	44	60.3	46	49.1	0.026*
Coffee farm	26.9	32	14.7	12	19.1	14	20.2	0.000*
Pasture land	8.1	10	16.6	14	23.2	18	16.0	0.014*
Woodlot	4.3	5	14.1	12	3.3	3	7.2	0.000*
Average of land size per HHs	1.46		1.84		1.73		1.19	
Total land size	**84.7**	**100**	**119.6**	**100**	**131.8**	**100**	112.0	**0.051***

Source: Field survey (2016)

* The mean difference is significant at the 0.05

The size of land classified in the form of coffee farm was estimated to be 26.9 ha, 14.7 ha and 19.1ha Mazora and Waro kolobo and Merawa sites in that order. A coffee land size was a statistically significant difference (P≤ 0. 05) between the study sites. Around 4.3 ha, 14.1 ha and 3.3 ha of land was allocated as forms of woodlot in Mazora, Waro kolobo and Merawa sites, respectively.

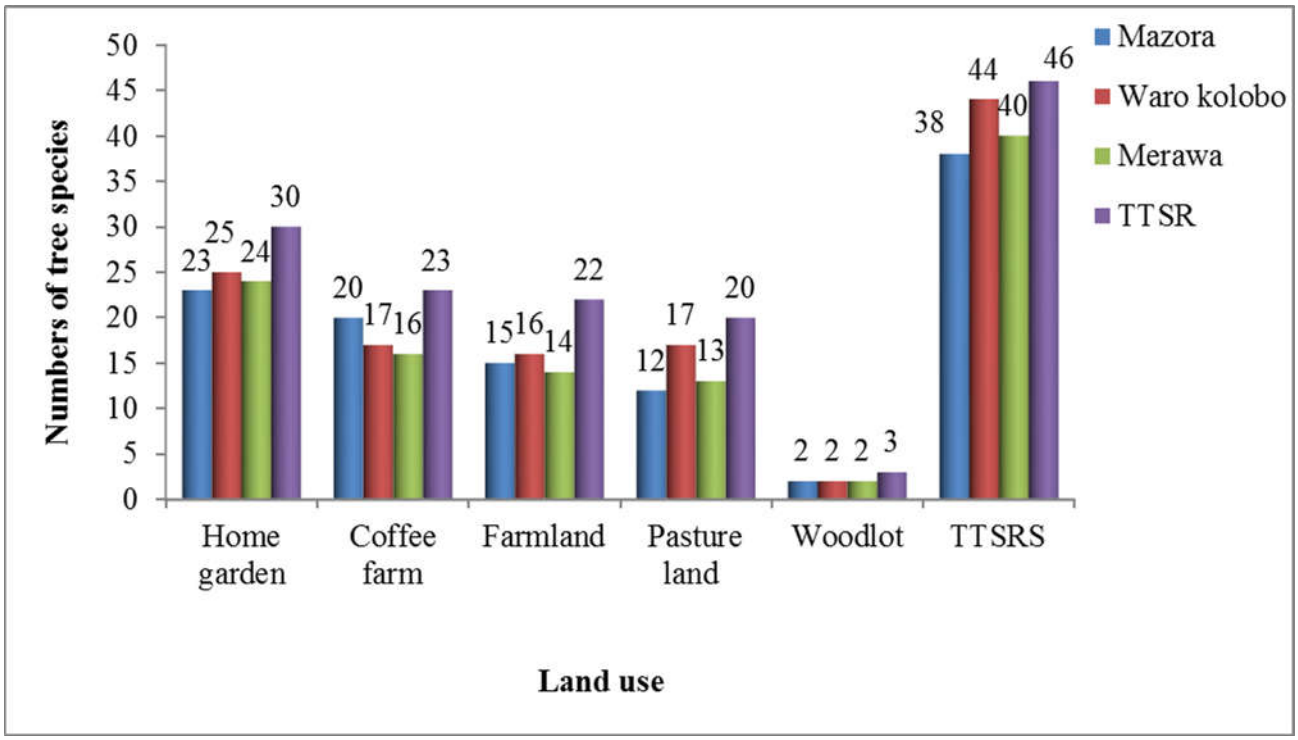
Depending on the study findings, it is possible to conclude that in Merawa site, home garden, farmland and pasture land were larger in size than Waro kolobo and Mazora sites. Besides, In Mazora and Waro kolobo sites the size of coffee farm and woodlot lands were larger in size than Merawa sites, respectively. Generally, average landholding size per HHs was 1.46 ha, 1.84 ha and 1.73 ha in Mazora, Waro kolobo and Merawa sites, respectively. The total average value of land size estimated to be 1.19 ha in the study sites. Kechero *et al.* (2013) reported that the size of land holding per HHs is vary, generally from 0.25 to 2.5 in Jimma, Southwestern Ethiopia. The total land size was statistically significant difference between the study sites (P≤ 0.05).

The numbers of tree species recorded in the study sites were shown in (Figure 2). The study result showed that total 46 numbers of tree species with 25 different families were recorded in the study sites. Among the recorded families, Fabaceae family was dominant. Accordingly, 30, 23, 22, 20 and 3 numbers of tree species were totally recorded in home garden, farmland, coffee farm, pasture land and woodlot, respectively. The name of each tree species was listed in (Appendix 2) respective to land use types across the study sites. Total tree species recorded across the study sites were not statistically significant difference (p >0. 05). However, the numbers of tree species recorded per land use types were statistically significant difference (P≤ 0.05) within site.

In home garden, 23, 25 and 24 numbers of trees species were recorded in Mazora, Waro Kobolo, and Merawa sites, respectively. Similarly, in coffee farm, 20, 17 and 16 number of trees species were recorded in Mazora, Waro Kobolo, and Merawa sites, respectively. In addition, 15, 16 and 14 number of trees species were recorded in Mazora, Waro Kobolo, and Merawa sites, in that order. *Eucalyptus camaldulensis* and *Cupressus lusitanica* were a common known as a woodlot tree-based agroforestry land use in Waro Kobolo and Merawa

sites while Mazora site is known by *Eucalyptus camaldulensis* and *Grevillea robusta* as woodlot tree-based agroforestry land use.

Generally, in the study sites, more trees were recorded in home garden than other land use. In home garden, fruit tree was the most dominant one. This result is similar with Kebebew and Urgessa (2011) who reported that home garden land use is mainly known by fruit tree species, which in turn assist the farmer for food/fruit and cash in Southwestern Ethiopia.



Source: Field survey (2016)

*TTSRS= Total Tree Species Recorded across Sites

Figure 2: Number of tree species recorded per land use across Mazora, Waro Kobolo and Merawa sites

4.3 Socio-economic, Cultural and Environmental Benefits of Tree-Based Agroforestry in the Study Sites

The benefits of tree-based agroforestry practice across land use in the study sites were shown in (Table 6). The study result showed that smallholder farmers were appreciated tree-based agroforestry practice through a socio-economic, cultural and environmental point of views.

4.3.1 Socio-economic benefits

The study result showed that among the sampled HHs 60% and 82.8% confirmed that tree available in home garden and woodlot help them to increases their income in Mazora site, respectively. Similarly, 62.1% and 85.6% of sampled HHs affirmed that tree in the home garden and woodlot provides extra income in Waro Kobolo site in that order, while 59.2% and 68.4% of sampled HHs were replied that they were benefited via income from home garden and woodlot tree products in Merawa site, respectively. This result is in line with Emukule *et al.* (2013) who reported that agroforestry practice increase farmer's income (59%) in Northern Rwanda. In this finding, tree-based agroforestry practice plays a major role in increasing the farmers' income in the study sites. Discussion with key informant showed that woodlot tree product provides more income than other land use tree products in the study sites.

In addition to direct income (cash) tree present under different land uses also provides numerous benefits to smallholder farmer in the study sites. In other words, it is called subsistence income; it is the value of tree products which the farmer used for house consumption or provided as a gift to neighbors. Among the sampled household 20.7% and 19.7% confirmed that they gained charcoal for house consumption from coffee farm tree in Mazora and Merawa sites, respectively, whereas 9.2% of HHs gained charcoal from farmland trees in Waro kolobo site. About 51.7%, 55%, and 71.1% of respondents responded that they were obtained construction materials from woodlot tree products in Mazora, Waro kolobo, and Merawa sites, respectively.

Table 6: Socio-economic, cultural and environmental benefits of tree-based agroforestry land uses across the study sites

Sites		Benefits												
		Socio-economic							Cultural			Environmental		
		Income (%)	Charcoal (%)	Construction (%)	Firewood (%)	Fodder (%)	Timber (%)	Fruit (%)	Beehives hanging (%)	Medicine (%)	Shade (%)	Soil moisture/fertility increase (%)	Soil and water conservation (%)	Coffee shade (%)
Mazora site	HG	60	6.9	46.6	46.6	13.8	34.5	62.1	6.9	34.5	13.8	25.9	-	20.7
	FL	41.4	15.5	15.5	46.6	25.9	20.7	-	-	-	10.3	27.6	67.2	-
	CF	46.6	20.7	15.5	25.9	10.3	15.5	-	20.7	10.3	-	46.6	20.7	92
	PL	20.7	10.3	25.9	41.4	36.2	10.3	-	-	22.1	87.9	-	-	-
	WL	82.8	-	51.7	48.3	-	-	-	-	-	5.8	-	-	-
Waro kolobo site	HG	62.1	-	41.5	32.3	18.5	36.9	55.4	18.5	9.2	9.2	9.2	-	13.8
	FL	32.3	9.2	13.8	41.5	9.2	46.2	-	-	13.8	18.5	27.7	73.8	-
	CF	32.3	4.6	18	18.5	23.1	9.2	-	9.2	27.7	-	41.5	-	69.2
	PL	41.5	4.6	41.5	36.9	32.3	13.8	-	-	-	78.5	-	-	-
	WL	85.6	-	55.4	46.2	-	-	-	-	-	10.5	-	-	-
Merawa Site	HG	59.2	-	43.4	27.6	15.8	35.5	71.1	15.8	11.8	15.9	7.9	-	15.8
	FL	39.5	3.9	63.2	35.5	15.8	43.4	-	-	19.7	11.5	33	67.1	-
	CF	51.3	19.7	7.9	23.7	7.9	15.8	-	7.9	15.8	-	39.5	-	89.6
	PL	43.4	3.9	15.8	15.8	26.3	32.9	-	-	29.5	71.1	-	-	-
	WL	68.4	-	71.1	63.2	-	-	-	-	-	8.9	-	-	-

Source: Field survey (2016)

HG=Home garden, FL= farm land, CF= coffee farm, PL= pasture land and WL= woodlot

The survey result showed that about 48.3%, 46.2%, 63.2% of farmers were collecting their firewood from woodlot in Mazora, Waro kolobo, and Merawa sites respectively. In study sites, primary energy (firewood) is obtained from tree products. This is in line with Missanjo *et al. (*2015) and Ndalama (2015) who reported that in the rural area, the farmer obtained their primary energy from trees products in Malawi. Fruit is one of the most advantages of tree products in the study sites because it helps the farmer as food sources, particularly children easily consumed it. Majority of the respondents per site mentioned that they obtained fruit from home garden fruit tree in the study sites. *Persea americana* is the most popular fruit tree, which is abudantly existing in the home garden in the study sites. This finding concurs with Emukule *et al.* (2013) who reported that agroforestry practice provides fruit in Northern Rwanda. Agize *et al.* (2016) also reported that farmers obtain fruit from home garden tree in Wolaita Zone, Southern Ethiopia.

