DETERMINANTS' OF FARM HOUSEHOLD ADOPTION OF AGRO - ECOLOGICAL FARMING PRACTICES IN BANJA WOREDA;

AWI ZONE, ETHIOPIA

GETNET AMARAE SAHILU

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Determinants' of Farm Household Adoption of Agro-ecological Farming Practices in Banja Woreda; Awi Zone, Ethiopia

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Declaration

I, the undersigned, declare that this MA thesis is my own work. I in compliance with internationally accepted practices and trends; I have fully acknowledged and referenced all materials used in this my work. I understand the non-adherence to the principle of academic honesty and integrity, misrepresentation of any idea and fact source will ground sufficient for disciplinary action by the university

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This thesis have been submitted for examination with my approval as a university advisor

Advisor's Name: Dawit Diriba (PhD) Signature: _____ Date: _____

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This is to certify that the research project thesis by Getnet Amare, entitled: ‘‘Determinants’ of Farm Household Adoption of Agro-ecological Farming Practices in Banja Woreda; Awi Zone Amhara Region, Ethiopia” that submitted in partial fulfillment of the requirements for the degree of master of arts in Environment and Sustainable Development complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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ABSTRACT

Determinants' of Farm Household Adoption of Agro-ecological Farming Practices in Banja Woreda; Awi Zone, Ethiopia

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Addis Ababa University, 2019

Agriculture is the main livelihood of farmers in Banaja Woreda. But influenced internal and external factors in agro-ecological farming practices. The main objective of this study is to assess awareness and attitude level of farmers, investigate locally acceptable technologies and to examine factors affecting farmers' choices of agro-ecological farming practices at the household level in Banja Woreda. Mixed research approach, both qualitative and quantitative analysed was employed. The survey questions covered 211 total sample size; 192 household head, 12 focused group discussion and 7 key informant interviews were selected through simple random sampling method with the selection of two kebeles, sampling units of four village households and field observation conducted. The result shows that, 169 (80%) households have perceived adoption practices of crop rotation, mixed farming and agro-forestry and the remaining 42 (20%) have not perceived in Akayeta& Kessa-Chewsa Kebeles. Analysis of the model indicated that, there is 46% variation between adopters& non-adopters. Farm size, extension services and land degradation negatively significant at 5% level and income, awareness, market distance and environmental factors at 1% level. While, family size and education positively significant at 10 % level and agricultural management at 1% level. It is concluded that in Banaja Woreda, there is problem of farmers in adoption practices to respond food security. Farm size, income, awareness, technology, extension, policy incentives, degradation and natural frost were the main factors hindering farmers' choices decided to adopt agro-ecological farming practices. This implies, need to support locally acceptable technologies in terms of policy incentives, off-farm income targeted at household level. Furthermore, creating opportunities in adoption of agro-ecological farming practices encourage non- adopter farmers in limited farm and technologies.

Keywords: *Agro-ecological farming, Adoption, Determinants, Households and Multinomial logit***.**

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LIST OF ACRONYMS

AANRO	Amhara Agricultural and Natural Resources Office
ADLI	Agricultural Development Lead Industrialization
AEBFP	Agro-ecological Based Farming Practices
AEFP	Agro- ecological Farming Practices
AfDB	African Development Bank
AMSL	Above meter Sea Level
ARBCO	Amhara Regional Bureau of Communication Office
ARTO	Awi Zone Transport Office
AZAD	Awi Zone Agricultural Development
AZANRO	Awi Zone Agriculture and Natural Resources Office
AZARO	Awi Zone Agriculture and Natural Resources Office
AZDAR	Awi Zone Department of Agriculture and Natural Resource
AZDDRMP	Awi Zone Department of Disaster Risk Management and Prevention
AZEPO	Awi Zone Environmental Protection Office
AZFED	Awi Zone Finance and Economic Development
BOAANRO	Bureau of Amhara Regional State Agriculture and Natural Resources Office
BOAEPLUA	Bureau of Amhara Environmental Protection and Land Use Authority
BOFED	Bureau of Finance and Economic Development Office
CC	Climate Change
CCR	Climate Change Resilient
DAs	Development of Agricultural extension Agents
DBU	Debre Berhan University
DV	Dependent Variables
EBC	Ethiopian Broad Casting Corporation
EIAR	Ethiopian Institute of Agricultural Research
FDRE	Federal Democratic Republic of Ethiopia
FTC	Farmers Training Center
HH	Household
IFRI	International Food Policy and Research Institute
IK	Indigenous Knowledge

IPM	Integrated Pest management
IV	Independent Variables
KMs	Kilo Meters
LDCs	Least Developing Countries
MEF	Ministry of Environment and Forest
MNL	Multinomial logit Regression
MOA	Ministry of Agriculture
MTPME	Midterm Performance Monitoring and Evaluation
RRF	Runoff Rain Fall
RS	Regional State
SHF	Small Holder Farmers
SSDD	Supply and Demand
SWS	Soil and Water Conservation
TFM	Traditional Farm Management
TLU	Total Livestock Unit
WHT	Water Harvesting Technologies
WKS	Western Knowledge System

CHAPTER ONE

INTRODUCTION

1.1 Background

Globally, the agriculture sector supports a majority of population as a sources of income and livelihood of the rural communities attached to the urban and linked between poverty alleviation and natural resources conservation. The study found in Brazil indicated that the determinant of farm household adoption of agro-ecological farming practices grouped under related to socioeconomic factors, institutional factors, information sources, agro-ecological factors, perceived by farmers, behavioral factors and technological factors influenced the agricultural production (Tey and Brindal, 2012; Pierpaolia et al., 2013).

