INDIRA GANDHI NATIONAL OPEN UNIVERSITY (IGNOU)

DEPARTMENT OF RURAL DEVELOPMENT

THE ROLE OF AGROFORESTRY PRACTICE FOR SUSTAINING THE RURAL LIVELIHOOD:-THE CASE OF BORECHA WOREDA, ILLUBABOR ZONE OF OROMIA REGIONAL STATE, ETHIOPIA

BY

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DECLARATION

This is to declare that the dissertation entitled "**THE ROLE OF AGROFORESTRY PRACTICE FOR SUSTAINING THE RURAL LIVELIHOOD:-THE CASE OF BORECHA WOREDA, ILLUBABOR ZONE OF OROMIA REGIONAL STATE, ETHIOPIA"** submitted by me for the partial fulfillment of Master of Art in Rural Development to Indira Gandhi National Open University (IGNOU) is my original work and has not been submitted either to IGNOU or any other institution for the fulfillment of the requirement of any course of the study. I also declare that no chapter of this manuscript in whole or in the part is lifted and incorporated in this report from any earlier work done by me or others.

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This is to certify that Mr. Zeleke Kassa Emiru student of MARD from Gandhi National Open University; New Delhi was working under my supervision and guidance for his project work. His project work entitled "**THE ROLE OF AGROFORESTRY PRACTICE FOR SUSTAINING THE RURAL LIVELIHOOD:-THE CASE OF BORECHA WOREDA, ILLUBABOR ZONE OF OROMIA REGIONAL STATE, ETHIOPIA**, which he is submitting is his genuine and original work.

Place: Addis Ababa, Ethiopia **Signature _____**

November, 2016 **Name: Dr. Wondimagegne Chekol**

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ACRONYMS

ADB	Asia Development Bank
ADLI	Agricultural Development Led Industrialization
AF	Agroforestry
AFS	Average Family Size
AI	Artificial Insemination
ANOVA	Analysis of Variance
BoIRDP	Borecha Integrated Rural Development Project
CSA	Central Statistical Agency
DARDO	District Agricultural and Rural Development Office
ETB	Ethiopian Birr (currency)
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
SPSS	Statistical Package for Social Science
GDP	Gross Domestic Product
IFAD	International Fund for Agricultural Development
IGNOU	Indira Gandhi National Open University
Kebele	A district representing the lowest administrative hierarchy
MARD	Master of Art in Rural Development
MDGs	Millennium Development Goals
MoFED	Ministry of Finance and Economic Development
SEEP	Small Enterprise Education and Promotion
DARDO	District Agricultural and Rural Development Office
ZARDO	Zonal Agriculture and Rural Development Office

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ABSTRACT

The depletion of forest and increasing demand for forest products especially of the rural people who depend on the forests for livelihoods have widened the gap between the demand and supply of the forest products in the country. Finding alternative options to increase the supply of forest products to support rural livelihoods have become a fundamental concern. Hence, this study focuses on assessing the practice and role of Agroforestry on the livelihood of rural farming households in selected rural kebeles of Borecha Woreda. In this study Agroforestry adopters, non adopters and Agricultural and Rural Development office in the woreda were contacted. Primary and secondary data were collected by using structured and open ended interview questionnaires. One hundred forty four (144) households for sample survey, key informants interview and group discussion were the main source of the primary data collected. In addition to this secondary was gathered from various reports and other relevant documents. The collected data were analyzed descriptively and using Statistical Software Package for Social Science (SPSS).

The finding of the study indicates that agrosivopasture is the main agroforestry practice adopted by agroforestry adopters. Fruit, Timber, vegetables, coffee and honey were the main source of cash income of households who adopted Agroforestry when compared to non agroforestry adopter. In addition to this agroforestry practices saved time for collecting fodder and firewood from the forest to meet their need for firewood and fodder from their farmland/ agroforestry.

Therefore, it can be concluded that agroforestry has contributed mainly to the improvement of people's livelihood by assuring food security and financial formation of rural communities in the one hand and also maintaining environmental condition for sustainable use on the other. The livelihood of Agroforestry adopter increased by 15% compared with the non adopter.

Key Words: Agroforestry, Forest product, Adopters, Non Adopters, Rural Livelihood

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Ethiopia is a large country in the horn of Africa with a total area of about 1.1 million square kilometer and population of more than 80 million at a growth rate of 2.6 percent (CSA, 2007). Average household size and number of household are 4.7 and 15.5 million respectively. Ethiopia's economy is largely dominated by subsistence agriculture of crop and livestock farming. Agriculture provides approximately70 percent of raw materials for the industrial sector, generates more than 90 Percent of the export earnings and primary sources of income for more than 85 percent of the country's population (IFAD, 2009).

Nonetheless rapid population growth, forest clearing for expansion of crop cultivation and over grazing and exploitation of forest for fuel wood and construction materials without replanting has reduced the forest area of the country, which lead to depletion of natural resources that affected natural and human environment (MPFS, 1983). Forest resources of the country are dwindling day to day in quantity, quality and diversity. According to UNEP, 1983 forest coverage in Ethiopia in 19 century was more than 35 percent of the total land area. Forest cover reduced to 16 percent by 1950s and had been further reduced to 3.1 percent in 1982 (UNEP, 1983). This has a considerable impact on women and girls, who are responsible for fetching water and collecting fuel wood in rural areas (WHO, 2000). To overcome such a problem agroforestry play a vital role to meet the need of the growing population in terms of sustaining crop agriculture and livestock, production of commodities for exchange and as a form of energy and providing diverse tree products for sustaining rural livelihoods (Arnold, 1997).

Agroforestry is a relatively new name for a set of old practices, cultivating trees, agricultural crops and pastures and /or animals in intimate combination with one another spatially or temporally is an ancient practices that farmers have used throughout the world (Nair, 1989, 1993). Agroforestry is a land use system and practice in which forest trees, livestock, and arable land (for crops) are integrated on the same unit of land and managed to give yield on a sustainable basis either simultaneously or sequentially. It is a practice that is economically sound and culturally compatible. Trees are deliberately left

to grow on farmland or pasture. The total output is greatly enhanced under integrated management over production of each component in isolation. The integration can be linear, mixed or even in blocks in an arrangement based on specific objectives and appropriate technology required for a particular place. There are several types of traditional systems exist in different parts of Ethiopia, and there are also new technologies started by several institutions at a national level across different land use systems (Dechasa, 1990).

In Borecha Woreda/District/ Agricultural Development is found in poor condition. The agricultural Sector is suffering from shortage of agricultural inputs, improved technologies; Shortage of skilled man power and technical expertise to the required level. In addition, the farming system is not supported by Research – Extension. Therefore, Menschen für Menschen Foundation, Borecha Integrated Rural Development Project (BoIRDP) designed agroforestry technology to improve productivity and the economic well-being of the woreda by combating ecological degradation and increasing agricultural productivity.

1.2. Statement of the Problem

The role of forests and forest products to household food security and to the national economy is indispensable. However, deforestation has already affected the lives of many in the target area. This has resulted in environmental problems such as forest biomass reduction, decline in the productivity of the land, soil erosion, and loss of biodiversity which subsequently led to frequent socio economic problems. Many of the socio-economic problems in the country in general and in the study area in particular are associated with deforestation and misuse of land. Alteration of forest habitat through grazing and expansion of agriculture could not only lead to decline in local biodiversity but also affects food security of local communities as many people are directly or indirectly dependent on forest and forest related activities.

The population is continuously growing and causing serious environmental problems in Ethiopia. As the population continues to grow, the decrease in agricultural productivity, due to land degradation, and the gap between supply and demand for agricultural land, continues to expand. Such a situation is leading to severe land-use conflicts between the crop productions, and other types of land use such as forests, which will cause further

clearance of forestland and, consequently, environmental degradation, not only in terms of agriculture aspects, but also other demand like fuel wood collection and timber, construction material needs and others continue to put pressure on the limited forest resources.

Food insecurity, soil erosion, shortages of fuel wood and fodder and environmental degradation are still widespread. Agroforestry seems to have a potential to reconcile the dual goals of forest conservation and improved livelihoods for the local communities. Furthermore, in Illubabor zone where this study (Borecha district) is conducted, studies focusing on the role of agroforestry are scanty. Thus, this study intends to explore these links between forest conservation and local livelihood benefits. It is also expected that the study will lay the base line for further research in the area that has been neglected so far.

1.3. Research Questions

This study is mainly designed to address the following research questions:

- What is the role of agroforestry to household income generation?
- What is the role of agroforestry in preserving the existing forests?
- Is an agroforestry program able to deliver environmental benefits to the local population?
- What are the appropriate agroforestry management options and their economic and ecological impacts on farming systems and households welfare?

1.4. Objective of the Study

1.4.1 General Objective

The general objective of this study is to investigate the role of agroforestry systems in sustaining rural livelihood in the study area.

1.4.2 Specific Objectives

The specific objectives of this study are:

- To assess the role of agroforestry system in improving livelihoods and food insecurity in the study area;
- To examine the attitude of farmers towards agroforestry systems;
- To investigate the major problems encountered during the implementation of the system;

- To recommend possible solution for improvement of the existing agroforestry system in the study area

1.5. Significance of the Study

In Ethiopia, agriculture is the main sources of livelihoods for the majority of the people where most of them live under the poverty line (IFAD, 2009). On the other hand the country is endowed with plenty of natural and human resources. Alleviating poverty and achieving sustainable development needs efficient utilization of these available resources. This can be realized by focusing on effective use of the existing ample productive human power and natural resources. In this regard, there is a strong believe that agroforestry as a strategy can fuel the development efforts of the rural people particularly that owned small pieces of land by diversifying their income. Thus, the study provides insights into role of agroforestry to the livelihoods of large and marginal households. The results of this study will be useful in redirecting, improving and strengthening the agroforestry programs in the area and elsewhere.

1.6. Scope and Limitations of the Study

This study was undertaken in Borecha district focusing on the limited number of sample rural households; those who adopted AF and not adopting AF practice. Therefore, the final result may not representative and applicable to all households. The major constraints of the study may include limitation of time to conduct the research, financial and logistic constraints and unavailability of reliable recorded data.

1.7. Organization of the Paper

This study is organized into five chapters. Chapter one gives an overview of the background of the study, statement of the problem, research objectives, research questions, and the importance of the study. Chapter two discusses theoretical and conceptual frameworks in which the study is understood. The third chapter deals with the methods employed to generate and analysis data of the study. Chapter four comprises the analysis part. It describes how farmer's benefits from agroforestry system and estimation of key determinants of Agroforestry technology adoption. Finally, Chapter five gives concluding remarks by outlining the relevant aspects of the study.

CHAPTER TWO: LITERATURE REVIEW

2.1. Concepts and Definitions of Agroforestry

Searching for better farming method has continued ever since man domesticated plants and animals at the birth of agricultural revolution. Agroforestry has became an important part of the new thrust to develop more sustainable land use to replace destructive techniques since the revolution. Therefore, agroforestry is a new name for an old set of land use practices. It is an integrated approach to solving land use problems by allowing farmers to produce food, fodder, fiber and fuel simultaneously from the same unit of land. A common characteristic feature of all forms of agroforestry is that a tree component is deliberately grown or retained in an agricultural setting. Various definitions for the term agroforestry have been given through the years since its advent as a scientific approach to land use problems in the early 1980s. The best and probably official definition is the one that is common used by the World Agroforestry Center: "Agroforestry is a collective name for land use systems and technologies where woody perennials(trees, shrubs, palms, bamboos etc.) are deliberately used on the same land management units as agricultural crops/ or animals, in some form of spatial arrangement or temporal sequence. In agroforestry system there are both ecological and economical interactions between the different components" (Lundgren and Raintree 1982).

The concept of agroforestry is based on the development of the interface between agriculture and forestry. It is a sustainable multiple-production system whose outputs can be adjusted to local needs. The main components of agroforestry systems are trees and shrubs, crops, pasture, and livestock together with the environmental factors of climate, soil, and landform. Other components (e.g., bees, fish) occur in specialized systems (Young 1989). Under this definition, a variety of combinations of plants may be possible. But there are two important features that identify agroforestry from other land-use systems:

1. There must be a tree component deliberately grown or retained in the land-use system

2. There must be significant interaction, positive and/ or negative, between the woody and non-woody components of the system.

Agroforestry, therefore, involves two or more species of plants and /or animals at least one of which is a woody perennial and with two or more outputs. Owing to the variety of mixtures, therefore, even the simplest agroforestry system is more complex both ecologically and economically than a mono-cropping system. The aim and rationale of agroforestry lies in optimizing production based on the interactions between the components and their physical environment. This will lead to higher sum total and a more diversified and /or sustainable production than from a monoculture of agriculture or forestry alone.

2.2. Importance of Agroforestry

Oram (1993) reported that agrofoestry provides a wider range of products, more secure subsistence or more cash income from wood products to enable the farmer to buy food. Nair (1993) found that in tree home gardens, the production is for home consumption, but any marketable surplus can provide a safe guard against future crop failures and security for interval between the harvests (e.g. rice in Java and Sri Lanka, coffee and maize in Tanzania, coconut and rice in South Western India). Some important service roles of agroforestry are: soil conservation, either erosion control (presence of a permanent soil cover, barrier effect against runoff), soil fertility maintenance (incorporation of organic matter into the soil, nutrient pumping from the deep layers of the soil through the tree's roots, these nutrients then improve the crops through litter and mulch, nitrogen fixation) or soil physical properties maintenance (Young, 1989). He indicated that the creation of a microclimate, which can be beneficial to certain plants or animals, for example modifications of light, temperature, humidity or wind, and can also help fight weed proliferation.