During FGD farmers reported that tree-based agroforestry practice is helping them in supplying charcoal, firewood, pole, timber, and fodder for animal and construction materials. Because of this farmers not going further to collect trees products from natural forests in the study sites. This agrees with Emukule *et al.* (2013), Gideon and Verinumbe (2013) who reported that tree existing on farmland provides various benefits such as fodder, fuel wood, and building equipment. Mekonnen (2010) reported that *Eucalyptus* is the alternative for improving the livelihoods of farmer's because it provides various products like firewood, construction materials and incomes.

Source: Field survey (2016)

Figure 3: The discussion of community under Acacia *abyssinica* shade tree in the study sites

The study result showed about 34.5%, 27.7% and 29.5% of respondents responded that trees in the home garden, coffee farm and pasture land were used for traditional medicine in Mazora, Waro kolobo, and Merawa sites, respectively. According to KI mentioned that *Croton macrostachyus* is the most popular tree species used for traditionally medicine in the study sites. This agrees with Abera (2014) who reported that some tree species used for traditional medicine, especially *Croton macrostachyus,* in Ghimbi district, Southwest Ethiopia. Around 18.5% and 15.8% of HHs revealed that they have been traditionally hanging their beehives upon tree present in the home garden in Waro kolobo and Merawa sites, respectively. But also 20.7% of respondents responded that they were hanging beehives upon home garden trees in Mazora site. *Cordia africana, Croton macrostachyus, Acacia abyssinica* and *Albizia gummifera* were common trees which beehives were hanging upon them because

these trees have good branches for beehives hanging upon them (Figure 4). Woldemariam (2003) and Hartmann (2004) reported that the farmers are traditionally hanging beehives on tall trees in Southwest, Ethiopia. Around 87.9%, 78.5%, and 71.1% of sampled HHs revealed that tree exists in pasture land helping them as shade in Mazora, Waro kolobo and Merawa sites, respectively.

Beehives hanged on *Acacia abyssinica (a) and Albizia gummifera (b)*

Source: Field survey (2016)

Figure 4: Tree used for beehive hanging in the study sites

During field observation people were assembled under shade trees during social issue and holiday celebrations, especially during the dry season (Figure 3). *Acacia abyssinica, Albizia gummifera, Cordia africana, Podocarpus falcatus* were the most popular shade tree in the study sites. As farmers mentioned such kind of group discussion on a social issue will strengthen the intimacy of societal in the study sites. Mugure and Oino (2013) reported that people are planting/retaining *Grevillea robusta* and *Makhamia lutea* trees for the purpose of shade in Kenya. Negash (2007) reported that elder's people are collected under the shade of *Podocarpus falcatus* and *Ficus sur* trees elder's people are collected for resolution of numerous social issues and praying in Gedeo Zone, Southern Ethiopia.

4.3.2 Environmental benefits

In additional to socio-economic benefits, tree-based agroforestry practices also provide environmental benefits in the study sites. The study result showed about 67.2% of respondents responded that the integration of tree within crop field is assisting the soil and water conservation in Mazora and Merawa sites, whereas 73.8% also responded that trees exists in farmland supporting soil and water conservation in Waro kolobo site. This is in line with Kalaba *et al.* (2010) and Ndalama (2015) who noted that agroforestry support improving soil fertility, water retention, and soil and water conservation then in turn increase the crop yields in farmland. Among the interviewed HHs 92%, 69.2%, and 89.9% were answered that tree exist in coffee farm support as a coffee shade in Mazora, Waro kolobo and Merawa sites, respectively. Besides, 46.6%, 41.5% and 39.5% of sampled households also responded that tree in coffee farm also enhances the soil fertility/soil moisture in Mazora, Waro kolobo and Merawa sites, respectively. This agrees with Nigussie *et al*. (2014) who reported that coffee shade trees species is not only providing tree products but also improve soil fertility and reduce soil erosion in South Ethiopia. During FGD the farmer displayed that their general impression on coffee shade was quite positive and they considered shade as a precondition for coffee production systems in the study sites.

Generally, planting/retaining the tree under different land uses contributes socio-economic and environmental benefit from a single land unit to smallholder farmers in the study sites. Therefore, tree-based agroforestry land use practice is really the best strategy in solving land use problems in the study sites. This is in line with FAO (2013) who reported that agroforestry practice plays a major role in solving some African land use problems and through offering various tree products either for house consumptions or sales (Franzel *et al.,* 2001).

4.4 Source of Households' Annual Income in the Study Sites

In the study sites, agriculture crop, tree products, livestock and off-farm activities were the main income sources for sampled households (Table 7). The average income from sales of crops was estimated to be 6382 (60.15%), 2409 (26.33%) and 3817 (49.46%) ETB in Mazora, Waro kolobo and Merawa sites, respectively. Therefore, it is possible to conclude from these

results, in Mazora and Merawa sites, a crop is the major sources of income because both sites are mostly known by cash crop production like coffee and khat than Waro kolobo site. This is agreement with Woldemariam (2003), Kebebew (2010) and Megerssa *et al.* (2013) who reported that coffee and khat are a cash crop in Southwestern Ethiopia. The mean annual sources of household income from the agricultural crop was statistically significant difference between the study sites (F (2,196) = 8.82, p=0.000).

Tree products contribute an average income of 2592 (24.43%), 4652 (50.82%) and 1922 (24.90%) ETB to annual household income in Mazora, Waro kolobo, and Merawa sites, respectively. This coincides with Dwivedi *et al.* (2007) who reported that individual farmer is earning 24.4% of additional income from agroforestry practice in Western Uttar Pradesh. Furthermore, Safa (2005) also reported from Yemen, that AFS contributes extra income for farmers those practices of AFS than not practice. The mean annual income from tree products was statistically significant between the study sites (F (2,196) =5.31=p=0.006).

Table 7: Mean annual source of household income across in the study sites

Sources of HHs annual income (ETB)	**Sites**							
	Mazora		**Waro kolobo**		**Merawa**		**Avear age values**	**P-values**
	Mean	**Percent (%)**	**Mean**	**Percent (%)**	**Mean**	**Percent (%)**		
Annual income from crop	6382.1	60.15	2409.9	26.3	3817.6	49.45	4203.2	0.000*
Annual income from trees products	2592.6	24.43	4652.2	50.8	1922.1	24.90	3055.6	0.006*
Annual income from livestock	1204.8	11.36	1399.9	15.3	1592.7	20.63	1399.1	0.784
Annual income from off-farm activity	431.0	4.06	691.5	7.6	388.2	5.03	503.6	0.632
Mean annual income	**10,610**		**9154**		**7721**		**9162**	

ETB=Ethiopia Birr

* The mean difference is significant at the 0.05

Source: Field survey (2016)

During FDG the farmer mentioned that integrated tree-based agroforestry land use is a fundamental approach in enhancing the individual household annual income. As a result, they can purchase their basic necessities such as cereal crops for consumption and clothes.

In the study sites, off-farm activities are helping as sources of income, the smallholder households obtain income from different formal and informal activities. Off- farm income source is the rural household income which helps as a source of income outside of crop, livestock and tree products during a one year of the agricultural production period. As a result showed that the farmer obtained an annual income of (431) 4.06%, (692) 7.55% and (388) 5.03% ETB from off-farm activities in Mazora, Waro kolobo and Merawa sites, respectively. The mean annual income earned from off-farm activities is low in the study sites. This is due to three reasons, first, the nature of off-farm activities, which means that most activity is a conditional or temporary and it depends on the farmer's interest, second less land size owner farmers are frequently engaged in off-farm activities than large land size farmer and third farmer participation more increasing during low crop production.

4.4.1 Mean annual income of tree products in the study sites

Table 8 shows the relative mean annual income from integrated tree products across land use types. Thus, tree products help a farmer either for household uses or as a source of income through sales of timber, poles, fruit, charcoal and firewood across land use. As the sampled HHs responded that they have been getting an average annual income of 1197 ETB, 1452 ETB and 898 ETB from home garden tree products in Mazora, Waro kolobo and Merawa sites. This is concurs with Agize *et al.* (2016) who reported that home garden provides an average annual income from 800 to 1500 ETB in Wolaita Zone, Southwestern Ethiopia. But it is less than Kebebew and Urgessa (2011) findings. They reported that home garden tree product contributes an average income of 1683 ETB to household income in Jimma zone, Southwest Ethiopia. This is may be due to difference place of the study sites. The income contributed from home garden tree products (pole) to total annual household income shows statistically significant ($p \leq 0.05$) different between the study sites, whereas it is not significant from timber and fruit tree products. This may be due to the extent of *Grevillea robusta* and *Cupressus lusitanica* tree around the home garden in the study sites.