Nationally, Ethiopia is one of the fastest growing populations in the world, with an average annual growth in GDP of 10% (Paul et al., 2016). Yet, the largest share of the country's GDP (46.9%) from agriculture (Diao et al., 2010). The country's population estimated to be about 84% in rural areas and a rapid increasing population accounted 90 million and near future expected to be double by 2050 (ECSA, 2015). Consequently, competition for available land, water, energy and other inputs increases posing pressure on the rural population's livelihoods (Bryan et al., 2009; Garnett et al., 2013).

Out of 112.3 million hectares of land, 16.4 million hectares is considered to be suitable for arable use and half is currently cultivated with rain-feed crops in addition to production of livestock (Demeke, 1997; Dial, 2010; Mesele& Leta, 2014). Smallholder farmers represent the majority of the rural population in the country. Out of 95% of the crop land, 90% is producing agricultural products to the country (Hanjra et al., 2009). However, their productivity is low, partly caused by lack of productive land, access to markets and technology. However, farm households' adoption of agro-ecological farming practice is highly affected by bio-physical and institutional factors (Teshome et al., 2016; Birhan Asmare and Assefa Abagaz, 2017). There are diverse factors behind affecting adoption of agricultural farming and contributing to low agricultural productivity and limited adoption of farm households in Ethiopia. Among others, recurrent drought, erratic rainfall, pests, land tenure insecurity, population pressure, soil erosion, overgrazing, deforestation, lack of

efficient rural organizations and weak institutional support are often cited (Beshah 2003; Berha; 2017).

In the Amhara Regional State lack of land use planning policy and experiences of poor farming system caused by less farm size resulted land degradation and less emphasis given to adoption of agro-ecological farming practices are the main determinants' of the Region and in the study area of Banaja Woreda (Benin, S. 2006; BOAGO, 2014; DBU, 2017). Currently, the Region's most of the Awi Zone part of the Banja Woreda is more influenced by the determinants' of farm households' adoption of agro-ecological farming practices particularly, Akayata and Kessa-Chewesa kebeles. Farming is the main backbone and the livelihood of the rural communities of the Banja Woreda. In the study area of Banja Woreda all farmers use mixed type of farming depend on rain feed agriculture, dominated by mono cropping and exotic tree planation based on traditional farming systems..

The agro-ecology of the area lays *Weyna –Dega to Wet- Dega* and suitable to use the type of agro-ecological farming adoption technologies. In practicing adoptions of agro-ecological farming practices such as; agro-forestry, farm- forestry, inter-cropping, alley-cropping, crop rotation, crop and animal mixture etc. combined with multipurpose trees, provide economic, environmental and social benefits to HHs such as; food and energy, reduces erosion, feed for livestock, generate income and increase productivity of the farm land and moderate micro climate change at farm house level.

The rational of this study is it helps to know the main determinants' of farm household adoption of agro-ecological farming practices and how farmers to understand awareness level and acceptable technologies used that contribute to enhance sustainable agriculture in general and increase small holder farmer encourage to improve livelihood by adopting diversified farming practices in particular, because the study examines what factors determine the choices of farm households adoption of agro-ecological farming practices.

1.2 Statement of the problem

The Government of Ethiopia developed ADLI strategy, since 1994 to promote productive improvements of smallholder agriculture based on the approaches practicing better agronomic

practices, more labor use, research & extension, technology transfer, rural infrastructure for sustainable agriculture to increase agricultural output and productivity. The implementation of ADLI has not brought anticipated outcome to support in the supply side such as; water harvesting, extension services, improvement of market, expansion of cooperatives and supporting micro-finance institutions for adoptions of agro-ecological farming practices at household level (Kenichi Ohno, 2009; Lulitte Mitike, 2010).

To increase the efficiency and the effectiveness of agricultural production, the alternative use of sustainable agriculture such as; agro-forestry farming systems (crop and tree, livestock and tree and /or both tree, livestock and crops) provides application of natural fertilizers and can increase agricultural production at farm household level. However, in the study areas of Banaja Woreda farming practices is dominated by traditional improper farming method. Such improper farming, practices of mono cropping (teff and potato), planation of invasive exotic species of *eucalyptus globules* and *acacia dicurrence* trees faced the problem of adoption of agro-ecological farming practices in the area (Bureau of Amhara Natural Resources Office and Environmental Protection and Land use Authority [BOANRO; BOAEPLU], 2015; 2016).