Agroforestry plays a better role in increasing agricultural productivity by nutrient recycling, reducing soil erosion, and improving soil fertility and enhancing farm income compared with conventional crop production (Kang and Akinnifesi, 2000). Furthermore, agroforestry also has promising potentials for reducing deforestation while increasing food, fodder, and fuel wood production (Benge, 1987and Young, 1997). Some of the

benefits that agroforestry offers are: soil-fertility improvement, provision of wood products (fuel wood, poles, timber, fruits, medicines, etc.), improved beekeeping, control of erosion, stabilizing of river and stream banks (i.e. prevention of siltation), improvement of water infiltration in to the soil, shrubs can act as live fences against livestock and human beings, trees and shrubs can contribute to better microclimate (shade, windbreak, etc,) and provision of fodder, especially in the dry season.

2.2.1. Soil Fertility Improvement and Soil Conservation

Land degradation and declining soil fertility create a major threat to agricultural productivity and affecting human welfare in most of African countries. Particularly it is serious in tropical and subtropical regions where many soils lack plant nutrients and organic matter and top soil erodes by intense rainfall. Soil fertility can be improved or sustained by the addition of vegetative organic matter, i.e. decomposition of leafy biomass and roots. Further, integrating leguminous trees is common in agroforestry, which have ability of fix atmospheric nitrogen and contributes to better soil fertility. Nitrogen fixing tree, under agroforestry significantly increased nutrient pool, organic biomass, and activities of organisms in the soil. This would not only be beneficial to the soil, but would also be cheaper for resource-poor farmers and provide fodder or firewood. On the other hand, erosion is the primary cause of reduction of crop yield due to loss of organic matter, associated nutrients and soil fertility. So, restoration and maintenance of fertility is essential. Root systems of woody perennials enable to adapt to steeply sloping sites that are unsuited to conventional cropping or grazing. Nitrogen fixing trees (legumes) in agroforestry have the capacity to grow in difficult sites subject to erosion and low soil fertility. They have also potential to restore degraded areas and control of soil erosion. Once established, they can create favorable conditions for the growth of other species. Additionally, tree legumes improve soil structure, which help to decrease erosion.

Due to its long lived nature, trees and shrubs can remain throughout the year in the farmland and serve as better resources to control of erosion and soil conservation. They reduce the wind speed and runoff (through enhancing percolation of rain water in to the ground through ground litter). The tree root protects the soil from erosion and the litter

serves as a buffer to direct rain drops and runoff and the tree crown reduces the wind speed and slows the direct force of the rain drops.

2.2.2. Fuel wood (Energy)

Over 90% of the populations in Ethiopia depend on fuel wood for their energy needs. Increased tree growing and better management of existing resources could provide for products such as fuel wood, poles, fruits and timber which have not only become scarce but increasingly expensive. Thus, such commodities could be produced both for subsistence and for cash. Scarcity of fuel wood may influence both the amount of food cooked and its type. Further, since fuel wood collection is women's work further away the source of fuel wood the greater their workload becomes. Consequently, they have less and less time and energy to spend on other activities such as caring for children or engaging in income-generating activities. Thus, the scarcity of fuel wood has a direct impact on the family's nutrition.

Within an ox culture where mono-cropping is predominantly practiced poor farmers use dung and crop residue for fuel. Cow-dung and crop residue use for fuel is the most land degrading practices. Burning crop residue and cow dung is the most nutrient depleting tasks of all wrong acts in conventional agriculture in Ethiopia. In the Northern part of Ethiopia in Menz for example where there is no tree at all and the entire land is covered with grass, fuel is cow dung and some crop residue. Under agro-ecology potential production classification, it is a high potential cereal zone with a high rainfall area. In Mono-cropping cereals of ox culture system long term gestation of perennial tree growth is the constraint. Agroforestry enables rural households to produce firewood in near and accessible places (homestead, farm, etc). It has potential to solve shortage of construction poles and timber, fuelwood problems, shortage of fodder during the dry season, silting and flooding of rivers and streams, declining soil fertility and soil erosion.

2.2.3. Carbon Sequestration

Now current global-climate change (global warming) is the most serious environmental problem affecting human lives on a global scale and it is because of primarily by the increase in atmospheric concentrations of greenhouse gases (GHGs) mainly carbon dioxide (CO_2). Forests play an important role in the global carbon cycle because they

store a large amount of carbon in vegetation biomass and soil. It also sinks CO_2 from the atmosphere. Conversion of especially high-biomass tropical forest to other land-uses like agriculture could lead to increased atmospheric CO_2 via biomass burning, increased soil respiration and decrease in CO_2 uptake by plants. So, this decrease in forest area reduces the carbon stock in the forest ecosystem.

In the past three decades, agroforestry has become recognized as an integrated approach to sustainable land use because of its production and environmental benefits and it received attention as a strategy for biological carbon sequestration. The potential of agroforestry in sequestering carbon is based on the premise that the greater effectiveness of integrated systems in resource captures and use than single species. The woody biomass of agroforestry systems could provide a source of local fuel. Through providing fuel, agroforestry would reduce pressure on forests and at the same time, provide a substitute for fossil fuel.

On the other hand, because of their capacity to give economic and environmental benefits, intervention of agroforestry are considered to be the best measures in making communities adapt and become resilient to the impacts of climate change. The other important elements of agroforestry systems that can play a significant role in the adaptation to climate change include changes in the microclimate, protection through provision of permanent cover, opportunities for diversification of the agricultural systems, improving efficiency of use of soil, water and climatic resources, contribution to soil fertility improvement and reducing carbon emissions and increasing sequestration. Generally, integrating more trees in the agricultural landscapes has a higher potential to sequester carbon.

2.2.4. Fodder

Grasses and cereal crop residues are the most important feed resources for livestock and which account for more than 70% of the dry matter in the animal feeds. But they are deficient in protein. On the other hand, there is an acute shortage of green fodder in many parts during the dry season. To overcome those problems, forages from leguminous trees (which mostly common in agroforestry) have a great potential to supply protein-rich fodder and play an important role in the supplementary feeding of livestock during the

dry season or in times of drought. A huge percentage of fodder trees are legumes and most of those are rich in protein and digestible. Farmers and pastoralists have long experience in feeding fodder trees and shrubs to their livestock to increase the benefits of the output gained from the animals, either by browsing or by cut and carry system. Faidherbia albida, sesbania sesban, Chamaecytisus proliferus, etc are a woody perennial which can provide fodder.

2.3. Classification of Agroforestry Systems

A variety of agroforestry systems are used around the world, and they can be classified in a number of different ways depending on the criteria employed. For example, one classification approach is based on the basis of their primary function. That is the classification approach that has been adopted in many areas. Thus, although all agroforestry systems have the capacity to provide a range of products and services simultaneously, this type of classification distinguishes between systems aimed at producing goods and multifunctional systems, which combine the production of timber and non-timber products with environmental, social and land use services (Nair, 1989, 1993).

Agroforestry systems can also be classified on the type of components involved namely, agrosilvicultural systems (woody plant species and seasonal plants)' silvopastoral systems (production of livestock and woody plant species), and agrosilvopastoral systems (production of livestock, woody plant species and seasonal plants)(Nair, 1989, 1993).

2.3.1. Agrosilvicultural Systems

This is an agroforestry system where agronomic crops are combined with shrubs/trees on the same unit of land for higher or better-sustained production of annual crops, fodder, and wood. An agroforestry system is identified by certain types of practices that, taken as a whole, form a dominant land-use system in a particular locality, characterized by environment, plant species and arrangement, management, and social and economic functions. Although an agroforestry practice is a distinctive arrangement of components in space and time, when the combinations are arranged in time sequence, such practice is called taungya practice. The combinations can also be arranged in space, such as the hedgerow/mixed intercropping practice.

2.3.2 Silvopastoral Systems

This is an agroforestry system where range crops and/or animals and trees are combined for better production of grasses and fodder. This combination can be arranged as a pure stand with fodder trees/shrubs planted as a protein bank (with cut-and-carry fodder production) and/or mixed in different configurations such as living fences of fodder trees and hedges. The trees and shrubs and grass components are arranged in such a way that their healthy coexistence is not disrupted. The acacia-dominant system in the arid parts of Ethiopia, Kenya, and Somalia are good examples of this system.

The main objective of this practice is to supply feed for livestock during the dry season with high quality tree leaves and pods. This will substantially increase the productive capacity of poor and scarce pasture lands common on the Hararghe Highlands. Fuel wood and construction poles can also be produced with this system.

2.3.3 Agrosilvopastoral Systems

This is an agroforestry practice by which food, pasture, and tree/shrub crops are combined on the same unit of land for the production of grass and browse feed, biomass for fuel wood and green manure, and food for human consumption.

This system is practiced when the farmer needs all the benefits that would be obtained from silvipasture and agrisilviculture systems from a unit of land. Usually, such a system is practiced on cultivated land. Alternative rows of hedges, grass strips and/or crops would form such a system, a form of alley cropping. Agrosilvopasture is also practiced when the cropland is constrained by slope and threatened by erosion. These are very common problems of land use in most of the Ethiopian Highlands; therefore, this system has potential for use in various regions of the country.

2.4. Agroforestry Practices

An agroforestry practice denotes a specific land management operation on a farm or other management unit, and consists of arrangements of agroforestry components in space and/ or time (Gholz, 1987). Examples of agroforestry practices are Tree home gardens, Woodlot, Windbreaks/shelterbelts, Boundary planting, Live fences, Hedgerow intercropping, improved fallow, Intercropping under scattered or regularly planted trees , Trees on rangelands ,Trees on soil conservation and reclamation structures etc. The

practices included here are just a few among the countless and diverse agroforestry practices that exist in Ethiopia.

2.4.1 Home gardens

Home gardens have been defined as a small-scale, supplementary food production system by and for household members by resembling the natural, multilayered ecosystem. Home gardens are characterized by being near residence, composed of a high diversity of plants, small, and an important source of household subsistence and cash needs. Tropical home gardens consists of an assemblage of plants which may include trees, shrubs, vines, and herbaceous plants, growing in or adjacent to a homestead or home compound and these gardens are planted and maintained by members of the household (Nair, 1993).

Home gardens are of economic importance to small farm families because they provide supplementary and continuous flow of products such as food for household consumption, medicine, poles, and offer a buffering capacity when the main crops fail (Soemarwoto & Conway, 1991; Torquebiau, 1992; Nair, 1993), the gardens also have considerable ornamental value, and they provide shade to people and animals (Nair, 1993).

Home gardens can be found in many parts of southern and southwestern regions of Ethiopia. Crops such as coffee, enset, pepper, and numerous kinds of vegetables are dominant components of the Ethiopian home gardens (Getahun 1988). Trees like Cordia africana, Milletia fruginea, Albezzia gummifera, Ficus species, and Acacia species are among the species that form the upper storey of home gardens. The structural complexity in the Ethiopian home gardens is varied and ranges from complex and diverse forms containing numerous species and strata, as in Sidama of the SNNPR, to the less complex forms, with one or two crop/tree mixtures, as in the Gurage Enset home-compound farms. Home gardens supply much of the basic needs of the local population and help reduce the environmental deterioration. Research on Ethiopian home gardens is at its infancy, with the exception of a few quantitative and descriptive studies (Getahun 1988; Abebe 2000; Negash et al. 2002). Multi-disciplinary biophysical studies, including soil-plant interactions and socioeconomic studies on home gardens, are needed for better understanding and use of these ecologically sound agroforestry systems.

2.4.2 Hedgerow Intercropping

This form of agroforestry is practiced in many parts of Ethiopia. The sorghum/maize and chat (Catha edulis) hedgerow intercropping in the Hararghe Highlands of eastern Ethiopia is one such example. The shrub chat is a stimulant cash crop that generates cash for the farmer. Although the soil regenerative properties of the system are not obvious, it has undoubtedly helped in the soil conservation of the hilly landscapes of Hararghe (Bishaw and Abdelkadir 1989).

Another form of hedgerow intercropping that has recently been introduced and has been widely tested in the scientific community is alley cropping (Hoekstra et al. 1990). Alley cropping is an agroforestry technology suited to humid and sub-humid tropics and entails the growing of food crops between hedgerows of planted shrubs and trees, preferably leguminous species. The hedges are pruned periodically during the crops' growth to provide biomass and enhance soil nutrient status (Nair 1989; 1993). There is great potential for use of the system in Ethiopia, particularly to improve soil and water conservation in the hilly and mountain ranges for which Ethiopia is known (Bishaw and Abdelkadir 1989).

2.4.3 Scattered Trees in Crop Lands

This practice involves the growing of individual trees and shrubs in wide spaces in croplands. Dispersed trees grown in farmlands characterize a large part of the Ethiopian agricultural landscape. Trees would be grown in a scattered form over a crop field, usually between 1–20 trees per hectare to minimize impact on the companion crop. In such mixed intercropping, lopping and pollarding of trees would be practiced. Some good examples of this practice include Cordia africana intercropping with maize in Bako and western Ethiopia; Acacia albida-based agroforestry in the Hararghe Highlands and Debrezeit area (Hoekstra et al. 1990). The system has much potential for supplying fodder, poles, farm equipment, fuel wood and agricultural improvements (Poschen 1986; Abebe 2000).