Table 8: Mean annual income of tree products per land use across the study sites

Mean annual HHs income of tree products (ETB)		Mazora Site	Waro kolobo Site	Merawa site	Average values	P-value
Home garden	Timber	38.17	41.85	177.12	85.7	0.087
	Poles	220.08	320.62	109.54	216.7	0.038*
	Fruit	939.03	1089.23	610.85	879.7	0.437
	Sub-total	**1197.28**	**1451.7**	**897.51**	**1182.2**	**0.368**
Farm land	Timber	14.03	33.08	103.32	50.1	0.03*
	Charcoal	11.88	32.85	00	14.9	0.372
	Sub-total	**25.91**	**65.93**	**103.32**	**65.1**	**0.177**
Coffee farm	Timber	20.93	31.61	67.39	40.0	0.143
	Charcoal	11.88	36.85	62.60	37.1	0.843
	Firewood	27.48	35.61	21.50	28.2	0.05*
	Sub-total	**60.29**	**104.07**	**151.49**	**105.3**	**0.260**
Pasture land	Timber	10.58	31.61	67.38	36.5	0.039*
	Charcoal	28.26	46.46	34.44	36.4	0.684
	Firewood	13.21	34.96	24.11	24.1	0.018*
	Sub-total	**52.05**	**113.03**	**125.94**	**97.0**	**0.15**
Woodlot	Poles	1239.09	2885.16	620.72	1581.7	0.000*
	Firewood	17.97	32.26	23.10	24.4	0.018*
	Sub-total	**1257.06**	**2917.42**	**643.82**	**1606.1**	**0.001***

ETB=Ethiopia Birr

* The mean difference is significant at the 0.05

Source: Field survey (2016)

Tree presence on pasture land contributed to household annual income of 52 ETB, 113 ETB and 151 ETB in Mazora, Waro Kobolo and Merawa sites in that older. The mean annual

income received from pasture land tree products was not statistically significant (P> 0.05) between the study sites, whereas the mean income from timber and firewood were a statistically significant difference (P≤ 0.05) between the study sites.

The average annual income from woodlot tree products contribute was estimated to be 1257 ETB, 2917 ETB and 644 ETB in Mazora, Waro kolobo and Merawa sites, respectively. Average of income obtained from woodlot products was relatively higher in waro kolobo than other sites. This is due to the extent of woodlot cultivation and the farmer's interest in Waro kolobo site. The average annual income obtained from woodlot was statistically significant difference (P ≤0. 05) between the study sites.

During FGD, farmers mentioned that they accrued extra income from integrated tree-based agroforestry products, additional to the annual income they earned from agriculture crops products, livestock and off-farm sources. They also boldly reported that income they earned from agricultural crop products like maize, teff, sorghum and coffee were not regular income because of some problems. These problems includes, crop disease, climate changes (rainfall) variation and land degradation which in turn bring low crop productions. However, the income obtained from tree products is helping them as a supplement (regular income) which enables the farmers cope up with such situation through enhancing the capacity of purchasing household materials, inputs, cereal crops, cover some cost likes fees of school and festivals. This agrees with Kebebew and Urgessa (2011) who reported that agroforestry contributes an average of 4148 ETB per household, which in turn help them to purchase food crops.

4.5 Preferred Tree Species in the Study Sites

The assessment result of tree species preference in the study sites is displayed in (Appendix 6). The study result showed that *Persea americana* was the most preferred fruit tree in home garden in the study sites (Figure 5), because it has the highest scored AGRPS value with the highest scored ARPS value for fruit and income. This finding concurs with Dimelu and Odo (2013) who reported that *Persea americana* is the most economical important fruit tree next to Ogbono (*Irvingia gabonensis*) and Kola (*Kola acuminate*) in home garden in Nigeria**.**

Source: Field survey (2016)

Figure 5: ***Persea americana*** **is the most preferred fruit tree in home garden in the study sites**

The AGRPS shown that *Cordia africana*, which scored the highest ARPS for income and timber, is the most preferred tree in farmland in Waro kolobo and Merawa sites, whereas *Acacia abyssinica* was the most preferred tree in Mazora site because it has scored highest AGRPS with highest scored ARPS for firewood. This finding agrees with Hoekstra *et al.* (1990) who reported that *Cordia africana* can be intercropped with maize crop. Negash (2007) also noted that *Cordia africana* assistant crop production in Gedeo, Ethiopia. As KI mentioned that *Cordia africana* has more quality of timber products than others trees and it also offers income when sold. *Millettia ferruginea* was the second most preferred tree species on farmland across the study sites because it has highest score of AGRPs with the highest score ARPS for firewood and income. This agrees with (Negash, 2007) who reported that firewood and timber products of *Millettia ferruginea and Cordia africana* are the most saleable on- farm income respectively in Gedeo Zone, Southern Ethiopia. Besides, Hailu *et al.* (2000) reported that *Millettia ferruginea is* the most suitable tree for improving soil fertility in addition to its economic benefits in Southern Ethiopia. Furthermore, Zebene (2003) aslo revealed that both are enhancing soil fertility in Sidama, Southern Ethiopia. The preferences of different tree on farmland were primarily underlining the suitability of tree for increasing crop production, through minimizing soil erosion and improving soil fertility. This finding consistent with different reports likes Kang and Akinnifesi (2000) and Neupane and Thapa

(2001) who found that agroforestry practice can increase the crops yield hrough nutrient recycling, reducing soil erosion and improving soil fertility.

The most preferred tree in coffee farm were *Millettia ferruginea, Albizia gummifera* and *Acacia abyssinica* in Mazora, Waro kolobo and Merawa sites, respectively (Figure 6). Individually each tree has scored the highest AGRPS with the highest scored ARPS for coffee shade. This is similar with Muleta *et al.* (2011) who reported that *Albizia gummifera, Millettia ferruginea* and *Acacia abyssinica* are the most favorable tree species for coffee shade in Southwestern Ethiopia. During FGD the farmers mentioned that the selection of appropriate trees for coffee shade is a crucial because they helps to increases coffee quality and coffee production. This finding was supported by Aerts *et al.* (2011) who found that the weight of coffee is relatively higher when produced under the *Millettia ferruginea* shade trees.

The study conducted on the potential and constraints of shade tree species in coffee production suggested that *Millettia ferruginea* is the father of coffee shade in Southern Ethiopia (Nigussie *et al.,* 2014). Besides, Kufa *et al.* (2007) and Ebisa (2014) also reported that coffee produced under *Acacia abyssinica* has a higher weight than other tree species. The main reason the farmer mentioned was that *Acacia abyssinica* is the most dominant and popular tree in coffee farms, and used for making a good quality firewood (charcoal) when its growth over matured which in turn offer income in Mazora. Besides, they also reported that it supports coffee as an umbrella in protecting coffee from exposing to hard climate condition, especially from high temperature during a dry season, from heavy rainfall and a chance of hail during the rainy season.

a) *Coffea arabica* (b) *Acacia abyssinica* (c) *Albizia gummifera* (d) Beehives

Source: Field survey (2016)

Figure 6*:* Preferred tree species in coffee farm

Eucalyptus camaldulensis was the most preferred tree as woodlot in the study sites (Figure 7a). Because it has the highest scored AGRPS value with the highest scored ARPS for income and construction. This agrees with Zerga (2015) who revealed that farmers ranked *Eucalyptus camaldulensis* at first for the source of income in Eza woreda, Ethiopia. Madalcho and Tefera (2016) reported that the farmer preferred Eucalyptus species for income, firewood and construction when planted as a woodlot in Wolaita Zone, Ethiopia. It is also used for firewood, which is very good when burned with smokeless fire. Besides, once it is planted it used for a long time because it has the behavior of coppicing ability within three up to four years. Ketsela (2012) and Bekele (2015) reported that *Eucalyptus globulus* species is the most preferred tree species in Ethiopia because it has the capability to be coppiced, fast growing, provides fuel, construction and cash.

Source: Field survey (2016)

Figure 7: *Eucalyptus camaldulensis* (a) and *Cupressus lusitanica* (b) woodlot tree based agroforestry land use in the study sites

Furthermore, the sampled HHs preferred *Grevillea robusta* next to *Eucalyptus camaldulensis* as woodlot in Mazora site, while *Cupressus lusitanica* next to *Eucalyptus camaldulensis* as woodlot in Waro kolobo and Merawa sites. Generally, the preferences of appropriate tree by sampled households were not similar from land use to land use and from site to site in the study sites. It depends on characteristics of tree, their benefit's (criterial) and farmer's desires.

4.6. Factors Affecting Income of Household derived from Tree Products in the study sites

The linear regression model analysis shows that out of the nine variables hypothesis, five of them found to be significantly affecting income derived from tree products ($P \leq 0.05$). These are, total land holding size, level of education and experience of tree planting were positively affecting income from tree products. However, the numbers of livestock holding and the major source of livelihood activities were negatively affecting and statistically significant ($P \leq 0.05$). The multiple coefficients of determination, R2 was above the moderate level of fitness,

which showed that 76.1% of the variation of income could be explained by the explanatory variables (Table 9).

As predicted, the level education of household head was positively and significantly (P≤ 0. 01) related to the amount of income earned from tree products. This implies that educated farmers' are relatively planting the tree than less educated one, as a means of income. For that reason when the farmer education level is increased by one grade, it would lead to increases the income of farmers by 294.203 factors other variables held constants. This coincides with Oyewole *et al.* (2015) who reported that educated farmer more participated in agroforestry adoption than a less educated farmer in Nigeria. Besides, educated farmers are more interested in planting tree species than uneducated one in Tigray, Northern Ethiopia (Gebreegziabher *et al.,* 2010).

The total land size was a positively affecting income of farmer earned from tree products and statistically significant (P≤ 0.01) as already predicted. With other factors held constant, when total land holding size was increased by 1ha, the amount of income the farmer obtained from tree products also increased by 627.927 factors. This suggests that the farmers who have a large size of land more participated in retaining or planting of different tree species on their land use which in turn provides income. This agrees with Oyewole *et al.* (2015) from Ekiti State, Nigeria, Gebreegziabher *et al.* (2010) and Abiyu *et al.* (2012) from Ethiopia who reported that farmers who have large land size more participating in tree planting than those farmers with relatively smaller size of land.