The main determinants' of farm households adoption of agro-ecological farming practices such as; biophysical (vegetation, land cover, sloppy terrain and topography), weather forecast and climate change (excessive rainfall, frost etc...) and infrastructure are influenced. While, the internal determinants such as; (land size, socio-economic factors, use of intensification of chemical inputs, improper plantation of exotic species and demographic factors are affecting the practices (Awi zone Agriculture and Natural Resources Office [AZAO], 2017).

In the Banja Woreda; the findings indicated that farmers traditionally depend on an age old of farming practices, both environment and natural resources conservation not yet improved, insufficient land tenure including; topography of the sloppy terrain, lack of improved technologies and lack of policy incentives such as; (access of credit and saving, establishment of small micro enterprises in value chain) are the main determinants' of farm households adoption practices. For example, the assessment study indicated that, in Ankesha, Banja and Burie Woredas; limitation of SWC measures, free grazing and expansion of exotic species (*acacia decurence* and *eucalyptus globules)* are the main indicators of soil loss and less production.

Therefore, the result indicating that, the causes of farm households limited to adoptions of agro-ecological farming is mainly due to low per-capita income, less farm size, population growth that leads to repeated farming of steep slopes (Hailu and Getnet, 2017). Particularly kebels of Akayta and kessa- Chewesa, the land is exposed to soil erosion, deforestation, strong free grazing and absence of proper land use management, lack of improved technology both (rain feed, irrigation and livestock), low farm size and income are more experienced the problem too (AZDAR, 2014). The survey result indicating that, the main problems are; locally acceptable technologies used to improve food security, less awareness level of farmers' indigenous knowledge with agro-ecological farming practices to land use system and the gaps of training, incentives, farm size, market distance, low income, expansion of *exotic eucalyptus globules*& *acacia decurrence*, infrastructure, institutional setup and un employment are the main gaps determinants' of farm households adoption of agro-ecological farming practices in the study areas of Banaja Woreda particularly Akayata and Kessa-Chewesa kebeles.

1.3 Objectives of the study

1.3.1 General objective

The general objective of this study is to assess the awareness level of farmers, to investigate locally acceptable technologies that to examine factors affecting the choices of agro-ecological farming practices at the household level in Banja Woreda.

1.3.2 Specific objectives

The specific objective of this study is:

1. To assess the awareness level of farmers' indigenous knowledge with agro-ecological farming practices to land use system,
2. To investigate locally acceptable technologies and determinants' of farm household adoption of agro-ecological farming practices and
3. To examine factors affecting farmers' choice of agro-ecological farming practices.

1.4 Significance of the Study

The significance of the study can helps to provide Government institutions, policy makers, Woreda and Zone Administrations, future research work and societies in the study areas. The main findings found from the assessment of detail information, awareness level of farmers' indigenous knowledge regarding locally acceptable technologies used to these institutions and implementers significantly important to promote farm households' adoption of agro-ecological farming practice and used to develop related to livelihood strategies, policy incentives, program and projects at household level.

Furthermore, it helps as a base line data and back ground, including; to replicate farmers' attitude and perception of indigenous knowledge and experiences to the other farmers and used as a reference and interested academicians' for future research work in the areas of the agro-ecological farming for the choice of farmers' adoption practices.

1.5 Scope of the Study

The Awi zone has nine Woredas and there are different factors that determine the awareness, attitude and factors affecting farmers' choices of agro ecological farming practices at household level. There are many kebeles facing challenges and determinant factors affecting the farm households' adoption of agro-ecological farming practice in the Banja Woreda. But, in the context of different severity and intensity of the problem, the geographical coverage of spatial and temporal consideration the study is limited only areas of Akayata and Kessa- Chewesa kebeles. The study covered the issues only related to the major determinates' of farm household adoptions options and factors affecting agro-ecological farming practices special emphasis given to Banaja Woreda. From these areas of the study, information was gathered from households includes; females and male. Woreda expert and Development Agents from (Farmers Training Centers) were participated. The study has relied on the cross sectional data collected from the sampled households of the selected Woreda of Banaja from April 1st, 2019 to mid-May, 2019. Besides, the study has been used a sample of 211 households from two sampled kebeles of four villages.

1.6 Limitation of the study

To understand properly, the determinants' of farm household adoption of agro-ecological farming practices there might made a gape and limitation in this study. The researcher has concentrated only the issues related to adoption of agro-ecological farming practices and determinant factors that influencing agro-ecological farming practices at household level. But due to the time and financial constraints of the researcher there might be made some limitations in quality and gaps. Because some farmers might be reluctant to respond required data and information that addresses realities on the ground. In addition to these this study does not addressed the environmental and natural resources degradation impacts might be limited in the study areas.