2.4.4 Windbreaks/Shelterbelts

Windbreaks are narrow plantings of trees and shrubs, mainly tall woody species that form a linear barrier perpendicular to the prevailing winds; they protect cropland, pastureland,

roads, farm buildings and houses from the harmful effects of wind and wind-blown sand and dust. Windbreaks usually consists of multi-story strips of trees and shrubs planted at least three rows deep and are placed on the windward side of the land to be protected and are most effective when oriented at right angles to the prevailing winds (Nair, 1993). When properly designed and maintained, a windbreak reduces the velocity of the wind, and thus its ability to carry and deposit soil and sand, improve the microclimate in a given protected area by decreasing water evaporation from the soil and plants, protect crops from loss of flowers, reduce crop loss due to sand-shear of seedlings, in addition windbreaks can provide a wide range of useful products from poles and fuel wood to fruits, fodder, fiber, and mulch (Nair, 1993; Torquebiau, 1994). Well-designed windbreaks, i.e. ones that are not too dense, not only reduce wind speed but may also increase humidity and reduce water loss from the soil. When establishing new fields, some protection from runoff and wind can be obtained by leaving a shelterbelt.

2.4.5 Woodlot

A woodlot is an agroforestry practice where multi-purpose woody perennials are planted and managed over time to produce fuel wood, poles, and stakes for climbing crops; food and animal components may be integrated into woodlots, especially during the initial establishment phase (Nair, 1993). Depending upon the nature of the land and the purpose for which the woodlot is being established the selected plot of land is marked, lined, and pegged at the recommended or required spacing and on marginal or degraded lands, a spacing of 1m x 1m is recommended to ensure early canopy closure, soil protection and weed suppression (Young, 1997). He reported that where food crops are integrated into woodlots, pruning's from the trees should be spread on the ground to serve as mulch and green manure. Harvesting regime and frequency depends on the type of species, the rate of growth and the purpose to which harvested tree is going to be put (Nair, 1993).

2.4.6 Boundary Planting

Boundary planting is an agrosilvicultural technology and the components are spatial zoned (Torquebiau, 1994). It involves planting of trees (including fruit trees), shrubs and grasses in single or multiple lines to define boundaries or spaces dividing separate land-use units and it is mainly used along boundaries of farms, home compounds, pastures or

scattered cropland (Torquebiau, 1994; Young, 1997). It is preferred to use tree species that provide useful products which could be sold to generate additional income while at the same time delineating the boundaries (Nair, 1993). Fruit trees like mangoes, avocadoes, citrus, oil palm, coconut, or timber trees are good species for boundary planting (Nair, 1993). Moreover, Nair (1993) reported that planting trees on boundaries will affect more than one land user and crops on neighboring farms could be affected through shading at some time of the day. This could lead to conflicts between farmers and in practice, it is important that all land owners and users agree on its establishment.

2.4.7. Live Fencing

Live fences are barriers of closely spaced trees or shrubs to protect crops or structures against livestock and human interference. It may be established all around the farm, but it is commonly established around the homesteads and gardens. It is commonly practiced in Ethiopia. Live fences can be combined with other trees for production of wood and fruits. They can be made of single or multiple densely planted rows. Alternatively, one row of living fence posts can be planted widely spaced, with wire, sticks or dead branches between the trees. The use of live fences is a cheap method of fencing large areas because once the live fences become established they are permanent. Their establishment requires no expensive materials to be purchased and they are easy to maintain. Living fences may also give produce, e.g. fruits. Native tree species to be promoted for this purpose will be: Accacia tortilis, Accacia bussei, Accacia seyal (Kindeya, 2004). These trees have been revealed to provide fuel wood, charcoal, shade for human and livestock, fodder, etc. while serving the primary objective of fencing. Since they can be grown along the boundary in croplands, agreement to its installation is needed among all affected land owners and users.

Protection and management are crucial for success. Protection is needed for young seedlings till they will be large enough to protect themselves. As the trees grow, they will be trimmed, providing either mulch for the soil or fodder for livestock. The planting pattern is often in lines. This practice does not require substantial labour for planting and maintenance. It can also serve as boundary demarcation, and windbreaks in wind prone areas.

2.4.7 Trees on Rangelands-Silvipastoral systems

This involves the incorporation of the native tree species having high fodder values in rangelands. They can either be scattered irregularly or arranged according to some systematic pattern. Species that can be promoted include: In the semi-arid and sub-humid areas: Ficus albida, Acacia seyal, Acacia tortilis, Acacia sieberiana, Acacia abyssinica, Acacia etbaica, Acacia bussei (Kindeya, 2004). These tree species have had great potential in their fodder value for most of the livestock. Most of them produce leaf fodder and edible pods. Most have higher crude protein, mineral content and some higher dry matter density than the associated grasses, particularly during the dry season. Though the species will primarily be incorporated to produce fodder, they can also provide poles, fuel wood, pollen and nectar for bee fodder, or improve the soil.

The paramount importance of the trees in this agroforestry practice is to meet wood and fodder demands throughout the year and maintain fodder through dry periods. They can also help to maintain the stability and fertility of grazing lands and reverse trends in land degradation and desertification. Either planting or natural regeneration or both would be involved. This can be encouraged through rain harvesting with micro catchments, as well as protection from grazing animals. Especially in the arid areas, in the past extended periods of rest, where natural regeneration was encouraged used to be practiced. With the ever increasing pressure, these periods have become progressively shorter, now resulting in very minimum regeneration. Some management schemes will be necessary to promote and enable the establishment of seedlings and saplings to ensure the future of these systems. To minimize the protection requirements, the trees could be planted in clumps. Because it is easier and economical to protect group of trees than the same number of trees planted in lines or dispersed throughout the pasture. In sloppy lands the planting pattern should follow contour lines (Kindeya, 2004).

2.4.8 Trees on Soil Conservation and Reclamation Structures

Soil and water conservation has been practiced in many parts of Ethiopia, and it has been promoted by the governments (the past and present) for more than 20 years. It is thus increasingly becoming a culture in many areas. In this light, native tree species have a lot to contribute. Traditionally, they have been incorporated in many of the conservation earthwork structures - especially, soil and stone bunds. Furthermore, they can be grown

on terraces, raisers etc. with or without grass strips for the purpose of reclamation of degraded soils, and sand dune stabilization while providing various tree products. There exists a great potential in improving productivity and land use sustainability in sloppy farmlands. Where adequate moisture can be conserved to plant fruit and cash trees, the following species could be considered: Musa spp., Cofee arabica, Persea americana, Carica papaya, Rsidium guajava, Mangifera indica, and Citurs spp. could be planted (Kindeya, 2004).

These tree species have been indicated to have potentials in providing various tree products while stabilizing the conservation structures found in farmlands. They make lost cropping space productive by using the surfaces of structures where other crops can't be grown. To maximize water availability to the growing seedlings in the bunds, micro catchments can be utilized. Cut-off drains could also be incorporated during wet seasons (Kindeya, 2004).

Protection against browsing will be necessary during the early establishment periods. Cut and carry could be used to supply fodder for livestock in a form of stall feeding. Trees should not be allowed to grow too high and cause shedding on the accompanying crops, in cases of croplands. Topping and pollarding need to be done to secure light shade for growing crops and this also maximizes biomass production both for soil litter and fodder for livestock.

2.5 The Concept of Adoption

The process of developing and disseminating agroforestry as a viable alternative for farmers under various ecological and socioeconomic conditions has become a challenging constraint to promote agroforestry. Moreover, as noted by Raintree 180 R.P. Neupane et al. / Agricultural Systems 72 (2002) 177–196 (1983), no agroforestry technology, regardless of its ecological and economical soundness, will have significant impacts on land management, productivity and income unless it is adopted by a significant proportion of farmers.

Adams (1982) conceptualized that adoption of innovation by the individual innovator is of five stages:

- Awareness – the individual first hears about or becomes aware of the innovation, but is not yet motivated to seek further information.

- ❖ Interest stage – he feels that the innovation may be relevant to his needs he becomes interested and seeks additional information about it.
- ❖ Evaluation stage: Weigh up the advantages and disadvantages of using it.
- ❖ Trial Stage: If his evaluation is favorable, he may decide to give the innovation a trial, by applying it on a small scale to determine its utility under his condition.
- ❖ Adoption – in the light of his experience during the trial stage, the individual may decide to apply the innovation fully, thus, on a relatively large scale and continuous use of the idea and personal satisfaction of it.

It does not necessarily mean the constant use of the idea but that the idea has been accepted and the individual intends to include it in his practice. According to Ahmed (1991) a farmer is considered to have adopted a technology if he uses it to any extent on his farm.

From the concept put forward by Adams (1982) it may be decided that adoption of new innovations is not immediate and the final decision is usually the result of a series of influences operating through time. It might also be important to distinguish between adoption and diffusion. Agyemang (1991) gave a theoretical distinction between diffusion and adoption as: - Diffusion begins at a point in time when technology is ready for use. How the technology is made available to the potential user is the main focus of diffusion. Adoption considers the behavior of individuals in relation to the use of the technology; more particularly the reasons of adoption at a point in time are of primary interest.

The concept of adoption has often attracted considerable attention as a result of the infrequent success in achieving high adoption rates in developing countries .Some of the underlying factors for low adoption rates can be found in the proposition by Rogers and Shoemaker (1971). According to them the adoption rate usually is a function of: - the relative advantage of the innovation as perceived by the farmer; the compatibility of the innovation in the context of the farming systems; the complexity, that is the degree to which the innovation is perceived as difficult to understand and use; the degree to which it can be subjected to simple and non–consequential trial on the farm; and the observability of the innovation and its effect. These propositions have been the core of much research on adoption. For example, Burch (1992) analyzing evidence from 100

studies found that innovations that permit a trial run have strongest initial local support. The perceived advantage and compatibility, he concluded, does not seem to be a great consideration in adoption.

2.6 Factors that Affect Adoption of Agroforestry

Similar to any other new technologies, agroforestry adoption is a complicated process that may be influenced by a number of factors, such as socioeconomic characteristics of farmers, access to and level of resources, provision of extension, infrastructure and market, and other institutional factors. Farm level studies can provide insights into key social and economic factors affecting farmer use and management of agroforestry practices and their effects on household resource base (Scherr, 1990). Agroforestry systems, however, can often be more complex than existing crop and other farming practices (Arnold, 1987). Thus there is the need to isolate factors that might specifically affect the adoption of agroforestry technologies. This is even more important because sometimes where trees are especially scarce, rural people may be unwilling to grow them. It is unlikely that the reason for this is ignorance of the benefits of trees or of the technologies used in cultivating them; it is far more likely that there is other real constrains (FAO, 1986).

2.6.1 Socio-economic Factors

Socio-economic considerations are increasingly becoming important in technology diffusion and adoption processes. This is more so for agricultural, forestry, agroforestry and related innovations, which are meant for the diverse environments and circumstances of rural people (Rocheleau & Raintree, 1986). The need to examine socio-economic factors in the adoption of agroforestry technologies has been highlighted by Raintree (1991) in his evaluation of the storm over Eucalyptus in social forestry programmes in India. Among his findings he stated that: “On closer examination of the issues, it appears that while most of the debate has been couched on ecological terms, many of the underlying issues are social and economic in nature. The debate demonstrated how important the socio-economic context of the intended user can be in determining whether or not he or she will be able to make effective use of a particular tree planting practice. Again, Hoskin (1987) gives a partial list of socio-economic issues that must be taken into

consideration if farm families are to adopt agroforestry technologies as: local uses and knowledge of trees, tenure, organization, conservation, landlessness, enterprises and marketing, labour, nutrition and gender/age. In his analysis on socio-economic context and development strategy for tree growing Raintree (1991) pointed out that factors that are relevant to consider under the broad heading of socio-economic will vary from place to place. Among the most important are: - degree of local socio-economic stratification (by wealth, land holding size, gender, ethnic group etc.); access to resources (land and tenure); overall economic development strategy; general approach to tree planting programmes, opportunity for relocation of resources; access to credit; processing technology and marketing assistance etc. It could be seen from the above discourse that the socioeconomic factors that affect the adoption of agroforestry are many and varied and differ from place to place and it is time specific. In spite of these variations the major socio-economic factors that are necessary in the adoption of agroforestry by individuals are land tenure and ownership issues, socioeconomic stratification, labour requirements, capital, markets and institutions.

2.6.1.1 Land Tenure and Tree Ownership Issues

One of the critical factors that have been given consideration in determining the potential acceptability and viability of agroforestry is land tenure systems and tree ownership. Francis (1987) gave the assertion that patterns of technology adoption will be shaped by the structure of opportunities and constraints presented by the rules of tenure. In the study of "Agroforestry adoption and risk perception by farmers in Senegal", Caveness and Kurtz (1993) found out that land ownership was one of the two predominant factors (the other was labour) affecting the adoption of agroforestry practices. Raintree (1991) has also found that if a user does not have security over the intended planting location; adoption of the tree planting innovation may be quite out of question. Kolade (1984) also noted that in vast agricultural lands of Tropical Africa, agroforestry has yet to make a break through. The reason is largely due to the flexible system of land tenure as well as its attendant insecurity.

Governments in many African countries are aware of the need for tenure reformation. For example in Ghana the Rent Stabilization Act 109 of 1960 as amended the same year by

Rents (Cocoa Farms Amendment) Regulation among others prohibited ejection of tenants without ministerial approval (Arhin, 1985).

Leach and Mearns (1988) asserted that tenure issues in agroforestry do not relate to land tenure only but also to tree tenure. The distinction between land and tree tenure is crucial to the participation of rural communities in projects involving tree growing. Fortmann (1985) has listed four major categories of rights that make the bundle, which comprises tree tenure: - the right to plant, the right to use, the right to dispose and the right to own or inherit. Each of these categories or combinations of any, Fortmann emphasizes, have restrictions on community participation in agroforestry projects in several African countries. He also points out that tree tenure issues in the community intended for the project needs careful examination to avoid problems like the loss of rights, particularly to other uses of land or the trees on it and loss of gathering rights among others. The complexity of tenure issues is believed to have discouraged many tenants from growing trees. Francis (1987) said that in areas where land pressure is more intense and other terms of tenancy are more definite, permanent tenants, many of whom grow food crops under tenancy leases, may be disallowed from planting tree.