The experience of tree planting of HHs head, as predicted, was positively and significantly (P≤ 0. 01) affecting income obtained from trees. This suggests that income of household should increase by a coefficient of 80.527when the experience of the farmer in tree planting increased by one year. This result agrees with Oyewole *et al.* (2015) who reported that more experienced farmer is purposively planting/retaining trees on their land than a less experienced farmer.

Dissimilarity to the predicted, the numbers of livestock holding by HHs was negatively and statistically significant (P≤ 0. 05) affecting income derived from tree products. This implies

that farmers who have large numbers of livestock allocated large land size for pasture than tree planting in order to feed their livestock. This is due to traditional ways of keeping livestock through free grazing. Therefore, the farmer's income from tree products is decreased by 160.772 coefficients as the farmer's numbers of livestock increased by one TLU keeping all other variables constant. Gebreegziabher *et al*. (2010) reported that when the number of cattle increased the farmer attention was on them and comparatively they give less attention for tree planting in Tigray, Northern Ethiopia.

As prior assumption forecasted, the farmer's livelihood activity (source) was negatively affecting the income obtained from tree products and statistically significant ($P \leq 0.01$). This implies that a farmer who have additional livelihood source excluding agriculture activity they have an opportunity of getting additional income. Due to this reason, the farmer livelihood sources were diversified. Particularly, farmers who have additional income from off-farm activity is less likely to retaining/planting tree than farmers who have livelihood activity (only agriculture) because tree may take a long period to mature and return the income. Therefore, as the livelihood activity is diversified (agriculture + off- farm) the amount of income obtained from tree decreased by 9687.782 factors other factors remain constants.

Table 9: Multiple linear regression results in the study sites

Determinant factors	**Unstandardized Coefficients**		**Standardized Coefficients**	**T**	**p-value**
	B	**St. Error**	**Beta**		
(Constant)	7870.833	1696.894		4.638	.000
Sites	25.789	239.526	.004	.108	.914
Sex	133.903	541.128	.009	.247	.805
Age	40.528	21.049	.096	1.925	.150
Family size	-32.643	95.133	-.013	-.343	.732
Level of education	294.203	82.567	.167	3.563	.000***
Total holding land size	627.952	220.213	.111	2.852	.005***
Tree planting experience	80.527	29.025	.144	2.774	.006***
Livestock numbers	-160.772	68.674	-.099	-2.341	.020**
Major source of livelihoods	-9687.782	871.791	-.536	-11.113	.000***
R^2=.761		**Adjusted R^2 =.750**		**F =66.99**	

** and *** statistically significance at 5%and1% respectively

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions

In, Jimma zone, southwestern part of Ethiopia, smallholder farmers are familiarized with tree-based agroforestry land use practice. That is why this research was conducted on analysis of socio-economic and environmental contribution of agroforestry.

The result of the study shows that 38, 44 and 40 numbers of tree species were recorded in Mazora, Merawa and Waro kolobo sites, respectively, and a total of 46 different number of tree species were recorded in the study sites.

Smallholder farmer obtains multiple benefits from tree-based agroforestry land use under different forms of arrangements. Smallholder farmers appreciated trees were different with land uses and sites. Smallholder farmers appreciated trees importantly from the socio-economic point of views in home garden; pasture land and woodlot, while significantly appreciate from environmental point of views on farmland and coffee farm across sites.

Income from tree products contributes significantly to the livelihood of sampled farmers in the study sites. Respondent farmers obtained an average annual income of 3055 ETB in the study sites. This income helps them as a supplementary income, which enables the farmers to fulfill their family needs.

Persea americana, *Eucalyptus camaldulensis* and *Acacia abyssinica* were the most preferred tree species in the home garden, woodlot and pasture land in the study sites, respectively. On farmland, *Cordia africana* was the most important tree species in Waro kolobo and Merawa sites, while *Acacia abyssinica* was the most important tree species in Mazora site. In a coffee farm, *Millettia ferruginea, Albizia gummifera,* and *Acacia abyssinica* were the most important tree species in Mazora, Waro kolobo and Merawa sites, respectively.

From the total of nine (9) independent variables hypothesized to be affect income from tree products, five variables were found to have significantly impact. Among the significant

variables education level, tree planting experience and total land size were positively affecting income derived from tree products, while livestock possession and major livelihood activity were negatively influencing income in the study sites. Generally, integrating tree in land use practice was accounted as a keystone in improving the livelihoods of the households through providing socio-economic and environmental benefits in the study sites.

5.2 Recommendations

Based on the study findings, this research comes up with the following recommendation:-

- The sampled HHs highly realized the contribution of tree-based agroforestry in improving their livelihoods through socio-economic, cultural and environmental, so that the government should be encouraging this practice in the study sites.
- Educated famers are relatively more participated in retaining/planting tree on their own land. So that education should be encourage.
- More experienced farmers are relatively more participated in tree-based agroforestry land use practice. Therefore, empowering and inspiring more experienced farmer for retaining/ planting tree should be needed.
- The extent of retaining/planting tree is increases with land size increase; it should be modified through integrating of the tree into land use intensively rather than extensively.
- High numbers of livestock are need large size of land in order to feed them because livestock were traditional kept in the study sites. This is will affecting planted/regenerated tree species. Therefore, intervention should be needed through training on how tree integrate with livestock at fixed land unit can improve fodder without affecting planted/regenerated trees.
- Finally, to insure the sustainability of farmer's livelihood; awareness should be given to smallholder farmer on AF practice and the government also proclaim a policy on how tree can be integrate with crop and livestock production.
- Further research is needed on management system, cost-benefits analysis of AFS and market availability to tree products in the study sites.

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APPENDICES

Appendix 1: Questionnaire survey formats

I. BASIC INFORMATION

- Name of enumerator _____date _____

1. Name of farmer_____sex (male/female)_____Age_____
   Region_____District_____Mayibas/site/_____Kebele (PA) ___
2. Family size: _____Male _____ female _____
3. Level of education: (educated /uneducated)_____
4. Wealth status based on kebele's criteria (Poor/medium/rich)_____
5. Major sources of livelihood activity
   1) Agriculture activity 2) Agriculture and off- farm activity
   If you have off- farm activity mention it

   _____
6. Tree planting experience years _____

II. SOCIO-ECONOMIC

1. Land use types and landholding size

Land use types	**Area (ha)**	**Remark**
Home garden(HG)		
Farm land (CL)		
Woodlot(WL)		
Grazing land (GL)		
Coffee farm (CF)		
Total		

2. List of livestocks

Name	**Number/Unity**	**Remark**
Oxen		
Cows		
Heifers		

3. List the name of tree agroforestry respective land use type

Land use type	Name of tree species	Planted (P) or natural regenerated(N)	Benefits of Tree-Based Agroforestry land use practice (a) Socio-economic (b) Cultural (c) Environmental

3.1 **Benefits of Tree-Based Agroforestry land use practice** (make tick ✓ t benefit of trees)

Land use	Name of Tree species	Benefits of																
		Socio-economic									Cultural				Environmental			
		Income	Firewood	Charcoal	Fruit/Food	Construction	Timber	Fodder			Shade	Bee hive hanging	Medicine	Others	Maintain soil moisture/im	Soil and water conserve	Coffee shade	Others
Home garden																		
Farmland																		
Coffee farm																		
Pasture land																		
Woodlot																		

III. ANNUAL SOURCE OF HOUSEHOLD INCOME

3.1. Annual income from livestock

No	Livestock	Number /Unit	Sold		Unity/price		Total income		Remark
			Life	Products					
1	Oxen								
2	Cows								
3	Heifers (*gider)*								
4	Young bulls (*woyfen*)								
5	Calves								
6	Sheep								
7	Goats								
8	Donkeys								
9	Horses								
10	Mules								
11	Poultry								

3.2 Annual incomes from crop product

No	Crop production	Unit	Qty	Qty Sold	HHs consumptions	Unit/price	Total income	
1	Maize							
2	Teff							
3	Wheat							
4	Sorghum							
5	Barley							
6	bean							
7	Peas							
8	Khat							
9	Coffee							

3.3 Annua income derived from trees product

No	Tree species	LU	Tree products	Units	Price /unity	Total cash /income	Remark
1							
2							
3							
4							

***Tree products**: Charcoal, firewood, pole, fruit and timber

3.4 Annual incomes from off- farm activities

No	Types of activity	When	Unity	Income /unity	Total income	Remark
1						
2						
3						

***Unity** =Month, daily or years

3.5 Pair wise ranking of tree species in each land use (Home garden, farm land, Coffee farm, pasture land and Woodlot) across the study sites

<u>Criteria;</u> Income, firewood, charcoal, fruit/food, coffee shade, timber and construction materials per land use across the study site

Name of tree species	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Cordia africana (A)										
Eucalyptus camaldulensis (B)										
Mangifera indica (C)										
Cupressus lusitanica (D)										
Grevillea robusta (E)										
Persea americana (F)										
Acacia abyssinica (G)										
Albizia gummifera (H)										
Croton macrostachyus (I)										
Millettia ferruginea (J)										

<u>Questionnaire for Key informants</u>

1. What are the basic major livelihoods activities of household farmer in study sites?
2. What are the criteria used to identify household wealth status?
3. What is currect state of tree-based agroforestry practice in the area?
4. List all tree species available in the area respective to land use types?
5. List and rank ten most important agroforestry tree species in the area depend on their multi purpose benefits in the area?

Questionnaire for focus group discussion

1. Discuses on the socio-economic and environmental benefits of trees to smallholder farmer in site?
2. Discuses on the income contribution of tree products to annual household income?
3. Discuses on the reason of tree preferred in each land use in site?