1.7 Organization of the Thesis

The entire study of this thesis is organized in to five parts. The first part deals with introduction in which background of the study, statement of the problem, objectives of the study, significance of the study, scope of the study, limitation of the study and operational definition of concepts are discussed. In the second part, it explains with literature review, under this study it describes draw sharing from others intellectual and academia deals with theoretical and empirical reviews, which explains theoretical perspectives and concepts of agro-ecological farming practices, determinants of farm household agro-ecological farming practices, empirical findings and conceptual framework analysis are described. The third part, explains methodology of the research includes; description of the study, research designed, target population, sampling size determination, sampling techniques, procedures of sampling and methods of data analysis. The fourth part consists of results and discussions of the study. Finally, the last part describes conclusions and recommendations.

1.8 Operational Definition of Concepts

Different authors define agro-ecological farming practices of terms and concepts in different ways in different literature. But, mostly the working definition of these terms are agreed on the best agro-ecological farming practices of Training Manual adopted and taken from Agro-ecology Best practices third world Network (Jalan, 2015).

Agro-forestry: Tree grown together with annual crops in addition to modifying micro climate, improve soil fertility, contribute to nitrogen fixation while, plant litter from the leaf helps to replenish soil nutrient and maintain organic matter.

Farm forestry: Farming system in which different plant species are planted sparsely throughout plots of the farm land, tree leaf litter can enhance soil fertility and maintain micro climate, tree branches regenerate and maintain soil nutrient value to increase productivity.

Crop rotation: Is temporal diversity of crops in the form of cereal-legume sequences, nutrients are provided from one season to the next in which the life cycle of insects, pests, weeds and disease are interrupted.

Monoculture: Cropping system in which one crop species is planted in one season a tendency of exposing to disease, pest weed intensification and reduction of yield.

Poly culture: A cropping system in which two or more crop species are planted within certain spatial resulting it improve nutrient use efficiency and pest regulation that is used to enhance crop yield stability.

Cover crop: The use of pure or mixed stands of grass-legumes cover crops so as to reduce erosion, provide to improve nutrients and lower fluctuation of soil moisture, temperature and resulting crop yield performance.

Green manure: A type of crop plant farming that grows fast sown to cover bare soil while their foliage smothers weeds and their roots prevent soil erosion.

Crop-livestock mixture: Crop-animal integration; fodder shrubs planted at high densities intercropping highly productive& trees enhance total productivity without need of external inputs.

Landscape diversity: A diversity of plant/tree species including in amount &type of vegetation surrounding farm areas.

On-farm crop and diversity: Consisting of different number of species covered in farm land, area covered by diversity in ha, /plot etc...

Genetic diversity: It consist number of local crop varieties and/or animal races

Soil quality: Content of soil fertility consisting productivity of land in ha, /production in quintal, and organic matter content covered on the soil in ha. /and or plot of land.

Sign of degradation or resources loss: Soil erosion arising from either runoff rain fall or exposed deforestation, habitat fragmentation impacted from human interaction, described in ha.

Plant health: Either infected or healthy plant or tree type explained by absence or presence of pests, disease and weeds, covered by crop damage in ha.

Dependence on external inputs: Expense of money for inputs for agricultural production expressed in percentage of inputs originating outside farm.

Level of food self- efficiency: Percentage of food originating on farm land of HH combined with access of food self-efficiency number of households.

Interaction and bio resources flow between farm components: Recycling of crop residuals (after harvesting like; maize, wheat, barley, bean etc.)& manure (effective use of biomass, complementarities between plants level of natural pest control, etc...).

Resilience of external disturbances: Capacity to resist/ recover before and after occurrence of hard conditions of environmental hazard like; storms, frost, drought, pests and disease etc.

Perception: The ability to see, hear, or become aware of something through the senses: *the normal limits to human perception (*Oxford Advanced Learner's Dictionary, 2015).

Attitudes: defines attitudes evaluative statements which are either favorable or unfavorable concerning objects, people or events. They reflect how one feels about something (Robbins, 2001) Cited by (Hannah, 2009; Rehima, 2016).

CHAPTER TWO

LITERATURE REVIEW

2.1 Theoretical Perspectives and Concepts of Agro-ecological Farming Practice

2.1.1 Concepts of Agro-ecology

Theoretically, the concepts of agro ecology is explained and defined in different concepts by different authors. There is no single way to define agro-ecology, but the concept agrees and unifies different groups of scientists, practitioners in the food system and social movements. Agro-ecology was defined as the application of ecological systems to agriculture (Altieri, 1995). Twenty years later agro-ecology was enlarged and expanded in to the whole food system linking production with the food chain and consumers (Jalan, 2015).

Agro-ecology, agro-refers to agriculture; bringing ecological principles to bear in agro-ecosystem and can suggest novel farm management approaches aligned with the natural and environmental conservation. Here the novel farm management, definition is applied to agricultural production systems, the study of ecological processes applied to refer to “a science, a movement or practices (Kathounian, 2001; Cetap, 2006: a; Jalan, 2015). Following this definition, agro-ecologist would study agriculture's various relationships with soil health, water quality, air quality and micro-fauna, surrounding flora, environmental toxins and other environmental contexts.