2.6.1.2 Socio-economic Stratification

Raintree (1991) pointed out that the degree of socio-economic stratification, which exists within a locality, is important in determining the adoption of a new technology particularly if it is highly attached to factors, which govern access to resources. The stratification of a community can be on the basis of wealth, landholding size, gender, age, ethnicity, religion, education etc. Eckman (1991) deduced from his studies that individuals within a household may have different rights depending on gender or birth. He found also that in some African countries, for example, women plant and tend firewood or fruit trees but do not have right to harvest fruits or wood; these may be sold or appropriated by male members. Fortmann (1985) has also pointed that group rights which alienate “strangers” and deny them use rights of trees and discourage their participation in agroforestry projects. Socio-economic stratification has been found to be important in extension work. Johnson (1987) has concluded that to be effective in encouraging adoption of innovations, extension workers must work with rather

homogenous categories of farmers i.e. Based on their access to land, water, labour inputs, markets, credit and information.

2.6.1.3 Labor Requirements

One of the major factors influencing farmers' adoption of agroforestry is labor requirement (Arnold, 1987). He stated that a farmer's decision to grow trees can be influenced by two main factors: one is the high cost of labor and capital and the other is the potential of income to be generated from tree as distinct from food production in farmers' production objectives. Njoku (1991) in his studies on adoption of improved oil palm production found that a major constraint was high cost of labor. He concluded that many new technologies require intense labor use, which contrasts greatly with the limited amount of labor expended in the traditional wild oil palm groves and that smallholder farmers must hire expensive labor to implement the improved technologies.

The strong competition for household labor with other activities in the farming system particularly during critical periods in the agricultural season would obviously influence farmers decision about adopting agroforestry. This has been found for example to be true of alley farming (Kang & Wilson, 1987).

2.6.1.4 Capital

One of the captivating arguments about capital requirements and adoption of agroforestry products has been put forward by Arnold (1987) as; "It is widely argued that the lengthy production period and the incidence of most of the costs at the time of establishment, create financial problems for farmers in adopting practices involving tree growing". It is this argument that underlies the widespread provision of planting stock, either free or at subsidized prices in programmes to support tree growing. However, the evidence that tree systems are favored by farmers when capital is scarce because trees require less investment than alternative crops and/ or provide substitutes for purchased inputs example fertilizer and herbicides suggests that improved access to capital would not necessarily increase adoption of agroforestry practices. In support of Arnold argument, Hyman (1983) in his investigation on pulpwood production in the Philippines concluded that capital could be an impediment to investment in larger rotation timber species grown as cash crops. In this situation however, the constraint seems to be not the capital cost of establishment but lengthy period that elapses before there is any return.

Schutjer and Van der Veen (1977) argued that adoptions of scale-neutral innovations are not necessarily inhibited by credit constraints. They stated that the profitability of innovations often induces small-scale farmers to find the cash required for adoption from their relatively meager resources. Contrary to the above discourse, capital in the form of savings and credit is required in order to form many agricultural and agroforestry innovations.

Therefore differential access to capital is frequently cited as a major factor determining adoption rates (Mercer & Hyde, 1992). For example, Owusu Sekyere (1991) concluded that participating farmers in an agroforestry project complained that they needed credit in the form of cash to pay for extra labor required to maintain their agroforestry plots and that without attending to farmers cash needs project implementation can be very slow.

2.6.1.5 Markets

Marketing of products could serve as a great incentive or disincentive to virtually all productive ventures. According to Hedge (1990), the important criteria for farmers to grow any new tree species, depend among others on assured demand for the produce and really market outlets, minimum support price, at which tree growing is profitable; and generation of cash surplus as the most powerful incentive for most farmers. The important role of markets in tree growing is further highlighted by an observation of a participant in a farm forestry project in Gujarat, India and quoted by FAO (1989):

"Having invested heavily in planting and maintaining the trees we waited patiently for four years. Now it is the end of 1986 and we have not been able to sell the trees. There are no buyers the Lokhariti workers are hiding away from us and the Forest Department Official who used to visit us has been transferred to another place, so we have nobody to turn to. We see this business of farm forestry as a disaster for our people". The scenario above depict the frustrations farmers go through if they cannot market their tree products and also it underscores the risk aversion tendencies of farmers in adopting tree planting practices. It is only with a coordinated effort to market the forest produce at a remurative price that afforestation programmes can be implemented successfully with the active participation of the rural people (Hedge, 1990).

2.6.1.6 Institutions

Policy analysis defines institutions as rules, norms and values that shape our behavior. Sometimes known as the „rules of the game; institutions can be:

- Both formal (example, laws that govern land tenure, market transactions or civil rights) and informal (example, social customs and conventions);
- Created (example, as a result of deliberate political or policy decisions) or may evolve overtime;
- Present at local, organizational, national, and international levels.

In many developing countries, policies and institutions discriminate against those with few assets and disadvantage poor people. Such discriminatory policies and institutions undermine development efforts to eradicate poverty. It is now generally accepted that significant and sustainable gains in poverty reduction cannot be achieved unless accompanied by pro-poor reforms to domestic and international policies and institutions (Ashley & Carney, 1999).

2.7. Conceptual Framework

It is a framework for analyzing causes of poverty, peoples' access to resources and their diverse livelihoods activities, and relationship between relevant factors. The four relevant factors that to be analyzed under the studies are:

2.7.1. Agroforestry and Environmental Conservation

Agroforestry has the potential to mitigate land degradation by controlling soil erosion (barrier approach), maintenance of soil organic matter through mulch and biomass transfers. The barrier approach to erosion control by checking runoff and keep valuable top soil in place. The contour hedges created by multipurpose trees provide soil erosion control through barrier approach mechanism. Many trees and shrubs planted through agroforestry can increase plant and ecosystem biodiversity; trees are also helpful in ameliorate global climate change by sequestering vast amount of carbon. The physical presence of trees on farm boundaries serve as living fences and protect home gardens from free grazing livestock.

2.7.2. Agroforestry and Socioeconomic

Agroforestry can contribute to food security through provision of edible products such as fruits and seeds. Trees can also improve soil fertility by fixing nitrogen from the air and

recycling nutrients, thereby helping to increase crop yields. Trees provide valuable supplemental fodder for animals to enhance livestock production. Trees provide household energy for cooking, heating and lighting. Agroforestry provides farmers with products, many of them high in value, which can be sold in rural and urban markets such as selling timber, poles, charcoal and honey. Many trees and shrubs have medicinal value that keeps the farm family healthy and generate additional income. Trees that adapt well to the environment and drought tolerant tree species are insurance mechanism against crop failure.

2.7.3. Agroforestry and Technology

Fuel Saving Technology using large –scale distribution of improved biomass fuelled injera stoves that help to reduce pressure on the biomass resources, including forests which increase land productivity by reducing crop residue and dung usage for fuel wood, and improve family health. Additionally, modern beehive techniques that help to improve the income by increasing the honey production. Capacity building through training helps to introduce different technologies that are important in improving the livelihood of the rural people.

2.7.4. Land Tenure System and Land Tenure Policy

One of the critical factors that have been given consideration in determining the potential acceptability and viability of agroforestry is land tenure systems and tree ownership. Francis (1987) gave the assertion that patterns of technology adoption will be shaped by the structure of opportunities and constraints presented by the rules of tenure.

As vast experience throughout the world has demonstrated that private ownership of land is prerequisite to agricultural development and improve livelihood. Public policy decision can profoundly affect the uptake and impact of agroforestry innovations-tenure security, availability of appropriate credit facilities and inputs, extension services, marketing systems and price fluctuations.

2.8. Agroforestry and Household Food Security

The severity of the environmental degradation coupled with poverty expresses itself in the large proportion of the country's population lacking food security. Many countries in the world face drought, yet not all occurrences of drought end up with famine. The

famine in Ethiopia is only an expression of the complex interrelated problems of environmental degradation, poverty and lack of alternatives (Kindeya, 2004).

The success of any land use intervention is determined in its capability to deliver the intended benefits. In order to attain food security, one needs to find a system that will not completely collapse when there is drought and one that will provide the farming community with alternative income earning possibilities. In a prior study conducted by the author in 1995, several indigenous tree species incorporated in agroforestry systems were found to be sources of fuel, feed (during dry season), poles, farming implements, shade, live fence and other local uses like in traditional medicine, human food and bee-keeping. Hence, agroforestry to be a sound practice, has to meet the farmers' short term needs (fuel, feed, poles etc.) and provide service functions (maintain soil fertility, erosion control etc.) in the long-term (Kindeya, 2004). Similarly, agroforestry systems often provide habitat for wildlife and thereby increase the availability of bush meat. The many foods available from agroforestry systems can provide a more varied and potentially more nutritious diet (1979. Agroforestry to combat desertification: A case study of the Sahel). It also enables rural Sahelian populations to relate economic production directly to their own cultural traditions and management capabilities rather than to alien perspectives and approaches to management, which are often insensitive to local needs, capabilities, and conditions. By increasing the self-reliance of rural populations and maintaining cultural continuity, agroforestry can help stabilize rural communities and reduce the destructive social anomie so often associated with rapid socioeconomic change. By simultaneously permitting increased production while relieving pressure on environmental systems, agroforestry also enables rural populations to maintain or restore the traditions of environmental stewardship so basic to the long-term well-being of the Sahel region(1979. Agroforestry to combat desertification: A case study of the Sahel).

2.9 Agroforestry for Rural Livelihood

Agroforestry can help people to be more self-reliant by meeting daily needs through a more varied and often more productive economy, and by reducing the need to import food, fuel, fertilizer, herbicides, pesticides, fodder, building materials, and other products (1979. Agroforestry to combat desertification: A case study of the Sahel). Nair (1993)

indicated that the combination of several types of products which are both subsistence and income generating, helps farmers to meet their basic needs and minimizes the risk of the production system's total failure. A great economic advantage of the Agroforestry is that villagers can harvest something daily for their own consumption, for sale in the market or for raw materials for their home consumption. Increased production and improved handling of vegetables have great potential to enhance the nutrition of the rural and urban poor in the developing countries, as well as to increase their incomes and provide greater opportunities for employment.

Ethiopian home gardens agroforestry have two-fold functions: some products are mainly for home consumption, while others generate income generation. Consequently, they represent an important foundation for rural livelihoods, economic earnings, floristic richness and the application of local knowledge to the farming, processing and use of plants, animals and products (Zemede Asfaw, 2001).

At the macro-level it is difficult to assign monetary value to agroforestry products, because a large part of the common vegetables produced in agroforestry are directly consumed without ever entering the market system; also, in many cases statistical figures do not differentiate between home gardens agroforestry and dry fields. However, figures for the production of fruit and livestock may be used as a rough indication of the importance of the agroforestry in the village economy, since they are almost exclusively produced in the home garden, and little is consumed by the people (Zemede Asfaw, 2001).

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1. Description of the Study Area

3.1.1. Location and Climate

Study area, Borecha district/woreda is one of the 24 districts found in Illu-ababora zone, Oromia National Regional State. Yanfa, the capital town of the district is situated at a distance of 500kms south west of Addis Ababa and 173kms south east of zonal town (Mettu) respectively. The district bounded by the Gechi district in the West, Didesa River in the East & North and Didesa district in the South. The total land coverage of the area is estimated to be 961km^2 (96,100 hectares) (BARDO, 2009). The district sub-divided into 34 administrative units (kebeles) from which 33 are rural kebeles and only one Yanfa is urban Kebele. Of the total kebeles, six of the rural areas are resettlement areas.

As information collected from Woreda Agricultural and Rural Development Office the district(woreda) is categorized into three types of agro- ecological zones; dega (highland) 5 percent, woyna-dega (midland) 66 percent and kola(lowland) 29 percent with altitudes ranging between 1280 m.a.s.l. and 2400 meter above sea level(m.a.s.l.). The district receives annual rainfall ranging from 1100 ml to1760 ml from March up to October while the dry season lasts for four months from November to February. The annual temperature ranges from 19C^0 to 25C^0(BARDO, 2009).