Appendix 2: Name of tree species recorded across land use in the study sites

- Mazora site

S.no	Local name	Scientific name	Family name	Land use					Establishment form
				HG	CL	CF	PL	WL	
1	Lafto	*Acacia abyssinica Hochst.ex Benth.*	Fabaceae	0	0	+	+	0	B
2	Kofale	*Albizia grandibracteata Taub.*	Fabaceae	0	0	+	0	0	N
3	Ambabessa gurracha	*Albizia gummifera (J.F.Gmel.) C.A.Sm*	Fabaceae	+	0	+	0	0	B
4	Ambabessa	*Albizia schimperiana Oliv.*	Fabaceae	+	+	+	+	0	B
5	Gishta	*Annona senegalensis (A. chrysophylla)*	Annonaceae	+	0	0	0	0	P
6	Jackfruit	*Artocarpus heterophyllus*	Moraceae	+	0	0	0	0	P
7	Lolchisa	*Bersama abyssinica Fresen subsp.*	Melianthaceae	0	0	0	+	0	N
8	Pappaya	*Carica papaya L.*	Caricaceae	+	0	0	0	0	P
9	Kashmir	Casimora edulis La Llave & Lex.	Rutaceae	+	0	0	0	0	P
10	Jimaa	*Khata edulis (Vahl.) Forssk.ex Endl.*	Celastraceae	+	0	0	0	0	P
11	Lomi	*Citrus aurantifolia (Christm.) Swingle*	Rutaceae	+	0	0	0	0	P
12	Buna	*Coffea arabica L.*	Rubiaceae	+	0	+	0	0	P
13	Wadessa	*Cordia africana Lam.*	Boraginaceae	+	+	+	+	0	B
14	Bakanissa	*Croton macrostachyus Hochst.ex Del.*	Euphorbiaceae	+	+	+	+	0	B
15	Ulaga	*Ehretia cymosa Thonn.*	Boraginaceae	0	0	+	0	0	N
16	Welensu	*Erythrina brucei Schweinf.*	Fabaceae	+	+	+	0	0	N
17	Bargamo dima	*Eucalyptus camaldulensis Dehnh.*	Myrtaceae	+	0	0	0	+	P
18	Adami	*Euphorbia candelabrum*	Euphorbiaceae	0	+	0	+	0	N
19	Harbu	*Ficus sur Forssk.*	Moraceae	0	+	+	0	0	N

20	Dambi	*Ficus thonningii Blume*	Moraceae	+	0	0	0	0	N
21	Kiltu	*Ficus vasta Forssk.*	Moraceae	0	0	+	+	0	B
22	Gravillea	*Grevillea robusta A.Cunn.ex R. Br.*	Proteaceae	+	+	0	+	+	P
23	Gatira–faranji	*Cupressus lusitanica Mill.*	Cupresaceae	+	0	0	0	0	P
24	Abeyi	*Maesa lanceolata Forssk.*	Myrsinaceae	0	+	+	+	0	N
25	Mango	*Mangifera indica L.*	Anacardiaceae	+	0	0	0	0	P
26	Askira	*Millettia ferruginea (Hochst.) Bak.*	Fabaceae	+	+	+	+	0	B
27	Baya	*Olea welwitschii* (Knobl.)Gilg. and Schellenb	Oleaceae	0	+	+	0	0	N
28	Avocado	*Persea americana Mill.*	Lauraceae	+	0	0	0	0	P
29	Birbirsa	*Podocarpus falcatus (Thunb.)* R. B. *ex Mirb.*	Podocarpaceae	0	+	+	0	0	N
30	Keraro	*Pouteria adolfi-friederici* (Eng.) Baehni	Sapotaceae	0	0	+	0	0	N
31	Homi	*Prunus africana* (Hook.f.) Kalkm.	Rosaceae	0	+	+	+	0	N
32	Kocki	*Prunus persica (L.) Batsch*	Rosaceae	+	0	0	0	0	N
33	Bosoka	*Sapium ellipticum* (Hochst.) Pax	Euphorbiaceae	0	0	+	+	0	N
34	Qundo berbere	Schinus molle L.	Anacardiaceae	0	+	+	0	0	N
35	Sesbania	*Sesbania sesban* L. Merr	Fabaceae	+	+	+	0	0	P
36	Badessa	*Syzygium guineense* (Wild.) DC.subsp.	Myrtaceae	0	+	0	0	0	
37	Ebicha	*Vernonia amygdalina* Del.in Caill.	Asteraceae	+	0	0	0	0	N
38	Reji	*Vernonia auriculifera* Hiern.	Asteraceae	+	0	0	0	0	N
Total tree species		***38***		**23**	**15**	**20**	**12**	**2**	

Key

Land use; HG=Home garden, FL= farm land, CF= coffee farm, PL= pasture land and WL= woodlot

Presence indicator; +=presence 0= not presence

Establishment form; N=natural, P=planted and B=both (N and P)

- Waro kolobo site

S.nº	Local name	Scientific name	Family name	Land use					Establishment form
				HG	CL	CF	PL	WL	
1	Gishta	*Annona senegalensis (A. chrysophylla)*	Annonaceae	+	0	0	0	0	P
2	Lafto	*Acacia abyssinica Hochst.ex Benth.*	Fabaceae	0	+	+	+	0	B
3	Kofale	*Albizia grandibracteata Taub*	Fabaceae	0	0	+	0	0	N
4	Ambabessa gurracha	*Albizia gummifera (J.F.Gmel.) C.A.Sm*	Fabaceae	0	0	+	+	0	B
5	Ambabessa	*Albizia schimperiana Oliv.*	Fabaceae	0	+	0	0	0	N
6	Jackfruit	*Artocarpus heterophyllus*	Moraceae	+	0	0	0	0	P
7	Lolchisa	*Bersama abyssinica Fresen subsp.*	Melianthaceae	0	0	0	+	0	N
8	Pappaya	*Carica papaya L.*	Caricaceae	+	0	0	0	0	P
9	Kashmir	*Casimora edulis La Llave & Lex.*	Rutaceae	+	0	0	0	0	P
10	Jimaa	*Khata edulis (Vahl.) Forssk.ex Endl.*	Celastraceae	+	0	0	0	0	P
11	Lomi	*Citrus aurantifolia (Christm.) Swingle*	Rutaceae	+	0	0	0	0	P
12	Burtukana	Citrus sinensis (L.) Osbeck	Rutaceae	+	0	0	0	0	P
13	Buna	*Coffea arabica L.*	Rubiaceae	+	0	+	0	0	P
14	Wadessa	*Cordia africana Lam.*	Boraginaceae	+	+	+	+	0	B
15	Bakanissa	*Croton macrostachyus Hochst.ex Del.*	Euphorbiaceae	+	+	+	+	0	N
16	Ulaga	*Ehretia cymosa Thonn.*	Boraginaceae	0	0	+	0	0	N
17	Sombo	*Ekebergia capensis Sparrm.*	Meliaceae	+	+	+	0	0	N
18	Welensu	*Erythrina brucei Schweinf.*	Fabaceae	+	0	0	0	0	N
19	Bargamo dima	*Eucalyptus camaldulensis Dehnh.*	Myrtaceae	+	0	0	0	+	P
20	Adami	*Euphorbia candelabrum*	Euphorbiaceae	0	0	0	+	0	N
21	Oda	*Ficus sycomorus L.*	Moraceae	0	0	0	+	0	N

22	Dambi	*Ficus thonningii Blume*	Moraceae	+	0	0	0	0	N
23	Kiltu	*Ficus vasta Forssk.*	Moraceae	0	0	+	+	0	N
24	Gravillea	*Grevillea robusta A.Cunn.ex R. Br.*	Proteaceae	+	+	0	0	0	P
25	Gatira–faranji	*Cupressus lusitanica Mill.*	Cupresaceae	+	0	0	0	+	P
26	Abeyi	*Maesa lanceolata Forssk.*	Myrsinaceae	+	+	+	+	0	B
27	Mango	*Mangifera indica L.*	Anacardiaceae	+	+	0	0	0	P
28	Kombolcha	*Maytenus arbutifolia (Hochst.A.Rich.)Wilczek*	Celasteraceae	0	0	0	+	0	N
29	Askira	*Millettia ferruginea (Hochst.) Bak.*	Fabaceae	+	+	+	+	0	B
30	Baya	*Olea welwitschii (Knobl.)Gilg. and Schellenb*	Oleaceae	0	+	+	0	0	N
31	Avocado	*Persea americana Mill.*	Lauraceae	+	0	0	0	0	P
32	Birbirsa	*Podocarpus falcatus (Thunb.) R. B. ex Mirb.*	Podocarpaceae	0	+	0	0	0	N
33	Homi	*Prunus africana (Hook.f.) Kalkm.*	Rosaceae	0	0	+	0	0	N
34	Zeyituna	*Psidium guajava L.*	Myrtaceae	+	0	0	0	0	P
35	Bosoka	*Sapium ellipticum (Hochst.) Pax*	Euphorbiaceae	0	+	+	+	0	B
36	Qundo berbere	*Schinus molle L.*	Anacardiaceae	0	+	0	0	0	N
37	Sesbania	*Sesbania sesban L. Merr*	Fabaceae	+	0	+	0	0	P
38	Badessa	*Syzygium guineense (Wild.) DC.subsp.*	Myrtaceae	0	+	+	+	0	N
39	Ebicha	*Vernonia amygdalina Del.in Caill.*	Asteraceae	+	0	0	0	0	N
40	Rejji	*Vernonia auriculifera Hiern.*	Asteraceae	+	0	0	0	0	N
Total tree species		40		24	14	16	13	2	

Key

Land use; HG=Home garden, FL= farm land, CF= coffee farm, PL= pasture land and WL= woodlot

Presence indicator; +=presence 0= not presence

Establishment form; N=natural, P=planted and B=both (N and P)