Therefore, Agro-ecology can be defined as; refer to agro-ecology as the study of the interactions between plants, animals, humans and the environment owing of the farmers to their livelihood. Hence, inherently agro-ecology is multidisciplinary integrated farming system known as sustainable farming and organic farming including; factors from agronomy, ecology, sociology, economics and related disciplines (Dalgaard, et al., 1990s; Hailu Araya, 2017).

2.1.2 Evolution of Agro-ecological Farming Practice

The Evolution of agro-ecology explained in different ways as approach to rural and agricultural development. More conceptual evolution of agro-ecology is described and evolved based on a

holistic view on society and ecological principles. It is described as a science and as an approach to rural& agriculture development (Caporal& Costabeber, 2004; Negasa Bane, 2013). Traditional societies used farming methods that were suitable for local ecosystems. These traditional agricultural methods were informed by indigenous knowledge, practice and trends developed over time around specific conditions of women and men through the experience of better food security status (Ogle and Grivetti, 1985: a). This was long before Modern agricultural farming intervention in history of farm homestead plots. While, IK is being marginalized the existing modern agriculture built on WKS (Western Knowledge System) through the Western Education System (Warren, Slikkerveer& Brokensha, 1995:35).

For examples; from USA, Brazil, Germany and France discussed the evolution of different meanings to agro-ecology. The use of the term agro-ecology can be traced back to the 1930s. Until the 1960s agro-ecology referred only as a purely scientific discipline. Then, different branches of agro-ecology developed. Following environmental movements in the 1960s that went against industrial agriculture, agro-ecology evolved and fostered agro-ecological movements in the 1990s. As a concept of Agro-ecology as an agricultural practice emerged in the 1980s, and often intervene with different movements. From these evidenced ideas, the subject itself has been goes further.

Over the past 80 years, agro-ecological investigations changed in relation to the scales and the dimensions of plot and field scales to the farm and agro-ecosystem scales. These have been discussed the evolution of Agro-ecology (USA, Germany, Brazil and France; 1960s-1990s). From these three approaches are persisted, such as; (1) investigations at plot and field scales, (2) investigations at the agro-ecosystem and farm scales and (3) investigations covering the whole food system.

2.1.3 Classification of Agro-ecological Zones in Ethiopia

The classification of agro-ecological zone differs from country to country. The zonation of agro-ecology is done in different ways in different countries (Dereje Gorfu et al, 2011) cited by (Regassa, 2015). In Ethiopia two types of agro-ecological zone classification systems are known that include; the traditional agro-ecological zones and the elaborated agro-ecological zones developed by (MOA and EIAR, 2011). The traditional zones include; Bereha, Kolla, Weyna-Dega,

Dega, Wurch and Kur where many kinds of crops are grown in each of these ecological zones. According to (Mengistu Negash et al., 1989) Cited by (Regassa, 2015). A major attempt to carry out an agro-ecological zonation for the country was taken as the classification of the traditional zones used in existing agricultural farming in the country of Ethiopia. Whereas, the elaborated once are mainly considering temperature, elevation and altitude.

2.1.4 Major Crops Grown in Agro-ecological Zones of Ethiopia

Ethiopia has many varieties of crops, these crops adapting in different agro-ecological zone of the country and altitudes. For example teff is a cool weather crop grown predominantly in the highland areas at optimum altitude range from 1800 to 2200 masl. While maize and sorghum are common warm weather cereal crops. These are cultivated mostly at lower altitudes along the country's Western, South western, and Eastern peripheries (Dereje Gorfu et.al, 2011). While currently, maize and sorghum grown between elevation of l500 and 2200 masl and require large amounts of rainfall for good harvests. Among oilseeds; sesame grows in warm weather areas unlike, niger seed which grows in the highlands with cool weather. In addition to these crops wheat, barley and potato are grown locally known as Weyna-Dega to Dega traditional zone ragging from 1500 to 2200 masl.

Agro-ecology shapes the performance of agriculture in Ethiopia (Menale Kassie et al., 2009). This implies that, the profitability of adopting sustainable agricultural practices will depend on the distribution of rainfall, adaptive capacity of the farmers to climate change and resistance of crop varieties. These adoption practices which are affected by agro-ecology and determinates of farm household characteristics affects the livelihood of farmers. This should play a role when formulating policies, programs and strategies that promote to adopt farmers in different agro-ecological farming practices to increase food security at farm household level.

2.1.5 Benefits of Agro-ecological Farming Practices

Different studies indicated that, there are tremendous opportunities of agro-ecological farming practices benefit to expand to grow diversified farming Practices. The theoretical findings indicated that, making better use of natural slops, dry season opportunities and an alternative for

the sustainable agriculture are the benefits of farmers to choose agro-ecological farming practices at household level (Chan and Fantle L., 2015).