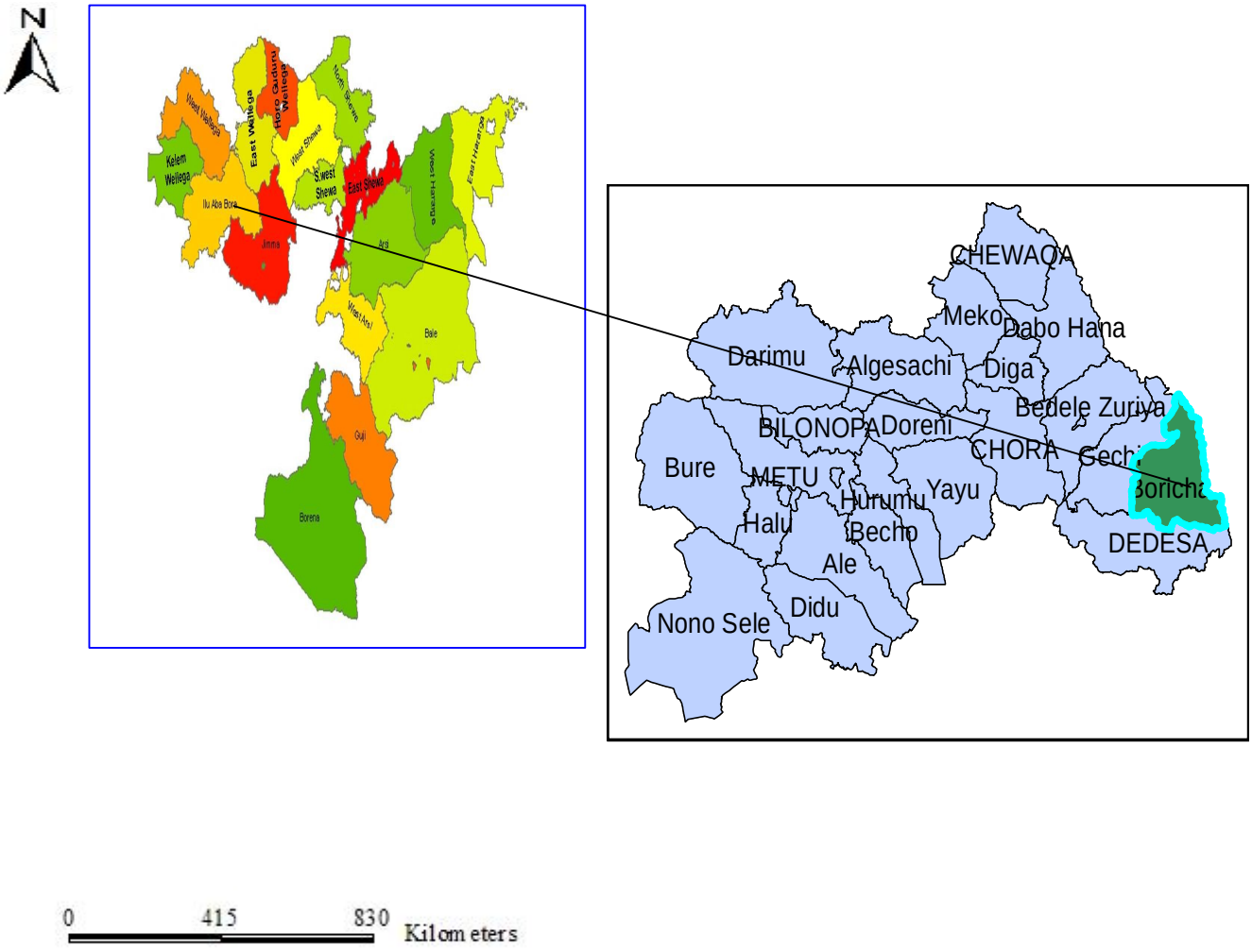

Figure 1. Map of the Study Areas

3.1.2. Socioeconomic Aspects

According to WoFED office, the population of the woreda is estimated to be about 85,000(considering 2.9%) of which women population account for 49%. Total number of households is 17,000 (95% are males). The crude population density is about 88 persons per square kilometer. The average family size is six persons per household. According to local sources, the population of the study area is rising continuously due to some immigrants and putting huge pressure on the existing natural resources, especially in the lowland areas of the district.

3.1.3. Means of Livelihood and Sources of Income

Mixed of crops production and livestock raring characterizes the major farming system of the district. Crop production plays significant role in the livelihoods of the rural people as main means of household's income source.

Crop production is produced on the area both by using rain-fed and irrigation systems. According to information from (BARDO, 2014), the total area under cultivation is 56,427 hectares of which 48,799 hectares used during rainy seasons (main and *belg*) and 5642 (10%) hectares using irrigation water to produce vegetables (Potato, Tomato, Onion, Cabbage and Garlic). Teff, Ground nut, Maize, Finger millet, Sorghum, Barley, Wheat and Bean are the major field crops grown in the district. Cash crops such as coffee and chat are also widely grow in the area.

Livestock production has also shown a significant contribution in improving households' income and alternative options of households' strategy to cope with shocks, stress, and combat food insecurity. Livestock like Cattle, Sheep, Goat, Donkey, Horse, Mule and Apiculture are common in the area. The type and total number of livestock owned by individuals in the area include cattle 68060, goats and sheep 12916, equines 3143 and poultry 19,323(Source: Woreda ARD 2011). Cattle serve as source of income (hide, milk, sale of animals), food, and fertilizer (making compost). Equines (horse and donkey) used for transport purposes. Small stocks (goats, sheep and poultry) kept primarily to meet the cash and meat needs of the household. In the district, natural mating is widely used in the area as means of reproduction. However, AI service is currently started by few farmers.

Poor management system, feeds during dry season, attitudes individuals have on quantity of animals (social prestige) rather than their economical value and prevalence of diseases are among the main problems that hinder the production of livestock.

Table 3.1 Numbers of Livestock in the District

Type of livestock	Heads	Percentage	Remarks
Cattle	68060	65.79	
Sheep and goat	12916	12.49	
Equines	3143	3.04	
Poultry	19323	18.68	
Total	**103442**	**100.00**	

Source: WARDO, 2011

3.1.4. Land Use/Land Cover

The total land area of the district is about 95898ha. According to agricultural and rural development office of Borecha woreda, agricultural land still accounts for the largest share of the land use types in the district. About 56427ha (58.8%) is cultivated land, 22,431ha (23.4%) is covered by natural forest & bushes, 8006ha (8.4%) is used for grazing and the rest 9034ha (9.4%) is wasteland & miscellaneous. Average cultivated land holding is about 3.3 ha per household and that of grazing land is 0.45ha per household at the district level. Agricultural expansion, settlement, forest fire and overgrazing are the major threats to the natural forest in the district.

3.2. Study Methodology

3.2.1. Selection of the Study Area

The study district, Borecha was selected purposively based on its convenience and accessibility. Moreover, in spite of the fact agroforestry practice have been undertaken by nongovernmental organization in the area for more than 10years no study on measuring their impact has been conducted in the specific Woreda (District). In this study, various constraints like budget, accessibility, time and other factors have been taken in to consideration to determine the sample size in which case 4 kebeles were selected from 34 kebeles in the district. These four kebeles namely Deneba, Gubahora,

Karsa yasin and Kitawo were selected from all ecological zones by using stratified random sampling technique. Deneba & Gubahora kebele were selected from kebeles representing lowland areas, Karsa yasin Kebele was selected from kebeles representing a mid altitude areas, and Kitawo was selected from kebeles representing highland areas.

3.2.2 Study Approach and Sampling Design

A key technique for undertaking impact evaluation is constituting a sample of program participants and non- participants. This technique is a vital step in the process of obtaining and comparing actual and counterfactual outcomes. As pointed out by (Karlan and Goldenberg, 2007), one need to compare the lives of participants relative to how they would have been had the program, product, services not been implemented. In addition, the choice of research method is the reflection of the interplay of various factors including the aim of research, specific analysis goal and its associated research question, the preferred paradigm, the level of investigator intervention, the available resources and time frame (Crabtree and Miller 1999). Appreciating this, both qualitative and quantitative methods were adopted as a research instrument for this study. During data collection, contact was first made with the Borecha Agricultural Rural Development Office and Menschen FÜr Menschen Borecha Integrated Rural Development Office to collect the necessary information about the target area. In this study, the major data collection tools employed were physical observation, key informant interview and focus group discussion to collect mainly qualitative information and household survey to collect mainly quantitative data from representative households.

3.2.3. Sample Size and Sampling Techniques

Both agroforestry adopters and non adopters were included in the survey. Only the head of the household were considered for household interview; other members of the family were included in focus group discussions and key informant interviews. At the same time, Sample size was calculated with the simple random sampling method presented below (Yamane, 1967).

$n= \underline{N X \sigma^2}$

$(N-1)X\ D2 + \sigma^2$

The explanations of the abbreviations are provided below:

n= No. of samples

N= No. of population in selected kebeles

σ^2= Variance of Population

D= $(d/t)^2$

D= A certain rate of deviation (5%) from the average

t= t table value (1.96) corresponding to the limit of the confidence interval 95%

The needed sample size was computed by plugging the values into the above formula, where N is the total household of the selected kebeles (2233HH), D is 5% and variance of population is 95%

$$\text{Number of sampled} = \frac{2233 \times 0.95}{(2233-1)X\ (0.05)^2 + 0.95} = \frac{2121.35}{6.53}$$

$$= 325$$

The sample size was 325 but due to time and resources constraints the researcher has determined the sample size to be 144 (one hundred forty four) (Table1:1). The survey was conducted on 112 households for detailed household survey and for gathering agroforestry inventory data. Twenty (20), Fourteen (14), Twelve (12) and Ten (10) households of both adopters and non adopters were interviewed from Deneba, Gubahora, Karsa yasin and kitaw kebeles respectively that means, One hundred twelve households of adopters and non adopters. For key informant interviews, three carefully selected persons from each sample kebele were involved; (one from elders, one educated, and one from kebele representative). Four focus group discussions were carried out with five selected persons, representing agroforestry adopters. Moreover, four development agents working in the sample PAs were involved in a group discussion.

Table 3.2 summary and descriptions of instruments by type, target and number of target group representations for data collection

No	Types of instruments	Target group	Number of target group representations	Types of sampling
1	Key informants discussions	Community leaders and administration	12	Purposive sampling
2	Focus group discussions	Adopter and non adopter	20	Purposive sampling
3	Survey method	Adopter	56	Stratified–systematic sampling
4	Survey method	Non adopter	56	Stratified–systematic sampling
	Total		**144**	

3.2.4. Types of Data and Tools of Data Collection

3.2.4.1 Reconnaissance

An initial discussion was held with Menschen für Menschen Foundation, Borecha Integrated Rural Development Project and woreda government Agricultural development office to explain the purpose of the survey and get permission to conduct the study in the selected area. Based on the information generated from the discussions at various levels, four kebeles (Deneba, Gubahora, Karsa yasin and Kitawo) where agroforestry adopters are dominant were sampled for the study among the rural kebeles found in the district where the project is operating. Through these discussions, participant farmers in focus group discussions were selected from both agroforestry adopters and non adopters.

3.2.4.2 Primary Data

1. **Key Informant Interview**

At kebele level, three key informants per PA and twelve for the four PAs were used to gain an overview of the evolution of vegetation cover changes, agroforestry practices and the interaction between local community and adjacent natural forest in the study area. The information obtained during key informant interview also used in the development

and modification of questionnaires that were employed for formal household survey. Key informant with better acquaintance with the local farming system, good knowledge in, and ability to articulate the functioning of agroforestry system, and who have lived continuously in the area for 10 and more years have selected.

2. Focus Group Discussion(FGD)

Focus group discussion was undertaken after the introductory meetings and the identification of participant farmers. Four focus group interviews were conducted and five persons were involved in each group discussion. A separate informal discussion was also held with development agent workers so as to make triangulation and validate the information given by different groups.

3. Household Survey

First, lists of all household heads of the selected kebeles were collected from the kebele administrator and development agents. A random selection procedure using the systematic random method was employed to obtain the representative samples of individual households from the listed household heads in the selected kebeles. One hundred twelve households were systematically selected and interviewed. Questionnaires were developed and modified based on the information gathered during the informal survey and were translated into required language to simplify for the enumerators. The questionnaires were pre-tested using randomly selected farmers from the sampled households to evaluate whether they were prepared in the way that clarify communication between interviewers and interviewed. The necessary adjustments to the questionnaires were then made before fully duplicating and distributing them to the enumerators. Four enumerators with Diploma qualifications were selected, trained and assigned each to selected kebele for data collection. Regular monitoring was conducted by the researcher while enumerators were interviewing the respondents and daily evaluation of the filled questionnaires was undertaken throughout the data collection processes.

3.2.4.3 Secondary Data

Secondary data was collected from the works of others on the impact, contribution and the role of agroforestry practices, experiences of other countries and review of published and unpublished literature and documents.

3.3. Data Analysis and Interpretation

To describe the general characteristics of sample respondents' descriptive statistics was used. To explore demographic profiles of each sample type frequency, summary statistics (mean, standard deviation, percentage, tabulation and others), and cross tabulation were displayed. Statistical Software Package for Social Science (SPSS) specifically designed for logistic regression was employed.

The data generated through quantitative method was organized and statistical computations were made to explore the inherent relationships among the different variables. Simple quantitative analysis techniques such as percentage and frequency distributions were also employed.

Finally the results were summarized in a table form so that the analysis and meaningful interpretations of results was made to draw conclusions and implications. The qualitative data collected through key informant interview, focus group discussion and physical observation was narrated and summarized.

CHAPTER 4: RESULTS AND DISCUSSIONS

4.1 Characteristics of Respondents

When this study was conducted, 112 households including the Agroforestry adopters and non adaptors sample were randomly selected from these Kebeles selected proportionately for the study. Hence, 35.72%, 25%, 19.64% and 19.64% of respondents are from Deneba, Gubahora, Karsayasin and Kitawo respectively representing all agro ecological zones of the areas (highland, mid altitude and lowland).

Table 4.1 Sample Size of respondent households by kebeles

Kebele of respondent HH	AF Adopter		Non AF Adopter		Total	
	Number	Percentage	Number	Percentage	Number	Percentage
Deneba	20	35.72	20	35.72	40	35.72
Gubahora	14	25	14	25	28	25
Karsayasin	11	19.64	11	19.64	22	19.64
Kitawo	11	19.64	11	19.64	22	19.64
Total	**56**	**100**	**56**	**100**	**100**	**100**

Source: household Survey

4.1.1 Gender

Gender wise 105(93.75%) of respondents are male and 7 (6.25%) of them are female this indicates that large proportion of household heads in rural area of the district under study are male (Table 4.2). Again, generally males are physically stronger than females and can comparatively provide more labour.