- Merawa site

S.nº	Local name	Scientific name	Family name	Land use					Establishment form
				HG	CL	CF	PL	WL	
1	Lafto	*Acacia abyssinica Hochst.ex Benth.*	Fabaceae	0	+	+	+	0	B
2	Kofale	*Albizia grandibracteata Taub*	Fabaceae	0	0	+	0	0	N
3	Ambabessa gurracha	*Albizia gummifera (J.F.Gmel.) C.A.Sm*	Fabaceae	0	0	+	0	0	N
4	Ambabessa	*Albizia schimperiana Oliv.*	Fabaceae	+	+	0	+	0	N
5	Gishta	*Annona senegalensis (A. chrysophylla)*	Annonaceae	+	0	0	0	0	P
6	Jackfruit	*Artocarpus heterophyllus*	Moraceae	+	0	0	0	0	P
7	Lolchisa	*Bersama abyssinica Fresen subsp.*	Melianthaceae	0	0	0	+	0	N
8	Pappaya	*Carica papaya L.*	Caricaceae	+	0	0	0	0	P
9	Kashmir	*Casimora edulis La Llave & Lex.*	Rutaceae	+	0	0	0	0	P
10	Jimaa	*Khata edulis (Vahl.) Forssk.ex Endl.*	Celastraceae	+	0	+	0	0	P
11	Lomi	*Citrus aurantifolia (Christm.) Swingle*	Rutaceae	+	0	0	0	0	P
12	Burtukana	*Citrus sinensis (L.) Osbeck*	Rutaceae	+	0	0	0	0	P
13	Buna	*Coffea arabica L.*	Rubiaceae	+	0	+	0	0	P
14	Wadessa	*Cordia africana Lam.*	Boraginaceae	+	+	+	+	0	B
15	Bakanissa	*Croton macrostachyus Hochst.ex Del.*	Euphorbiaceae	+	+	+	+	0	N
16	Rukkessa	*Dracaena afromontana Mildbr.*	Agavaceae	0	0	0	+	0	N
17	Ulaga	*Ehretia cymosa Thonn.*	Boraginaceae	+	0	+	0	0	N
18	Sombo	*Ekebergia capensis Sparrm.*	Meliaceae	0	+	+	0	0	N
19	Welensu	*Erythrina brucei Schweinf.*	Fabaceae	+	+	0	0	0	B
20	Bargamo dima	*Eucalyptus camaldulensis Dehnh.*	Myrtaceae	+	0	0	+	+	P
21	Adami	*Euphorbia candelabrum*	Euphorbiaceae	0	0	0	+	0	N
22	Harbu	*Ficus sur Forssk.*	Moraceae	0	0	0	0	0	B
23	Oda	*Ficus sycomorus L.*	Moraceae	0	0	0	+	0	N

24	Dambi	*Ficus thonningii Blume*	Moraceae	+	0	0	0	0	N
25	Kiltu	*Ficus vasta Forssk.*	Moraceae	0	+	+	+	0	B
26	Gravillea	*Grevillea robusta A.Cunn.ex R. Br.*	Proteaceae	+	+	0	0	0	P
27	Gatira–faranji	*Cupressus lusitanica Mill.*	Cupresaceae	+	0	0	0	+	P
28	Abeyi	*Maesa lanceolata Forssk.*	Myrsinaceae	0	+	+	+	0	N
29	Mango	*Mangifera indica L.*	Anacardiaceae	+	+	0	0	0	P
30	Kombolcha	*Maytenus arbutifolia (Hochst.A.Rich.)Wilczek*	Celasteraceae	0	0	0	+	0	N
31	Askira	*Millettia ferruginea (Hochst.) Bak.*	Fabaceae	+	0	+	+	0	P
32	Baya	*Olea welwitschii (Knobl.)Gilg. and Schellenb*	Oleaceae	0	+	+	+	0	N
33	Avocado	*Persea americana Mill.*	Lauraceae	+	0	0	0	0	P
34	Birbirsa	*Podocarpus falcatus (Thunb.) R. B. ex Mirb.*	Podocarpaceae	0	+	0	0	0	B
35	Keraro	*Pouteria adolfi-friederici (Eng.) Baehni*	Sapotaceae	0	0	+	0	0	N
36	Qorasuma	*Premna schimperi Engl.*	Lamiaceae	0	0	0	+	0	N
37	Homi	*Prunus africana (Hook.f.) Kalkm.*	Rosaceae	0	+	0	0	0	N
38	Zeyituna	*Psidium guajava L.*	Myrtaceae	+	0	0	0	0	P
39	Bosoka	*Sapium ellipticum (Hochst.) Pax*	Euphorbiaceae	0	0	+	+	0	N
40	Qundo berbere	*Schinus molle L.*	Anacardiaceae	0	+	0	0	0	N
41	Sesbania	*Sesbania sesban L. Merr*	Fabaceae	+	+	+	0	0	P
42	Badessa	*Syzygium guineense (Wild.) DC.subsp.*	Myrtaceae	+	+	+	+	0	N
43	Rejji	*Vernonia auriculifera Hiern.*	Asteraceae	+	0	0	0	0	N
44	Sigilu	*Fagaropsis angolensis (Engl.) Dale*	Rutaceae	+					
Total tree species		**44**		25	16	17	17	2	

Key

Land use; HG=Home garden, FL= farm land, CF= coffee farm, PL= pasture land and WL= woodlot

Presence indicator; +=presence 0= not presence

Establishment form; N=natural, P=planted and B=both (N and P)

Appendix 3: IVI of the woody species of home garden, Farmland, pasture land, coffee farm and woodlots in overall study sites

Nº	Local name of Species	Importance value index of Species					Average IVI
		Home garden	Crop field	Pasture land	coffee farm	Woodlots	
1	Bargamo	6.31		8.72		125.35	28.08
2	Wadessa	14.58	53.56	18.03	23.56	15.56	25.06
3	Makanissa	8.54	14.90	28.46	33.51	24.94	22.07
4	Ambabessa	6.62	33.00	32.87	37.03		21.91
5	Lafto	19.43	20.29	16.11	24.30		16.03
6	Kiltu			9.97	68.33		15.66
7	Gravilia	16.84	9.21	15.64	5.87	24.89	14.49
8	Gatira	10.35	4.94	6.93	3.97	46.22	14.48
9	Chada	15.51	29.89				9.08
10	Dambi	43.14					8.63
11	Jima	18.33	18.98		3.38		8.14
12	Avocado	28.26		3.31	6.83		7.68
13	Sombo		5.61	3.94	1.59	20.35	6.30
14	Mango	11.75	10.98	6.35	2.28		6.27
15	Abayi	5.01	7.16	5.26		13.03	6.09
16	Askira	2.52		5.44	15.72		4.74

Source: Field survey (2016)

Appendix 4: Top ten tree species selected in the study sites

S.no	Local name	Scientific name	Families
1	Lafto	*Acacia abyssinica Hochst.ex Benth.*	Fabaceae
2	Ambabessa	*Albizia gummifera (J.F.Gmel.) C.A.Sm*	Fabaceae
3	Wadessa	*Cordia africana Lam.*	Boraginaceae
4	Bakanissa	*Croton macrostachyus Hochst.ex Del.*	Euphorbiaceae
5	Bargamo dima	*Eucalyptus camaldulensis Dehnh.*	Myrtaceae
6	Gravilia	*Grevillea robusta A.Cunn.ex R. Br.*	Proteaceae
7	Gatira–faranji	*Cupressus lusitanica Mill.*	Cupresaceae
8	Mango	*Mangifera indica L.*	Anacardiaceae
9	Askira	*Millettia ferruginea (Hochst.) Bak*	Fabaceae
10	Avocado	*Persea americana Mill.*	Lauraceae

Source: Field survey (2016)

Appendix 5: Pair wise ranking matrix in each land use (Home garden, farm land, Coffee farm, pasture land and Woodlot) across the study sites

Trees species	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**Score**
Cordia africana (A)		B	-	D	E	-	-	-	-	-	0
Eucalyptus camaldulensis (B)			B	B	B	B	B	B	B	B	9
Mangifera indica (C)				D	E	-	-	-	-	-	0
Cupressus lusitanica (D)						D	D	D	D	D	7
Grevillea robusta (E)							E	E	E	E	6
Persea americana (F)								-	-	-	0
Acacia abyssinica (G)									-	-	0
Albizia gummifera (H)										-	0
Croton macrostachyus (I)											
Millettia ferruginea (J)											

Example of pair wise ranked result on woodlotfor single criteria (income)

Appendix 6: The result of MS, ARPS (%) and AGRPS (%) preference of different tree species respective to land use across the study sites

Mazora	***Cordia african***	***Eucalptus camendulisis***	***Mengifera indica***	***Cupressus lusitanica***	***Grevillea robusta***	***Persea americana***	***Acacia abyssinica***	***Albizia gummifera***	***Croton macrostachysus***	***Millettia ferruginea***	**Criteria**	**MS(SUM)**
Home garden	2.50	0.00	6.50	3.60	2.00	7.00	0.00	0.00	0.00	0.00	MS (income)	21.6
	11.57	0.00	30.09	16.67	9.26	32.41	0.00	0.00	0.00	0.00	Income (ARPS %)	
	2.00	0.00	2.50	1.00	3.00	0.50	5.00	1.00	3.00	1.00	MS (firewood)	19
	10.53	0.00	13.16	5.26	15.79	2.63	26.32	5.26	15.79	5.26	Firewood (ARPS %)	
	0.70	0.00	0.20	3.60	4.40	0.00	0.40	2.40	1.80	0.80	MS (construction)	14.3
	4.90	0.00	1.40	25.17	30.77	0.00	2.80	16.78	12.59	5.59	Construction (ARPS %)	
	0.00	0.00	6.80	0.00	0.00	8.40	0.00	0.00	0.00	0.00	MS (fruit)	15.2
	0.00	0.00	44.74	0.00	0.00	55.26	0.00	0.00	0.00	0.00	Fruit/food (ARPS %)	
	0.60	0.00	0.00	0.00	0.00	0.00	0.20	5.80	0.00	7.10	MS (shade)	13.7
	4.38	0.00	0.00	0.00	0.00	0.00	1.46	42.34	0.00	51.82	Coffee shade (ARPS %)	
	7.90	0.00	0.00	1.70	4.40	0.00	0.00	0.00	0.00	0.00	MS (timber)	14.0
	56.43	0.00	0.00	12.14	31.43	0.00	0.00	0.00	0.00	0.00	Timber (ARPS %)	
ARPS (SUM)	87.80	0.00	89.39	59.25	87.25	90.30	30.57	64.38	28.38	62.68	600.00	
AGPS (%)	14.63	0.00	14.90	9.87	14.54	15.05	5.10	10.73	4.73	10.45		
Rank	**3**	**10**	**2**	**7**	**4**	**1**	**8**	**5**	**9**	**6**		
Farmland	1.19	0.00	0.00	0.00	0.00	0.00	4.00	0.88	0.55	3.00	MS (income)	9.62
	21.88	0.00	0.00	0.00	0.00	0.00	73.53	16.18	10.11	55.15	Income (ARPS %)	
	1.21	0.00	0.00	0.00	0.00	0.00	5.00	2.62	2.17	3.50	MS (firewood)	14.5
	8.10	0.00	0.00	0.00	0.00	0.00	33.49	17.55	14.53	23.44	Firewood (ARPS %)	
	0.88	0.00	0.00	0.00	0.00	0.00	1.33	1.62	1.62	0.84	MS (construction)	6.29
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	36.18	47.10	16.72	Construction (ARPS %)	
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	MS (fruit)	0