Mainly, opportunities of agro-ecological farming practice provides benefits to increase farmers' income, utilizing micro-climate for agricultural intensification and diversification, fodder for livestock, retain soil and water and creation of water capture as a means of water harvesting. (Sherstha etal, 2001). Secondly, encourages households adopt dry season opportunities. For example, in Nepal findings indicated that, farm households during off-season that produce vegetable and cash crops to grow diversified food crops, fiber and fodder trees of economic value to the Region (Panth& Gaufam, 1990).The seeds, vegetables with WHT from runoff rain fall is used for farming off-rainy season and the use of drip irrigation are the best means of dry season opportunities (Nepal, 2017). Thirdly, agro-ecological farming is an alternative for the sustainable agriculture, protecting the environment and ensuring the sustainability of renewable natural resources (water, soil and biodiversity) reduce pressure on the environment and provides sustainable management of natural resources third World Network AEBP guide (Jalan, 2015).

In Ethiopia, in the Gedeo Zone, Wild coffees are grown naturally with a combination of indigenous trees like; indigenous agro-forestry System (*Cordia africana, Acacia abyssinica*) including; other indigenous forest tree species. This is a trend of practices and a five thousand years of sustainability Case Study on Gedeo Land Use (Southern Ethiopia, 2002). The theoretical findings of the Gedeo people could be sustained and preserved their natural landscapes and culture through their traditional administration known as ''Ballee'' system. As the same to other agro-forestry practices these indigenous tree species also have great potential for carbon sequestration and reducing pressure on adjacent natural forest to protect deforestation and soil erosion (Agro-forestry for Food Security and Climate Change Resilience [MOA &CCR], 2014).

Practically, the indigenous knowledge has not been systematically recorded to replicate adoption options and determinants of farm household to adoption of agro-ecological farming practices in different areas of the country like; Awi Zone, particularly Banja Woreda. Indigenous knowledge for agro-ecological farming practice provides understanding perception and willingness to adopt technology for opportunities of environmental conservation, improve livelihoods, adds economic

value and wellbeing of rural communities and contributes benefit to national economies (Madeley, 2002:11).

2.2 Determinates of Agro-ecological Farming Practices

The determinants' of farm households' adoption of agro-ecological farming practices combines the internal and external factors. The findings more explored that, the determinants of farm household agro-ecological farming practices that farmers decided to choose one over the other is mainly the interactions between household characteristics, socioeconomics and land use (Lambin et al., 2003; IFRI, 2013). Since, these determinants' can encourage or discourage farmers decided the choice of adoption of agro-ecological framing practices to adopt or not adopt. This is because of the fact that, households are the drivers in terms of resources use, operate biophysical uses, policy and institutional and environment for the use of land for farming.

A few studies have been done in Ethiopia and at International level that analyses of determinant factors affecting the choices of farm households in adoption practices of agro-ecological farming. But lack of research findings done households decided to choose on adoption practices in the study areas of Banaja Woreda. According to Research conducted in International Food Policy and Research Institute (Washington USA, 2013). Gender, education, trend experiences, resources & cooperatives membership, weather forecasts, farm land size, access to extension services, expenditure of the households were the determinant factors that were affected the choices of farm households' adoption practices in agro-ecological farming. Studies conducted in Pakistan, Bangladesh, Gahanna and Kenya (Ashfaq's et al., 2008; Ibrahim et al., 2009; Aneani et al., 2011; Oscar et al., 2012). Applied multiple regression model discovered that farming experience, land size, farm distance from main road center, farm equipment's, irrigation access, rented in land, education level of household head, extension visits, income from crop, access to credit and incentives and topography location of farm households affected crop diversification and adoption practices.

Similarly, a few studies conducted in Ethiopia (Benin et al., 2004; Seid and Seebens, 2008; Fetien et al., 2009; Wondimagegn, 2011; IFRI, 2013). Households of wealth, education, irrigation access, land size and slop, ownership of livestock, number of household farm plots, extension services,

attitude of the household head, market information, land physical factors, age of household, number of families, environmental factors like;(rain fall, temperature) are the main determinant and significant factors that are affected choices of adoption practices in agro-ecological farming for cereal crops in the northern Ethiopia (Tigray) and eastern Ethiopia respectively. From these studies of the above literature, that natural and socioeconomic factors are among the important determinants of farm household adoption choices and mainly focused on these factors.

The farm size is very important asset that affect the decisions of farmers to choose adopting strategies and more to demonstrate at household farm level. The concept generalize that; internal and external factors are the main determinants that influencing the choice of farm households' decisions on land use and farming practices (Pichón 1997; Nkonya et al., 2005; Vanwey et al., 2007, Oscar et al., 2012; Wondimagegn, 2013).

Therefore, it is concluded that there is a need of classifying farmers on the basis of their wealth characteristics, production orientations and livelihood adoptions strategies. This is more relevant when examining factors affecting the choice of farmers to agro-ecological farming practices for their livelihood (Tittonell et al., 2005; AZANR, 2017).

2.3 Empirical literature

Agriculture is the main source of income and livelihood to support for the majority of the rural households and attached urban populations in developing countries as well as in Ethiopia. Hence, adopting different agro-ecological farming practices in Banja Woreda in to the agricultural sector is necessary to assure food security and enhance the sources of income for farm households. Because farming based on agro-ecology is an effective measure to adopt different practices at the farm household level.