Table 4.2: Sex of the sampled households in the study area

Sex of respondent households	AF Adopters		Non AF Adopters		Total	
	Number	Percentage	Number	Percentage	Number	Percentage
Male	52	92.86	53	94.64	105	93.75
Female	4	7.14	3	5.36	7	6.25
Total	**56**	**100**	**56**	**100**	**112**	**100**

Source: Households Survey

The study revealed that there is not such a significance difference between the agroforestry adopter and non adopter respondents in their sex status. Male households in

the study areas are involved in arduous activities which are done manually like Planting and cultivation of perennial tree crops such as homegardens tree planting, woodlot, planting of shelterbelts and windbreaks, as well as fruit trees on cropland and traditional agricultural practice whereas Women are mostly involved in planting and cultivating vegetables in backyard areas to meet household consumption needs rather than perennial tree crops. In addition, Wives of agroforestry adopters were actively involved in home management and income generating activities (saving and credit) program organized by BoIRDP

4.1.2 Age of Sampled Households

The age composition of the sample shows that 9.82%, 50%, 21.43%, and 18.75% of the total respondents are within the age category of 26-35, 36-45, 46-55 and above 56 years respectively. With regards to agroforstry practice, the age range of the majority of AF adopters (91.07%) of them lied between 26 years and 45 years old which is within the category of economically active labor force which shows that younger farmers are more likely to adopt a new technology because they had more schooling than the older generation and could get the benefits of tree crops in their life time, whereas non adopters are older than agroforstry adopters and majority of non adopters (71.43%) were above 46 years of age (Table 4.3).

Table 4.3: Age Category of Sample Respondents

Age Category		**AF Adopter**		**Non AF Adopter**		**Total**	
		Number	Percentage	Number	Percentage	Number	Percentage
Age Category of respondent	26-35	10	17.86	1	1.79	11	9.82
	36-45	41	73.21	15	26.78	56	50
	46-55	2	3.57	22	39.29	24	21.43
	>56	3	5.36	18	32.14	21	18.75
Total		**56**	**100**	**56**	**100**	**112**	**100**

Source: Households survey

The calculated percentage of the agroforestry adopter is larger than the percentage of non agroforestry adopters. Hence there is real difference in age distribution in the study area. As indicated in the literature review, Tripp (1993) agree that younger farmers are more

likely to adopt a new technology, since they have had more schooling than the older generation or perhaps have been exposed to new ideas as migrant laborers.

4.1.3. Marital Status of Respondents

The majority of the surveyed sample 105(93.75%) are married while 4(3.57%) are widowed and 3(2.68%) of respondents are divorced. Among agroforestry adopter respondents 53 (94.64%) are married and 3(5.36%) are widowed. Whereas from agroforestry non adopter 52(92.86%) are married, 3(5.36%) divorced and 1 (1.78%) widowed. The result in the table 4.4 indicates that there is not such a significance difference between the agroforestry adopter and non adopter respondents in their marital status.

Table 4.4: Distribution of Respondents by Marital Status

Marital status of respondent households		**AF Adopter**		**Non AF Adopter**		**Total**	
		Number	Percentage	Number	Percentage	Number	Percentage
Marital status of respondent HH	Married	53	94.64	52	92.86	105	93.75
	Divorced	0	0	3	5.36	3	2.68
	Widow	3	5.36	1	1.78	4	3.57
Total		**56**	**100**	**56**	**100**	**112**	**100**

Source: Household Survey

The calculated percentage of the agroforestry adopter (94.64%) is similar to the calculated percentage of non agroforestry adopter (92.86%). Hence, there is no real difference in marital status of agroforestry adopters and non agroforestry adopters in the study areas.

4.1.4. Education Level of Respondents

Concerning the educational level of sample, the majority of the respondents 64 (57.14%) are attended grade 1-4 that means they can read and write. 37(33.04%) are illiterate categories of the respondents. 10(8.93%) are covered grade 5-8 level of education. Only 1(0.89%) of the total respondents attended high school education (grade9-10) but none of them exceeded high school level. The level of education among AF adopters was generally high.

Table 4.5: Description of Sample by Level of Education

Education level of the respondent		AF Adopter		Non AF Adopter		Total	
		Number	Percentage	Number	Percentage	Number	Percentage
Education level	Illiterate	6	10.71	31	55.36	37	33.04
	Grade 1-4	40	71.43	24	42.85	64	57.14
	Grade 5-8	9	16.07	1	1.79	10	8.93
	Grade 9-10	1	1.79	0	0	1	0.89
Total		**56**	**100**	**56**	**100**	**112**	**100**

Source: Households Survey

The study revealed that about 89.29% of agroforestry adopter respondents had formal education to the elementary level and above while 6 (10.71%) were illiterate whereas from non AF adopters 31 out of 56 (55.36%) were illiterates and only 44.64% were attended primary education and above (Table 4.5). Hence, in the level of education of respondents, AF adopters are in better position than non AF adopter. Tripp (1993) indicated that education is an important socio-economic variable that may make a farmer more receptive to advice from an extension agency or more able to deal with technical recommendations that require a certain level of literacy. As it is indicated above 31 out of 56 (55.36%) of non AF adopters were illiterates. A low education level can be a barrier for agroforestry and agricultural development, since education normally has a significant influence on a household's income strategies, land management and labour use (Nkonya et al. 2004). There is lack of knowledge of effective means for soli improvement, like basic information about the farmyard manure application and compost preparation.

4.1.5. Family Size of Respondents

Family size for all sample respondents ranges from 1-11. About 58.93% of the respondent households had between 5 to8 members, while 21.43 % had less than 5 members and about 19.64% of households had above 9 members (Table 4.6). About 64.29% of households of AF adopters had between 5 to8 members, 32.14 % had less than 5 members and about 3.57% of households had above 9 members whereas from non AF adopters 53.57% of households had between 5 to 8 members, 10.72 % had less than 5

members and about 35.71% of households had above 9 members (Table 4.6). Hence, the family sizes in the study area varied significantly.

Table 4.6: Patterns of Household Family Size in the Study Area

Family size of respondent households		AF Adopter		Non AF Adopter		Total	
		Number	Percentage	Number	Percentage	Number	Percentage
Family size of respondent	1-5	18	32.14	6	10.72	24	21.43
	5-8	36	64.29	30	53.57	66	58.93
	>9	2	3.57	20	35.71	22	19.64
Total		56	100	56	100	112	100

Source: Households Survey

In the pattern of family size of respondents, AF adopters have less number of family sizes than non AF adopter. This is because AF adopters are mostly educated and also users of family planning program supported by BoIRDP. The increasing population number forced the farmers to manage their agroforestry practices at plot level, at the same time they are also forced to clear natural forest for the purpose of agricultural expansion. On the other hand, the respondents mentioned as having benefited from this increasing family size for labor availability.

4.1.6. Farming Experience of Respondents

About (100%) of respondents' main occupation is farming. The majority of the respondents (99.11%) interviewed had above15 years of experience in farming while only 1(0.89%) had below14 years of experience in farming. Many agroforestry technologies require intensive labour use which contrasts greatly with the limited amount of labour expended in the traditional farming system. Also, it can be said that as the farmer ages increases, his/her physical ability decreases to provide labour.

Table 4.7: Years of Experience in Farming

Years of Experience in farming		AF Adopter		Non AF Adopter		Total	
		Number	Percentage	Number	Percentage	Number	Percentage
Years of Experience in farming	6-14	1	1.79	0	0	1	0.89
	15-24	7	12.5	6	10.72	13	11.61
	25-34	16	28.57	9	16.07	25	22.32
	>35	32	57.14	41	73.21	73	65.18
Total		56	100	56	100	112	100

Source: Households Survey

The calculated percentage of the of agroforestry adopters for more than 15 year experience in farming is 98.21% whereas the calculated percentage for non agroforestry adopters which have experience for 15 and above year is 100%. Hence there is no significance difference in distribution of years of experience in farming in the study area.

4.2. Perception about Agroforestry

The respondents were aware of the economic and environmental benefits of agroforestry practices and had positive attitude towards those practices. It may be due to the fact that significant portions of AF adopters are literate in the study area (Table 4.2). Most of the respondents agreed that agroforestry practices increased soil fertility, increased farm income and reduced the chances of complete crop failure (Table 4.8).

Table 4.8 Perception of Respondents about Agroforestry

Statement	**Response**					
	1	2	3	4	5	Total
Agroforestry practices						
Increased farm income	19(95%)	1(5%)	0	0	0	20(100%)
Increased soil fertility	20(100%)	0	0	0	0	20(100%)
Conserved soil and water	20(100%)	0	0	0	0	20(100%)
Reduced chances of complete crop failure	18(90%)	1(5%)	1(5%)	0	0	20(100%)
Saved time on collecting fodder and fuel wood from the forest	16(80%)	4 (20%)	0	0	0	20(100%)
Took a longtime to get income	3(15%)	6(30%)	0	11(55%)	0	20(100%)
Maintained /improved surrounding environmental condition	19(95%)	1(5%)	0	0	0	20(100%)

Note: Figure in parentheses is percentage

1= strongly agree, 2= agree, 3=neutral, 4=disagree, 5=strongly disagree

Source: Focus Group Discussion

The respondent households realized sequential or simultaneous production of fodder and grass, crop and vegetable and livestock contributed to increases in the overall household income. Tree plantations or Retaining of trees on farmland made households to cope with uncertainty and risks. That means at the time of insect or disease outbreak is occur in one species they can meet their need from other species. Thus this practice has reduced the chances of complete crop failure. The respondents strongly agreed that agroforestry practices maintained /improved surrounding condition of the forest and saved time on collecting fodder and firewood from the forest that means they meet their need of firewood and fodder from their farmland/ agroforestry areas. The saved time opened up venues for other farming activities such as vegetable gardening. However, 11 (55%) respondents disagreed on the statement that it takes long time to get income from agroforstry practices (Table 4.8). This is due to the fact that households have cultivated vegetables and fast growing trees that were able to give benefit especially vegetable and fodder in short period of time.

4.2.1 Farmers Reason for Planting and managing trees

Agroforestry adopter households are knowledgeable on the use of different trees they have grown on the farmland and have developed their own set of criteria for choosing what tree species to plant. During key informant interview, it was mentioned that tree species to be incorporated in to farmland must have a role in increasing farm income and soil fertility. Tree species with evergreen leave characteristics were kept around the residence, farm boundary and grazing land to provide shade and livestock fodder.

Table 4.9: Important Reason for Planting and managing trees

Most important reasons for planting trees	AF Adopters	
	Frequency	Percent
Provide construction materials	52	92.86%
Increase farm income	55	98.21%
Ability to increase soil fertility	47	83.93%
Used for shade purpose	41	73.21%
Potable leaves by animals	38	5.36%
Used for bee fodder	36	64.29%

Source: Household Survey

The survey results indicated that increase farm income and provision of construction materials are the best criteria followed by tree species that are conducive for ability to increase soil fertility. Ability to increase shade service for coffee, human and livestock is also the other attributes of trees on which the respondents (n=41) responded positively (Table 4.9). Accordingly, Gravillia robusta, Cordia africana, Acacia and Sesbania tree species were grown deliberately together with other crop components, while trees like Eucalyptus cammaldulensis and Cuppressus lustanica were grown around homes and as wood lots for construction and income generations purpose. There are also other attributes that are considered for incorporating tree species into agro forestry systems (Table 4.10).

As indicated in Table 4.9, 98.21%, 92.86% and 83.93% of AF adopter respondents reported that their main purpose for planting trees is to increase farm income, to use for construction materials and to increase soil fertility respectively. This supports the findings of Biruk (2006), who concluded that farmers in south east langano, Ethiopia maintained trees/shrubs on their farms for different socio-economic purpose including medicinal products, provision of shade shelter, fodder, fuel wood and the like.

4.3. Agroforestry Practice in the Study Area

Agroforestry has a great potential for alleviating the land degradation problems associated with poor traditional farming practices in the study area. It also plays a great role in improving agriculture and forest production on a sustainable basis by providing food, fuel wood, and fodder and farm income for agroforestry adopters. Nair (1993) stated that agroforestry is practiced for a variety of objectives and represents an interface between agriculture and forestry and encompasses mixed land use practices. The following agroforestry technologies were practiced in the study area.

4.3.1. Alley Cropping

Alley cropping is an agroforestry practice where crops are grown between lines of planted trees and/or shrubs, preferably leguminous species, which are pruned periodically during the crop's growth to provide green manure (which, when returned to the soil, enhances soil nutrient status and physical properties) and to prevent shading of the

growing crop(s). This technology helps increase production and land productivity by maintaining and improving soil moisture and fertility.

4.3.2. Home Gardens

Homegardens are characterized by being near residence, composed of a high diversity of plants, small, and an important source of household subsistence and cash needs. A home garden is one of the agroforestry system practiced in the study area. Crops such as Coffee, pepper, and numerous kinds of vegetables are dominant components of the study area homegerdens. Fruit trees like Avocado, Mango, Apple and Papaya are also practiced in homegardern agroforestry. Trees such as Cordia africana, Grevillea robusta, Milletia fruginea, Albizzia gummifera and Acacia species are among the species that form the upper story of home garden together with Ensete ventricosum. The main objectives of this practice are to produce fuel wood and provide farm equipments, food, construction materials for housing and making of household furniture.

Furthermore, it can serve as windbreaks and shelterbelts for humans, as well as provide feed and shelter for animals. Additional food supply and cash income are obtained by planting fruit trees around homesteads of agroforestry adopters.

4.3.3. Trees planting as Living Fences

Live fences can be combined with other trees for production of wood and fruits. Both internal and external farm boundary are used for tree planting to provide farm equipments, food, construction materials for housing, fuel wood and fodder. The main objective of this AF practice in the study area is to provide an alternative source of cash to AF adopters and to supply fuel wood. It also acts as windbreaks and shelterbelts.

4.3.4. Trees on Soil Conservation Structures

Planting trees/shrubs on earth structures such as soil bunds, terraces, raisers, etc combines soil conservation with production of various products such as fodder, fruit or fuel wood. This makes productive use of the land because trees would use the area along the structures where other crops cannot be grown.