	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Fruit/food (ARPS %)	
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	MS (shade)	0
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Coffee shade (ARPS %)	
	4.81	0.00	0.00	0.00	0.00	0.00	0.00	1.10	0.00	0.71	MS (timber)	6.62
	72.66	0.00	0.00	0.00	0.00	0.00	0.00	16.62	0.00	10.73	Timber (ARPS %)	
ARPS (SUM)	102.64	0.00	0.00	0.00	0.00	0.00	107.02	86.52	71.74	106.03	473.96	
AGPS (%)	21.66	0.00	0.00	0.00	0.00	0.00	22.58	18.25	15.14	22.37		
Rank	**3.00**	**-**	**-**	**-**	**-**	**-**	**1.00**	**4.00**	**5.00**	**2.00**		
Coffee farm	2	0	0	0	0	0	0	3.5	0	4	MS (income)	9.5
	30.77	0.00	0.00	0.00	0.00	0.00	0.00	53.85	0.00	61.54	Income (ARPS %)	
	0.5	0	0	0	0	0	3	3	2.17	4	MS (firewood)	12.67
	3.29	0.00	0.00	0.00	0.00	0.00	19.71	19.71	14.26	26.28	Firewood (ARPS %)	
	0.5	0	0	0	0	0	0.36	2.38	1.83	2.4	MS (construction)	7.47
	3.29	0.00	0.00	0.00	0.00	0.00	2.37	15.64	12.02	15.77	Construction (ARPS %)	
	0	0	0	0	0	0	0	0	0	0	MS (fruit)	0
	0	0	0	0	0	0	0	0	0	0	Fruit/food (ARPS %)	
	0	0	0	0	0	0	0.24	8.5	0	9	MS (shade)	17.74
	0.00	0.00	0.00	0.00	0.00	0.00	1.43	50.63	0.00	53.60	Coffee shade (ARPS %)	
	4	0	0	0	0	0	0	0	0	0	MS (timber)	4
	100	0	0	0	0	0	0	0	0	0	Timber (ARPS %)	
ARPS (SUM)	137.34	0.00	0.00	0.00	0.00	0.00	23.51	139.82	26.28	157.19	484.14	
AGPS (%)	28.37	0.00	0.00	0.00	0.00	0.00	4.86	28.88	5.43	32.47		
Rank	**3**	**-**	**-**	**-**	**-**	**-**	**5**	**2**	**4**	**1**		
Pasture land	0.31	0	0	0	0	0	2.38	0	0.09	0	MS (income)	2.78
	11.15	0.00	0.00	0.00	0.00	0.00	85.61	0.00	3.24	0.00	Income (ARPS %)	
	0.52	0	0	0	0	0	0.78	0	0.43	0	MS (firewood)	1.73
	30.06	0.00	0.00	0.00	0.00	0.00	45.09	0.00	24.86	0.00	Firewood (ARPS %)	
	0	0	0	0	0	0	0	2.38	1.83	0.84	MS (construction)	5.05
	0	0	0	0	0	0	0	47.13	36.24	16.63	Construction (ARPS %)	
	1.24	0	0	0	0	0	0	0.34	0	0	MS (timber)	1.58
	78.26	0	0	0	0	0	0	21.74	0	0	Timber (ARPS %)	
ARPS (SUM)	41.21	0.00	0.00	0.00	0.00	0.00	130.70	47.13	64.33	16.63	300	

AGPS (%)	13.74	0.00	0.00	0.00	0.00	0.00	43.57	15.71	21.44	5.54		
Rank	**4**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**2**	**5**		
Woodlot	8.5	0	0	4.4	0	0	0	0	0	0	MS (income)	12.9
	65.89	0.00	0.00	34.11	0	0	0	0	0	0	Income (ARPS %)	
	2.5	0	0	2	0	0	0	0	0	0	MS (firewood)	4.5
	55.56	0.00	0.00	44.44	0	0	0	0	0	0	Firewood (ARPS %)	
	6	0	0	3	0	0	0	0	0	0	MS (construction)	9
	66.67	0.00	0.00	33.33	0.00	0.00	0.00	0.00	0.00	0.00	Construction (ARPS %)	
ARPS (SUM)	188.11	0.00	0.00	111.89	0.00	0.00	0.00	0.00	0.00	0.00	300	
AGPS (%)	62.70	0.00	0.00	37.30	0.000	0.000	0.000	0.000	0.000	0.000		
Rank	**1**	-	-	**2**	-	-	-	-	-	-		

W/kolobo	***Cordia african***	***Eucalptus camendulisis***	***Mengifera indica***	***Cupressus lusitanica***	***Grevillea robusta***	***Persea americana***	***Acacia abyssinica***	***Albizia gummifera***	***Croton macrostachysus***	***Millettia ferruginea***	**Criteria**	**MS (SUM)**
Home garden	2.20	0.00	6.00	4.00	0.50	6.80	0.00	0.00	0.00	0.00	MS (income)	19.5
	11.28	0.00	30.77	20.51	2.56	34.87	0.00	0.00	0.00	0.00	Income (ARPS %)	
	0.50	0.00	1.00	2.50	1.80	0.90	1.40	0.00	4.00	6.00	MS (firewood)	18.1
	2.76	0.00	5.52	13.81	9.94	4.97	7.73	0.00	22.10	33.15	Firewood (ARPS %)	
	0.45	0.00	0.00	3.40	2.50	0.00	0.00	0.90	0.10	0.10	MS (construction)	7.45
	6.04	0.00	0.00	45.64	33.56	0.00	0.00	12.08	1.34	1.34	Construction (ARPS %)	
	0.00	0.00	7.00	0.00	0.00	7.60	0.00	0.00	0.00	0.00	MS (fruit)	14.6
	0.00	0.00	47.95	0.00	0.00	52.05	0.00	0.00	0.00	0.00	Fruit/food (ARPS %)	
	0.00	0.00	0.00	0.00	0.00	2.00	0.00	1.00	5.00	5.00	MS (shade)	13
	0.00	0.00	0.00	0.00	0.00	15.38	0.00	7.69	38.46	38.46	Coffee shade (ARPS %)	
	3.00	0.00	0.00	0.00	1.60	0.00	0.00	0.00	0.00	0.00	MS (timber)	4.6
	65.22	0.00	0.00	0.00	34.78	0.00	0.00	0.00	0.00	0.00	Timber (ARPS %)	

ARPS (SUM)	85.30	0.00	84.24	79.96	80.85	107.28	7.73	19.77	61.90	72.95	600.00	
AGPS (%)	14.2	0.0	14.0	13.3	13.5	17.9	1.3	3.3	10.3	12.2		
Rank	**2**	**-**	**3**	**5**	**4**	**1**	**9**	**8**	**7**	**6**		
Farmland	1.08	0.00	0.00	0.00	0.00	0.00	0.35	0.51	0.17	2.20	MS (income)	4.31
	51.18	0.00	0.00	0.00	0.00	0.00	16.59	24.17	8.06	104.27	Income (ARPS %)	
	2.74	0.00	0.00	0.00	0.00	0.00	3.06	2.32	2.89	2.50	MS (firewood)	13.51
	21.42	0.00	0.00	0.00	0.00	0.00	23.92	18.14	22.60	19.55	Firewood (ARPS %)	
	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.88	0.14	0.12	MS (construction)	1.59
	28.30	0.00	0.00	0.00	0.00	0.00	0.00	55.35	8.81	7.55	Construction (ARPS %)	
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	MS (fruit)	0
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Fruit/food (ARPS %)	
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	MS (shade)	0
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Coffee shade (ARPS %)	
	5.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	MS (timber)	5.38
	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Timber (ARPS %)	
ARPS (SUM)	200.91	0.00	0.00	0.00	0.00	0.00	40.51	97.66	39.46	131.36	509.89	
AGPS (%)	39.40	0.00	0.00	0.00	0.00	0.00	7.95	19.15	7.74	25.76		
Rank	**1.00**	**-**	**-**	**-**	**-**	**-**	**4.00**	**3.00**	**5.00**	**2.00**		
Coffee farm	0.55	0.00	0.00	0.00	0.00	0.00	0.22	5.00	0.11	0.50	MS (income)	6.38
	8.62	0.00	0.00	0.00	0.00	0.00	3.45	78.37	1.72	7.84	Income (ARPS %)	
	2.74	0.00	0.00	0.00	0.00	0.00	3.00	2.32	1.50	1.78	MS (firewood)	11.34
	24.16	0.00	0.00	0.00	0.00	0.00	26.46	20.46	13.23	15.70	Firewood (ARPS %)	
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.88	0.14	0.12	MS (construction)	1.14
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	77.19	12.28	10.53	Construction (ARPS %)	
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	MS (fruit)	0
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Fruit/food (ARPS %)	
	2.00	0.00	0.00	0.00	0.00	0.00	6.00	2.00	1.00	8.20	MS (shade)	19.2
	10.42	0.00	0.00	0.00	0.00	0.00	31.25	10.42	5.21	42.71	Coffee shade (ARPS %)	