The adoption of farmers in different agro-ecological farming practices which can increase food production, generate farm income and reduce vulnerability of adverse impacts. Farmers can adapt abnormal conditions by making adoption options at their farm land. Rural households have indigenous knowledge and able to prepare themselves better and support avoiding projected damages in adverse events (Krest and Ecsein, 2013). However the adoption of different agro-ecological farming practices at household level can be influenced by farm household determinant

characteristics. The main determinant factors that limit farm households for the choice of agro-ecological farming practices are the drivers of population-farming-environment. However, these drivers of population-farming-environment interaction are not well understood how to intervene in farm household. Hence, more commonly known as external and internal factors are the main determinants of farm household agro-ecological farming practices in the study areas of Akayata and Kessa-Chewsa kebeles.

Research study shows that, farmers' awareness, investment in varieties of programs, social awareness and protection programs may be some important aspects of the adaptation policy to adopt different practices which are determinants of the farm household biophysical environmental characteristics (Schlenker and Lobell, 2010; Abid et al., 2014).

Perceiving the ability of farmers' different adoption options or coping mechanisms is the first step in the process of adopting different AEFP (Deressa et al., 2011). This is because, a better understanding of farmers' concerns and the manner in which they perceive different agro-ecological farming practices affected by the perception of the farm households. To this end, to design effective policies for supporting successful adoption mechanisms of the agricultural sector is also important to have precise knowledge about the type and extent of adoption methods being taken up by farmers. In addition to these also a need for further advances in existing demography and location at the farm household level.

The extent to which the farmers' choice of agro-ecological farming practices are varied from one over the other. This is mainly because of the decision of the perception and intention of the farm households to adopt or not. The main determinants of farm household agro-ecological farming practices in the study areas are influenced mainly by external and internal factors. The main determinants of farm household external factors include; biophysical, institutional, infrastructure, technology and weather and climate change situations.

In Pakistan (M. Abid et al., 2014). Found that, the determinants of internal factors such as; farm experiences, land ownership and farm size, attitude and indigenous knowledge, education level, farm assets and household family size were affected the adoption of the farmers choice at household level. His empirical finding also revealed that, the external factors such as; institutional

services like; credit access, extension services, information on market access and weather forecast influenced the adoption of the farmers' practices.

M. Abid found that, access to extension services leads to 13.07% increase in the likelihood of adopting crop variety and decreased of 6.36% in the likelihood of changing crop type as an adaptation. Farmers living in different agro-ecological zones used different adoption measures determines adoption practices. Farming in mixed crop zones leads to an increase in the likelihood of changing crop variety (11.21 %), changing planting dates (24.47 %), planting shade trees (12.45 %) and changing fertilizers or inputs (13.35 %) compared to the farming in rain-fed zone. From these results concluded that, farmers in different crop zones adopt differently based on crop adoption practices and needs.

2.3.1 External Determinants of Farm Household Agro ecological Farming Practices

2.3.1.1 Biophysical Characteristics

Determinates of farm household comprises various land cover and land use change and topographic or physical factors. Land cover such as; trees, bare soil, grass, water etc. Whereas, land use is a description of how people manage and utilize the land for socio-economic activity such as; settlements, un used for farm land, agricultural land, forest land, wetland, grazing land etc. According to the household survey result, on average a total of 1ha to 1.5 ha of small holders' farm plot is covered by plantation of a *eucalyptus globules* and *decurrence* tree *species*. This is estimated to be greater than $1/4^{th}$ to $1/3^{th}$ all parts of the study area. This means that on average 0.63 ha to o.83 ha of potential farm land is dominated by exotic tree species. This is a critical issue for future implication of food security. Planation of these species completely reducing existing crop production, especially adoption of farming practices in the study areas and productivity by 25% to 30% every year.

In the study areas of the Banaja Woreda, the topography of the landscape (the terrains, land slope and infertile soil etc.) can affected the farm households to adopt and participate in different agro-ecological farming practices. The sloppy terrain is more exposed to the soil and water erosion and can required some soil and water conservation intervention measures. The result of this study indicates that, the slope is another topographical aspect that influenced the land use and farming

adoption at the household level. The steepest slope in the study area is situated in elevation range from (2000-2700) masl.

Out of the total of 47,915.82 hectares, the physical topography of the land used for farm land is only 45% level. While, the remaining 55% of the land is mountain and terrain greater than 15 % steep slope. Hence some farm households need extra labor, financial cost and time for the stability of the farm land farmers to perceive and adopt agro-ecological farming practices. Instead, farmers decided not to participate adoption of farm practices and plant long life plants. Hence, in these areas farmers not encouraged produce crops and stay long time to generate income and farmers are exposed to plant exotic species and waiting their farm to fallow (infertile land).