4.3.5. Woodlots

A woodlot is a small patch of land planted with trees to provide fuel wood, pole or timber products to the communities as well as for purposes of environmental protection. Woodlots are one of the agroforestry options with the capacity to arrest deforestation and shortage of wood fuel energy. The establishment of woodlots reduces the pressure on indigenous forest by alternative providing both wood and non wood products to the rural communities; and so maintains the biodiversity in the natural forests. Trees such as Eucalyptus species, Cupressus lustanica and Grevillea robusta are among the species that panted as woodlot in the study areas.

4.3.6. Windbreaks

Windbreaks are lines of trees or shrubs planted to protect fields, homes, institutions, etc from wind damage. It plays an important role in preserving soil and its fertility as well as improving the microclimate for crops. Well-designed windbreaks, i.e. ones that are not too dense, not only reduce wind speed but may also increase humidity and reduce water loss from the soil.

4.3.7 Scattered Trees on Cropland

This practice involves the growing of individual trees and shrubs in wide spaces in the farmland, while field crops are grown in the understory. The practice of growing trees dispersed on cropland may be based on protection and careful management of naturally regenerated trees, and it also involves planting new trees. Dispersed trees grown in farmlands characterize a large part of the study areas. Some good examples of this practice include scattered Cordia africana, Acacia species, and Croton macrostachys in the farmland.

4.4 Impact of Agroforestry on Livelihood of Households

4.4.1 Household Energy

Increased tree growing and better management of existing resource could provide for products such s fuel wood, poles and fruits and timbers which have not only became scarce but increasingly expensive. About (100%) of respondents emphasized that they are dependent on fuel wood for their house hold energy. The study indicated that the dominant energy type in rural households is fuel wood and therefore there is a need to

integrate trees in the land use system. Majority of the AF adopters (91%) reported that they collected fire wood from their farmland/agroforestry areas and only 2(3.57%) collected fire wood from the forest whereas 77% of non AF adopter respondents depend on the forest for meeting their firewood need for cooking (Table4.10).

Table 4.10 Source of household Energy for Cooking

Source of HH energy	**AF Adopter**		**Non AF Adopter**		**Total**	
	Number	Percentage (%)	Number	Percentage (%)	Number	Percentage (%)
Own farm	51	91.07	13	23.21	64	57.14
Forest	2	3.57	43	76.79	45	40.18
Own farm & Forest	3	5.36	0	0	3	2.68
Total	**56**	**100**	**56**	**100**	**112**	**100**

Source: house hold survey

This study revealed that AF adopters are self sufficient in firewood demand from their farmlands. In addition, AF adopters who integrated trees with food crops sold the tree on regular basis. This increased the income levels of farmers and had positive impact on their living standards. Because, they generate income from the sale of wood and have less and less time and energy to spend on other activities such as caring for children or engaging in income-generating activities.

This supports the findings of Gregerson et al (1989), who concluded that the key to solving the fuel wood problem is encouraging farm families to grow sufficient trees to meet their own requirements and to generate surpluses for sale.

4.4.2 Household Incomes

The farming method used by agroforestry adopters in the study area differed from non adopters. The agroforestry adopters cultivated more cash crops and produced more honey and received a better income than non adopters. AF adopters in the study area were dependent on the income from improved agroforestry systems together with that from livestock, irrigation and apiculture methods, while the income of non agroforestry adopters came only from farming, mainly based on traditional farming methods. Cereal crops like Maize, Sorghum, Ground nut, Wheat and Teff were cultivated by non adopters

in the study area in traditional ways, while all the cash crops like Coffee, Fruits, Honey and Vegetables were cultivated by agroforestry adopters with improved agroforestry systems. To cover daily expanse of the family, about 7.1% of non agro forestry adopters were engaged in off-farm activities such as hiring/working with other farmers and trading of chat and others cereal crops (Table 4.11).

Table 4.11 Food Security situation of Respondent Households

Food security situation of the HH		AF Adopter		Non AF Adopter	
		Frequency	Percentage	Frequency	Percentage
Food security situation	Not good	0	0	4	7.1
	Neutral	0	0	6	10.7
	Good	17	30.4	46	82.2
	Very good	39	69.6	0	0
Total		56	100	56	100

Source: Household Survey

According to data in table 4.11, improved agroforestry secured enough food in good condition throughout the year for all agroforestry adopter households, while traditional practices did it only for 82.2% of the non adopter households, even if they were mainly cultivating food crops. Therefore, one can conclude that Agroforestry practice has had a positive impact on the livelihood of the agroforestry adopters. The study revealed that adopters of agroforestry in the study area have been obtaining increased income levels, improved upon the household food security, a greater proportion are to a larger extent able to afford fees and learning materials for their children, clothes and medical treatment for individuals in the household after adoption of agroforestry. Some adopters have succeeded in building their own house from the sales of the trees crops/ products and food crops in town (beleti and yanfa town). Others have succeeded in changing their grass (thatch) house to Iron sheet at their dwelling place.

In addition, in focus group discussions (FGDs) agroforestry adopters mentioned that they have been obtaining diverse types of benefits from their agroforestry practices. Diversification of income, household consumption and soil conservation are some of the major benefits that they have been obtaining from agroforestry practice. Among these benefits, 100% of the AF adopter respondents indicated that, cash income and soil conservation are the most important benefit that was accrued from agroforestry practices.

Table 4.12: Annual gross income of AF adopters Vs non adopters from cash crops

Increase Income (%)		AF adopters		Non AF adopters	
		Frequency	Percentage	Frequency	Percentage
Income Increase	no change	0	-	14	25
	5%	4	7.14	15	26.79
	10%	26	46.43	27	48.21
	15%	16	28.57	0	0
	20%	10	17.86	0	0
Total		**56**	**100**	**56**	**100**

Source: household survey

The formal survey indicated that the majority of the agroforestry adopter households obtained fifteen times as high as annual gross income of non adopter households from cash crops. This was possible without great change in cultivation systems and achieved by adding some high value cash crops and cultivating the farms more intensively in combination with multipurpose tree species. Nair (1993) indicated that the combination of several types of products which are both subsistence and income generating, helps farmers to meet their basic needs and minimizes the risk of the production system's total failure.

All adopters were able to afford school fees and learning materials for their children, clothes and medical treatment for the household from improved food, tree crops, fruits and honey production after adoption of agroforestry. Most adopters obtained income from the sales of surplus food crops, tree crops, fruits and honey. It can be concluded that agroforestry adoption had a significant impact on the livelihood of adopters and their households (Table 4.12).

According to the data in Table 4.12, 25% of the non adopters agreed that there was no change in the quality and quantity of crop production. The reason behind no change in production and income are lack of agricultural inputs, scarcity of quality planting materials of different species that are appropriate for the study site and lack of close follow up by development agents (DAs).

The annual gross income from cash crops of four(4), twenty six(26), sixteen(16) and ten(10) agroforestry adopters households increased by 5%, 10%,15% and 20% respectively whereas the annual gross income from cash crops of fifteen (15) and twenty seven(27) non agroforestry adopter households increased by 5% and 10% (Table 4:12).

The reason behind improvement in production and income were the provision of agricultural inputs on time and availability of quality planting materials of different species that are appropriate for the study site and agroforestry system, past experience of farmers with tree planting and management, accessible market, better farmers' tree propagation and tree nursery management skills. Training and nursery developments were proven methods of building farmers' awareness, leadership and technical skills, production and management capacity. One can conclude from above that there is significant economic growth and significant improvement in the lives of the adopters' since the launch of Menschen für Menschen foundation, Borecha integrated rural development project.

In addition to this, animal production (honey products) played a significant role in the annual household income of agroforestry adopters and contributed by increasing the annual income of the majority of the households by more than 10%, whereas forty-eight (48%) of non adopters had traditional beehives but most of the time the product used for consumption not for sale (Table: 4.13).

Table: 4.13: Annual gross Income of AF adopters Vs non adopters from apiculture

Increase Income (%)		**AF Adopters**		**Non AF adopters**	
		Frequency	**Percentage**	**Frequency**	**Percentage**
Income Increase	No change	0	-	29	51.79
	5%	3	5.36	27	48.21
	10%	23	41.07	0	0
	15%	21	37.5	0	0
	20%	9	16.07	0	0
Total		**56**	**100**	**56**	**100**

Source: Households survey

The research convinced that with modern beehives and honey processing technology, the agroforestry adopters are able to raise incomes from their honey production significantly. As illustrated in Table 4.13, 5%, 41%, 37% and 16% of the agroforestry adopters stated that they experienced increased their annual income from modern apiculture practice (honey sale) by 5%, 10%, 15% and 20% respectively after adoption whereas the annual gross income of 51.79% of non AF adopters from apiculture remained unchanged and 48% of them were increased their annual income from traditional way of honey production only by 5%.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

Ethiopia is a large country in the horn of Africa with a total area of about 1.1 million square KM and population of more than 85 million. Eight out of ten Ethiopians live in rural areas mainly on agriculture. Agriculture provides approximately 70 percent of raw materials for the industrial sector, generate more than 90 percent of export earnings and account for 85 percent of employment. Even though, the sector is imperative for the livelihoods of the people and its potential, it is characterized by low productivity and outputs. The main problems are mainly attributed to limited access by smallholder farmers to improved production technologies, irrigation, agricultural market and poor land management practices.

The study has shown that there are huge potentials for agroforestry development in the study area, such as the existence of indigenous woody perennials (the basic component of agroforestry practices), commodity crops (coffee and fruit), other types of crops, livestock components integrated together and modern knowledge of the AF adopters which enable them managing the modern agroforestry practices. The study found significant knowledge acquisition taking place, not only for agroforestry methods, but for general soil management and farming practices.

Agroforestry technologies were introduced in the study area in 2007 by Menschen fur Menschen Foundation Borecha Integrated Rural Development Project (BoIRDP). The introduced technologies are home garden agroforestry, alley cropping, modern beehives, queen excluder, honey processing, fuel saving stove, high land and lowland fruit trees on cropland. The BoIRDP uses the farmlands of Agroforestry adopters as adaptive trials and demonstration farms in the study area, all in a bid to promote agroforestry adoption. The project has also provided training for farmers on modern agricultural practices, modern honey production technology and fuel saving technology. Also nurseries including different type of tree species such as Gravillea, Vetiver grass, Sesbania, Acassia, Mango, Banana, Avocado and Papaya were established in several areas of the study area.

The age group (26-45) forms the bulk of agroforestry adopters in the study area indicating its potential as the most important target group who could be involved in

dissemination of agroforestry. The approach is flexible and dynamic, adjusting to the conditions of target communities. Experience shows that farmers in the study areas are best positioned to enhance their agroforestry-based incomes by improving the quality and quantity of their products through intensification or expansion of their agroforestry system.

The study revealed high level of literacy rate among agroforestry adopters, which is likely to increase technical efficiency. All agroforestry adopters had their own farmland. This creates an opportunity to transfer and large-scale adoption of agroforestry technologies in the study area as there is no problem of land ownership and acquisition. Due to the transfer of technology AF adopters were able to produce reliable quantities of high quality products such as fruits, vegetables and processed honey in the last five years whereas non AF adopters harvested small quantities of food crops on their farmland for household consumption in traditional ways.

It was observed that, a greater proportion of the farmers had significant improvement in their annual income after adoption of agroforestry. This had a positive impact on the livelihood of the farmer and their household. Also a greater proportion of the farmers to a large extent are able to afford school fees and learning materials for their children, clothes and medical treatment for individuals in the household. It can therefore be concluded that agroforestry adoption has had a significant impact on the livelihood of most farmers households.

The active involvement of agroforestry adopters shows that they are aware of the value of on-farm tree diversity for the sustenance of their livelihood. But their major concern is how they can access the trees they prefer to grow on the farmland when the project support is terminated. This situation calls for exploration of other alternative means. One of the nearest sources for accessing seedlings is the government run nursery. But these nurseries mainly produce forest-based trees especially the timber species that are not the preference of the farmers. The group discussion revealed that government officials do not consult with them before the production of the seedlings. On the one hand these households perceive that officials' duty is just to manage government owned forestland; on the other hand, government officials focus their job to accomplish just their target oriented forestry development plan. This indicates that Woreda Agricultural and Rural

Development office has not given any attention towards on-farm agroforestry development.

Finally, this study could not precisely or separately analyze all the factors underlying the observed differences in crop yields and income between the two farmer groups (i.e. adopters and non adopters). The differences may also partly be explained by the qualitative criteria used when forming the two groups (adopters and non adopters).These may provide a categorization into well resourced and less resourced farmers. As it is known, the farmers in the study area are not normally keeping any records concerning the yields or income, thus all the qualitative information can be considered only as an estimate.

5.2. Recommendations

It is recommended to encourage the farmers to plant cash crops in the study area for several reasons. Cash crops can generate better income on smaller land areas as compared with food crops.

In the study area, a kind of cooperative among agroforestry practitioners was already initiated, and the AF adopters sell their honey product with a fixed price. Agroforestry adopters said they could easily intensify their honey production if they had better markets. Lack of their own market place in the town for selling of processed honey was the main challenge of agroforestry adopter's cooperation which had a negative impact on their success since the availability of market place is the main factor contributing to the success of the households. The effectiveness of a cooperative depends, however, on governance and management. The local government needs to provide market place for the cooperation so that they can sale their product with fare price in serving the community.

The research reveals there was no delivery of appropriate extension services (no technical advices, no provision of seedlings) from office of agricultural and rural development. The issue of appropriate extension work for increasing the scale of agroforestry is of particular importance because agroforestry is a relatively 'knowledge intensive' practice, reducing the likelihood that knowledge will spread easily on its own. Therefore, the woreda office of agricultural and rural development and other concerned bodies should provide suitable extension services.