	1.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	MS (timber)	1.48
	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Timber (ARPS %)	
ARPS (SUM)	143.20	0.00	0.00	0.00	0.00	0.00	61.15	186.44	32.44	76.77	500	
AGPS (%)	28.64	0.00	0.00	0.00	0.00	0.00	12.23	37.29	6.49	15.35		
Rank	**2.00**	**-**	**-**	**-**	**-**	**-**	**4.00**	**1.00**	**5.00**	**3.00**		
pasture land	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.50	0.17	0.00	MS (income)	2.67
	37.45	0.00	0.00	0.00	0.00	0.00	37.45	18.73	6.37	0.00	Income (ARPS %)	
	0.12	0.00	0.00	0.00	0.00	0.00	4.00	1.00	0.00	0.00	MS (firewood)	5.12
	2.34	0.00	0.00	0.00	0.00	0.00	78.13	19.53	0.00	0.00	Firewood (ARPS %)	
	0.12	0.00	0.00	0.00	0.00	0.00	3.06	1.00	0.00	0.00	MS (construction)	4.18
	2.87	0.00	0.00	0.00	0.00	0.00	73.21	23.92	0.00	0.00	Construction (ARPS %)	
	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.00	0.00	MS (timber)	1.2
	66.67	0.00	0.00	0.00	0.00	0.00	0.00	33.33	0.00	0.00	Timber (ARPS %)	
ARPS (SUM)	42.67	0.00	0.00	0.00	0.00	0.00	188.78	62.18	6.37	0.00	300	
AGPS (%)	10.67	0.00	0.00	0.00	0.00	0.00	47.20	15.55	1.59	0.00		
Rank	**3.00**	**-**	**-**	**-**	**-**	**-**	**1.00**	**2.00**	**4.00**	**-**		
Woodlot	0.0	7.2	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	MS (income)	9.8
	0.0	73.5	0.0	26.5	0.0	0.0	0.0	0.0	0.0	0.0	Income (ARPS %)	
	0.0	2.7	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	MS (firewood)	4.9
	0.0	55.1	0.0	44.9	0.0	0.0	0.0	0.0	0.0	0.0	Firewood (ARPS %)	
	0.0	8.2	0.0	4.8	0.0	0.0	0.0	0.0	0.0	0.0	MS (construction)	13
	0.0	63.1	0.0	36.9	0.0	0.0	0.0	0.0	0.0	0.0	Construction (ARPS %)	
ARPS (SUM)	0.00	191.65	0.00	108.35	0.00	0.00	0.00	0.00	0.00	0.00	300	
AGPS (%)	0.00	63.88	0.00	36.12	0.00	0.00	0.00	0.00	0.00	0.00		
Rank	**-**	**1**	**-**	**2**	-	-	-	-	-	-		

Merawa	***Cordia african***	***Eucalptus camendulisis***	***Mengifera indica***	***C. lusitanica***	***Grevillea robusta***	***P. americana***	***A.abyssinica***	***Albizia gummifera***	***C. macrostachysus***	***M.ferruginea***	**Criteria**	**Mean (SUM)**
Home garden	2.00	0.00	6.00	1.00	1.50	6.80	0.00	0.00	0.00	0.00	MS (income)	17.3
	11.56	0.00	34.68	5.78	8.67	39.31	0.00	0.00	0.00	0.00	Income (ARPS %)	
	0.50	0.00	2.00	2.50	1.80	0.90	1.40	0.00	0.30	2.00	MS (firewood)	11.4
	4.20	0.00	16.81	21.01	15.13	7.56	11.76	0.00	3.00	16.81	Firewood (ARPS %)	
	2.00	0.00	0.00	3.00	3.80	0.00	0.00	0.10	2.00	0.10	MS (construction)	11
	18.52	0.00	0.00	27.78	35.19	0.00	0.00	0.93	18.52	0.93	Construction (ARPS %)	
	0.00	0.00	6.00	0.00	0.00	7.60	0.00	0.00	0.00	0.00	MS (fruit)	13.6
	0.00	0.00	44.12	0.00	0.00	55.88	0.00	0.00	0.00	0.00	Fruit/food (ARPS %)	
	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.50	0.00	0.10	MS (shade)	2.6
	0.00	0.00	0.00	0.00	0.00	64.52	0.00	16.13	0.00	3.23	Coffee shade (ARPS %)	
	4.74	0.00	0.00	0.00	1.60	0.00	0.00	0.00	0.00	0.00	MS (timber)	6.3
	75.24	0.00	0.00	0.00	25.40	0.00	0.00	0.00	0.00	0.00	Timber (ARPS %)	
ARPS (SUM)	109.52	0.00	95.61	54.57	84.38	167.27	11.76	17.05	21.52	20.96	582.64	
AGPS (%)	18.80	0.00	16.41	9.37	14.48	28.71	2.02	2.93	3.69	3.60		
Rank	**2**	**-**	**3**	**5**	**4**	**1**	**9**	**8**	**6**	**7**		
Farmland	0.64	0.00	0.00	0.00	0.00	0.00	0.00	2.20	0.00	3.00	MS (income)	5.84
	22.54	0.00	0.00	0.00	0.00	0.00	0.00	77.46	0.00	105.63	Income (ARPS %)	
	2.53	0.00	0.00	0.00	0.00	0.00	5.00	2.61	1.20	1.00	MS (firewood)	12.34
	19.25	0.00	0.00	0.00	0.00	0.00	38.05	19.86	9.13	7.61	Firewood (ARPS %)	
	1.32	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.10	0.00	MS (construction)	6.42
	20.56	0.00	0.00	0.00	0.00	0.00	77.88	0.00	1.56	0.00	Construction (ARPS %)	

	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	MS (fruit)	0
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Fruit/food (ARPS %)	
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	MS (shade)	0
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Coffee shade (ARPS %)	
	4.74	0.00	0.00	0.00	0.00	0.00	0.00	1.22	0.00	0.78	MS (timber)	6.74
	70.33	0.00	0.00	0.00	0.00	0.00	0.00	18.10	0.00	11.57	Timber (ARPS %)	
ARPS (SUM)	132.68	0.00	0.00	0.00	0.00	0.00	115.93	115.43	10.69	124.82	499.55	
AGPS (%)	26.56	0.00	0.00	0.00	0.00	0.00	23.21	23.11	2.14	24.99		
Rank	**1.00**	**-**	**-**	**-**	**-**	**-**	**3.00**	**4.00**	**5.00**	**2.00**		
Coffee farm	0.22	0	0	0	0	0	2	2	0	0.83	MS (income)	5.05
	4.36	0.00	0.00	0.00	0.00	0.00	39.60	39.60	0.00	16.44	Income (ARPS %)	
	1	0	0	0	0	0	5	2.61	4	1.83	MS (firewood)	14.44
	6.93	0.00	0.00	0.00	0.00	0.00	34.63	18.07	27.70	12.67	Firewood (ARPS %)	
	0.46	0	0	0	0	0	0	0.54	2	0.75	MS (construction)	3.75
	12.27	0.00	0.00	0.00	0.00	0.00	0.00	14.40	53.33	20.00	Construction (ARPS %)	
	0	0	0	0	0	0	0	0	0	0	MS (fruit)	0
	0	0	0	0	0	0	0	0	0	0	Fruit/food (ARPS %)	
	0	0	0	0	0	0	6	0.1	0.5	0.5	MS (shade)	7.1
	0.00	0.00	0.00	0.00	0.00	0.00	84.51	1.41	7.04	7.04	Coffee shade (ARPS %)	
	4.50	0.00	0.00	0.00	0.00	0.00	0.00	1.22	0.00	1.17	MS (timber)	6.89
	65.31	0.00	0.00	0.00	0.00	0.00	0.00	17.71	0.00	16.98	Timber (ARPS %)	
ARPS (SUM)	88.86	0.00	0.00	0.00	0.00	0.00	158.74	91.19	88.08	73.13	500	
AGPS (%)	17.77	0.00	0.00	0.00	0.00	0.00	31.75	18.24	17.62	14.63		
Rank	**3.00**	**-**	**-**	**-**	**-**	**-**	**1.00**	**2.00**	**4.00**	**5.00**		
Pasture land	1.00	0.00	0.00	0.00	0.00	0.00	5.00	0.20	2.00	0.97	MS (income)	9.17
	10.91	0.00	0.00	0.00	0.00	0.00	54.53	2.18	21.81	10.58	Income (ARPS %)	
	0.00	0.00	0.00	0.00	0.00	0.00	6.20	1.00	2.00	1.00	MS (firewood)	10.2
	0.00	0.00	0.00	0.00	0.00	0.00	60.78	9.80	19.61	9.80	Firewood (ARPS %)	

	0.11	0.00	0.00	0.00	0.00	0.00	0.20	0.78	0.74	0.00	MS (construction)	1.83
	6.01	0.00	0.00	0.00	0.00	0.00	10.93	42.62	40.44	0.00	Construction (ARPS %)	
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	MS (fruit)	0
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Fruit/food (ARPS %)	
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	MS (shade)	0
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Coffee shade (ARPS %)	
	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	MS (timber)	5
	100.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Timber (ARPS %)	
ARPS (SUM)	116.9	0.00	0.00	0.00	0.00	0.00	126.24	54.61	81.86	20.38189	400	
AGPS (%)	29.23	0.00	0.00	0.00	0.00	0.00	31.56	13.65	20.46	5.095473		
Rank	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**4**	**3**	**5**		
Woodlot	0	8	0	5	0	0	0	0	0	0	MS (income)	13
	0.00	61.50	0.00	38.50	0.00	0.00	0.00	0.00	0.00	0.00	Income (ARPS %)	
	0	0.1	0	0.1	0	0	0	0	0	0	MS (firewood)	0.2
	0	50.00	0.00	50.00	0	0	0	0	0	0	Firewood (ARPS %)	
	0	0.7	0	0.4	0	0	0	0	0	0	MS (construction)	1.1
	0.00	60.00	0.00	40.00	0	0	0	0	0	0	Construction (ARPS %)	
ARPS (SUM)	0.00	171.50	0.00	128.50	0.00	0.00	0.00	0.00	0.00	0.00	300	
AGPS (%)	0	57.17	0.00	42.83	0	0	0	0	0	0		
Rank	**-**	**1**	**-**	**2**	-	-	-	-	-	-		