Farmers will need to be supported with appropriate country-wide policies that reduce some of the above constraints; removing barriers to land access and tree tenure, establishing seed sources and nurseries to meet demand and skilled extension workers with the capacity to provide information for farmers on the benefits and techniques of agroforestry. Improvements in these areas would do much to promote agroforestry in the woreda.

This study was conducted at specific site with limited experience. Therefore, similar study should be conducted in other part of the country to get reliable information on the role of agroforestry in improving the livelihood of rural people.

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ANNEX

The questionnaires contain three parts. The first part is questionnaire to be filled by the agroforestry adopters and non adopters. The second part is interview guide line to key informants, focus groups, administration and concerned offices. Only the households are required to fill the questionnaires and to respond to interview guidelines. Part one and part two are attached in the following annex.

Annex 1. Questionnaire for farmers

I. HOUSEHOLD BACKGROUND

1. Age (years) 1.1 18-25 1.2. 26-35 1.3 36-45 1.4 46-55 1.5 >56 (Years)
2. Sex: 2.1. Male 2.2.Female
3. Name of kebele_____Village _____
4. Marital status. 4.1 single 4.2 Married 4.3 Divorced 4.4 Widow
5. Household family size. 5.1 Small size (1 – 3) 5.2 Medium size (4 – 8) 5.3 Larger size (≥9)
6. Education level. 6.1 Illiterate 6.2 Elementary (Grade1-4) 6.3 Primary Secondary (Grade5-8) 6.4 Higher Secondary (Grade9-10) 6.5 Vocational/ Technical and above
7. Origin 7.1 Native 7.2 Settlers 7.3 Others
8. Years of living in the area. 8.1 1-5years 8.2 6-10years 8.3 11-15years 8.4 16-20years 8.5 above 21years
9. Years of experience in farming. 9.1 1-5years 9.2 6-14years 9.3 15-24years 9.4 25-34years 9.5 above 35 years

II. LAND TENURE

1. Do you have land for cultivation? 1.1 Yes 1.2 No
2. If yes, how did you obtain? (Multiple response is possible) 2.1 Freehold 2.2 Share Cropping 2.3 through purchases 2.4 Lease/contract 2.5 others (Specify) _____

3. What is the size of your farmland (cultivated, woodland, coffee & grazing/ pastureland) in hectares? 3.1 1-3hactares 3.2 3-5hactares 3.3 5-10hactares 3.4 ≥10hactares

4. What would you most likely use your land to grow?(Rank in order of priority 1, 2, 3)

4.1 Food crop 4.2 Cash crop 4.3 Tree crop 4.4 All 4.5 Others Explain _____

5. Do you think you will face land acquisition problems in the future? 4.1 Yes 4.2 No

6. If yes, why?(Multiple response is possible) 6.1 Population growth 6.2 Immigration of people 6.3 Land redistribution

III. LAND USE SYSTEMS AND PRACTICES

3.1 CROP PRODUCTION SYSTEM

1. What type of crop(s) do you cultivate? Mention each crop type.

1.1Food crop _____,_____,_____,_____,_____&_____

1.2 Cash crop _____,_____&_____

1.3 Tree crop _____,_____,_____,_____,_____&_____

1.4 Others (specify) _____

2. Total land size under cultivation (hectares) 2.1 1-2hactares 2.2 2-3hactares 2.3 3-5hactares 2.4 5-10 hectares 2.5 >10hactares

3. What are the main problems in your farm land? (Multiple response is possible) 3.1 Soil erosion 3.2 Soil fertility 3.3 Weeds 3.4 Disease and pest 3.5 other specify _____

4. What type of Farming system do you practice? (Rank in order of importance)

4.1. Home gardens 4.2 Fruit trees on cropland 4.3 Wood lot 4.4.Windbreaks

4.5. Alley Cropping 4.6. Strip Cropping 4.7.Live fences 4.8. Others specify _____

5. What limits your farm size? 5.1 Land 5.2 Capital 5.3 Labor 5.4 All 5.5 Others (specify) _____

6. What has been the trend of crop production over the last 5 years?

6.1 Increasing 6.2.Decreasing 6.3. No change

7. What has been the trend of vegetative materials (Enset and banana) production over the last 5 years? 7.1 Increasing 7.2.Decreasing 7.3. No change

8. What has been the trend of the fertility status of the farmland over the last 5 years?

8.1. Improving 8.2.Declining 8.3. No change

9. For Question number 8, if your answer is improving, explain the factors contributing to improving _____

_____

10. For Question number 8, if your answer is declining explain the cause's

_____

_____

11. If there is decline in soil fertility, how are you trying to resolve the problems?

_____

_____

_____

12. What is the mode of weed control in your farmland?(Multiple response is possible)

12.1. Use of herbicides 12.2.Manually 12.3. Mechanically12.3. others (specify) _____

3.2. TREE PRODUCTION SYSTEM

1. Do you produce seedling? 1.1 Yes 1.2 No

2. If yes, what type of seedling do you produce? (Multiple response is possible) 2.1 Coffee 2.2 Fruits 2.3 Multipurpose Trees 2.4 All 2.5 others specify _____

3. From where do you get the seedling/ seeds? (Multiple response is possible) 3.1 Own farm/ private nursery 3.2 Government 3.3 Non-government

4. What has been the trend of tree production over the last 5 years? 4.1 Increasing 4.2 Decreasing 4.3. No change

5. What has been the trend of fruit production over the last 5 years? 5.1 Increasing

5.2 Decreasing 5.3. No change

6. What has been the trend of coffee production over the last 5 years? 6.1 Increasing 6.2.Decreasing 6.3. No change

7. Do you think tree production in farmland minimizing deforestation? 7.1 Yes 7.2 No

8. If yes, explain how it minimizes? _____

_____

3.3. ANIMAL PRODUCTION SYSTEM

1. Do you rare animals? 1.1 Yes 1.2 No

2 .If yes, indicate the type and number of livestock do you have? (Multiple response is possible)

2.1 Sheep_____2.2 Goat_____2.3 Chickens ____2.4 Oxen_____2.5 Cows/heifers_____

2.6 Calves ____ 2.7 Donkey____ 2.8 Horse____2.9 Beehives____2.10 Mules____

2.11 others (specify) _____

3. Do you have livestock feed? 3.1 Yes 3.2 No

4. If yes, indicate the type of feed used for the animals? (Multiple response is possible) 4.1 Forage 4.2 Tree/shrub/ fodder. 4.3 Grassland/ grazing land 4.4 Feed from grains/ crop residue 4.5 Others (specify) _____

5. What has been the trend of using improved forage feed over the last 5 years?

5.1 Increasing 5.2 Decreasing 5.3. No change

6. What has been the trend of raring of animals over the last 5 years? 6.1 Increasing

6.2 Decreasing 6.3. No change

7. For Question number 6, if your answer is increasing, explain the factors contributing to increasing _____

_____

8. For Question number 6, if your answer is decreasing explain the cause's

_____

_____

9. What has been the trend of honey production over the last 5 years? 9.1 Increasing

9.2. Decreasing 9.3. No change

10. What is the contribution of raring animals for the household?

_____

_____

_____

IV. ENERGY AND INCOME OF THE HOUSEHOLD

1. What is the type of household energy (for cooking & lighting)?(Multiple response is possible) 1.1. Fuel wood 1.2 Charcoal 1.3. Kerosene/ Gas 1.4 Solar light 1.5 others (specify) _____

2. What is the source of household energy for cooking foods? 2.1 Own farm 2.2 Forest 2.3. Purchase 2.4 others (specify)_____

3. Do you use fuel saving stove? 3.1 Yes 3.2 No

4. If yes, does it improve the fuel wood consumption of the household? 4.1 Yes 4.2No

5. If your answer is yes for question No 4, Explain how it improve

_____

6. Does beekeeping increase your annual income? 6.1 Yes 6.2 No

If yes, by what percent. a) 5% b) 10% c) 15% d) 20% e) Others

7. How significant is the cash crops income to your family? 7.1 Nil 7.2 Slight 7.3 Moderate 7.4 Very important

8. Does the cash crops increase income to your family? 8.1 Yes 8.2 No

If yes, by what percent. a) 5% b) 10% c) 15% d) 20% e) Others

9. How significance is vegetable production income to your family? 9.1 Nil 9.2 Slight 9.3 Moderate 9.4 Very important

10. How significant is the Fruit trees income to your family? 10.1 Nil 10.2 Slight 10.3 Moderate 10.4 Very important

11. How is the general food security situation in the household after adoption of agroforestry?

11.1 Not good 11.2 Neutral 11.3 Good 11.4 Very good

12. What is/are the sources of labour on your farmland?(Multiple response is possible)

12.1 Family/household 12.2 Hired/wage-perday 12.3 Contract 12.4 Dado/Debo 12.5 others (specify) _____

V.ATTITUDE OF FARMERS TOWARDS AGROFORESTRY PRACTICE

1. Agroforestry practices increased farm income. 1.1 Strongly agree 1.2 Agree 1.3 Neutral 1.4 Disagree 1.5 strongly disagree

2. Agroforestry practices increased soil fertility. 2.1 Strongly agree 2.2 Agree 2.3 Neutral 2.4 Disagree 2.5 strongly disagree

3. Agroforestry practices Conserved soil and water. 3.1 Strongly agree 3.2 Agree 3.3 Neutral 3.4 Disagree 3.5 strongly disagree

4. Agroforestry practices reduced chances of complete crop failure. 4.1 Strongly agree 4.2 Agree 4.3 Neutral 4.4 Disagree 4.5 strongly disagree

5. Agroforestry practice Saved time on collecting fodder and fuel wood from the forest. 5.1 Strongly agree 5.2 Agree 5.3 Neutral 5.4 Disagree 5.5 strongly disagree

6. Agroforestry practices took a long time to get income. 6.1 Strongly agree 6.2 Agree 6.3 Neutral 1.4 Disagree 1.5 Strongly disagree

7. Agroforestry practices Maintained/improved surrounding environmental condition. 7.1 Strongly agree 7.2 Agree 7.3 Neutral 7.4 Disagree 7.5 strongly disagree

VI. MARKETING AND INSTITUTIONAL SUPPORT

1. Where do you sell your food crops and tree produces? (Multiple responses is possible)

1.1 Local Market 1.2 Urban Market 1.3 On farm 1.4 Other (specify) _____

2. To whom do you sell your produce? 2.1 Traders 2.2 Consumers 2.3 Both

3. If you are not satisfied with the marketing system, of the food crop and tree crops, what do you think can be done to improve it?

_____

_____

3. Have you been getting any assistance from a nongovernmental organization in terms of monetary support and/ or other inputs? 3.1 Yes 3.2 No

If Yes what kind?

_____

_____

4. Name the NGO(s)

_____

_____

5. Do you get extension support from government agencies or nongovernmental organizations in using the Agroforestry technology? 5.1Yes 5.2No

IfYes,explain_____

_____

Annex 2. Interview guide line to the key informants

Description of the study area

1. Location

- Woreda_____Zone_____Region_____
- Distance from Addis Ababa_____km
- Distance from zone capital (Mettu) _____km
- Number of PA`s in the woreda_____
- The name of the neighboring woredas and the direction they bordered

  _____

  _____
- Latitude_____north and

  longitude_____east

2. Biophysical data

2.1. Climate

- Annual rainfall (average in mm) _____mm
- Duration /belg / from_____to_____months,

  Meher from_____to_____months, and

  Dry Period from_____to_____months
- Average temperature, maximum_____minimum_____

2.2. Agro ecology

- Dega_____%, Weyina dega_____%, Kola _____%

2.3. Altitude_____m.a.s.l.

2.4. Topography_____

2.5. Soil types_____

2.6 Vegetation

- Dominant tree species in the woreda

  _____

  _____

  _____

- ❖ Current forest coverage in the woreda_____hectares
- ❖ How the current forest coverage as compared to the previous? Increasing or decreasing?
- ❖ If decreasing explain the causes _____
- ❖ If increasing, explain the factors contributing to increasing _____

3. Socio- economic environment

3.1. Population

- ❖ Total population _____Male _____Female _____
- ❖ Total head household _____ Male_____ Female _____
- ❖ Average family size_____

3.2. Land

- ❖ Total land coverage of the woreda _____hectare
- ❖ Average land size per HH _____hectare
- ❖ Population density per km2_____

3.2 Write the Land use of the woreda according to the table provided.

LAND USE TYPES	**AREA COVERAGE IN HECTARE**	**PROPORTION/%**	**REMARKS**
Forest Land			
Cultivated Land			
Grazing Land			
Settlement			
Margin land			

3.4. Livelihood (income source) of the population in the woreda

SOURCE OF INCOME	SHARE IN %	REMARKS

3.5 What are the major types of food crop grown in the woreda_____?

3.6 What are the major types of cash crop in the woreda

_____

_____?

3.7 What are the major types of livestock in the woreda

_____

_____?

4. Institutional and infrastructural aspects

4.1 Are there any credit facilities for the rural community? 1=Yes, 2= No.

4.2 If yes, mention the name of credit facilities_____

_____

4.3 Are there any extension services in agroforestry practices? 1= Yes, 2= No.

4.4 If yes, mention the types of extension services_____

if not, why?_____

4.5 Are there any nursery sites in the woreda? 1= Yes, 2= No.

4.6 If yes, how many? _____

4.7. Mention the names of exotic tree species produced in the nursery

_____

_____

_____

4.8. Mention the names of indigenous tree species produced in the nursery_____

_____

4.9 Mention the names of cash crops produced in the

nursery_____

_____