2.3.1.2 Institutional Services

The institutions that provide services to the farm households mainly comprises; health care services, Farmers Training centers (FTC), Schools for provision of educational to household families, market, credit and cooperatives services are the main farm household determinants for the adoption practices. As observed from the field household survey result, the study areas have lack of access of institutional setup in credit and saving, market access, health care services and cooperatives. The farmers travel to get the services at least 8 kilo meters

2.3.1.3 Infrastructure

The empirical studies conducted in Pakistan by (Maddison, 2007). The access of market information indicated that, a 1% increase in the distance of the farm from nearest local market results in a decrease of 0.05% in the probability of adoption to the changing crop type. This is a matter of difficult land scape and topography reduces farmers' perception to choose adoption practices.

In Banaja Woreda, the physical topography of the area is more of isolated from the dry weather and asphalted roads to the center of the market and the service that the farm households provided. The survey result indicated that, on the average the distance of the farm home to the nearest center of the service provided main rural road and asphalted extends to 10 to 15 (kilometers). The study again revealed that, greater than 107 kilometers of dry weather roads are under risk and lack of

maintenance. This is because of the topography and the limitation of government commitment to support for the service provided to the farm households (AZTDO, 2017).

However, some farm households specially, the kessa kebele (village) near to the urban have access to the market services from 4 to 6 kilometers. The result shows that, about 85 (40.3 percent) farm households have an opportunities and benefited from the services nearby urban. While, the remaining 126 (59.7 percent) of the farm households have not access to infrastructure. But in this village, nearby urban areas, the topography is more of the sloppy terrain extends from 12 % to 15 %. From this sloppy terrain, the result of the study indicated that, the farm land is covered by *acacia decurrences* and *eucalyptus globules* tree species and rented out to the private traders, farmers and/or government employees for 25 years further used for the planation purpose.

2.3.1.4 Technology

Plant disease let blight, wheat and barley rust and funguses are most commonly damaging one third of the annual crops every year (AZANRO, 2015). The survey result indicates that, 171 (80.9 percent) of the farm households reported that, there is a need to locally effective improved technology and supported by the government.

2.3.1.5 Seasonal Weather and Climate Change

Farmers of the Banja Woreda, lack some important weather information forecast and had influenced climate related changes such as; crop yield loss by frost and lack of resistance of crops and early harvest varieties. The existing crops like; wheat, barely, teff, potato are damaged every year with the occurrence of seasonal frost and high intensity of rain fall, snow and flood fluctuation (Awi Zone department of Disaster Risk Management and Prevention [AZDDMP], 2017).

According to the survey result, out of nine Woredas in Awi Zone, the Baja Woreda is very humid characteristics of weather condition in general and Akayta and Kessa-Chewessa Kebeles in particular influenced by these attributes. The altitude ranges from 1700-3000 masl and characterized by temperature (13.5 to 25.45) degree siliceous min and max rain fall 1850 to 1900 mm annually (Awi Zone Agriculture and Natural Resources offices [AZANRO], 2016).

2.3.2 Internal Determinants of Farm Household Agro-ecological Farming Practices

2.3.2.1 Demographic Determinants

Demographic factors are one of the determinants of farm households that affect farming practices. Because it is mainly focused on people's awareness, attitudes and the patterns of different farming practices with sex , age , educational status , family size, income towards adoption of agro-ecological farm practices.

Some findings indicated that, the farming system and land management practices of the Banaja Woreda is an old traditional method (Bitew, 2012; AZANRO, 2017). The settlement of the farm households are not settled towards to farm areas. The average distance of farm home to the nearest farm center is 9 kilometers. This distance affects adoption of AEF practices and extra time and cost expenditure. The survey result indicated that, especially for crop farming on average the residential of the household to the center of the farm extends 5-8 kilometers.

The method of farming and experiences of land preparation is still exists by oxen, while hoe cultivation is common along river banks and on steep slope hills. Agronomic practices are poorly and differently applied. For example; land preparation and planting dates are not dependent on optimum weather condition due to lack of oxen, seed and lack of extension support. According to the survey result indicated that, 52 out of 211 households were not totally visited and had not got extension services and 149 households had got extension services and visited on average 3 to 10 days per year.

Family size and education level affects the adoption of agro-ecological farming practices. Education is assumed to be an important factor in accessing advanced information on new improved agricultural technologies and increased agricultural productivity (Norris and Batie, 1987; Elahi et al., 2015). For this study, the farm households are categorized in to two. One category is those farmers who read and write and the second category is those farmers who cannot read and write, but participated in the adoption practices. Then the survey result indicates that, 62 percent and 38 percent of the sampled households were not read and write and read and write respectively.

2.3.2.2 Socio-economic Determinants

Mixed agriculture is the major livelihood strategy in the study area. In this farming system, crop and livestock production prevails. Rain-feed wheat, barely, potato, and teff are the main sources of food in the farming systems. While livestock, goat and sheep and horses are the main livelihoods that determines in the areas. In addition to these, households generate income from off-farm activities like; local products of bamboo tree plantation, carpenter, blacksmith, local alcoholic products and daily family wages.

2.3.2.3 Legal Land Right and Farm Size Determinants

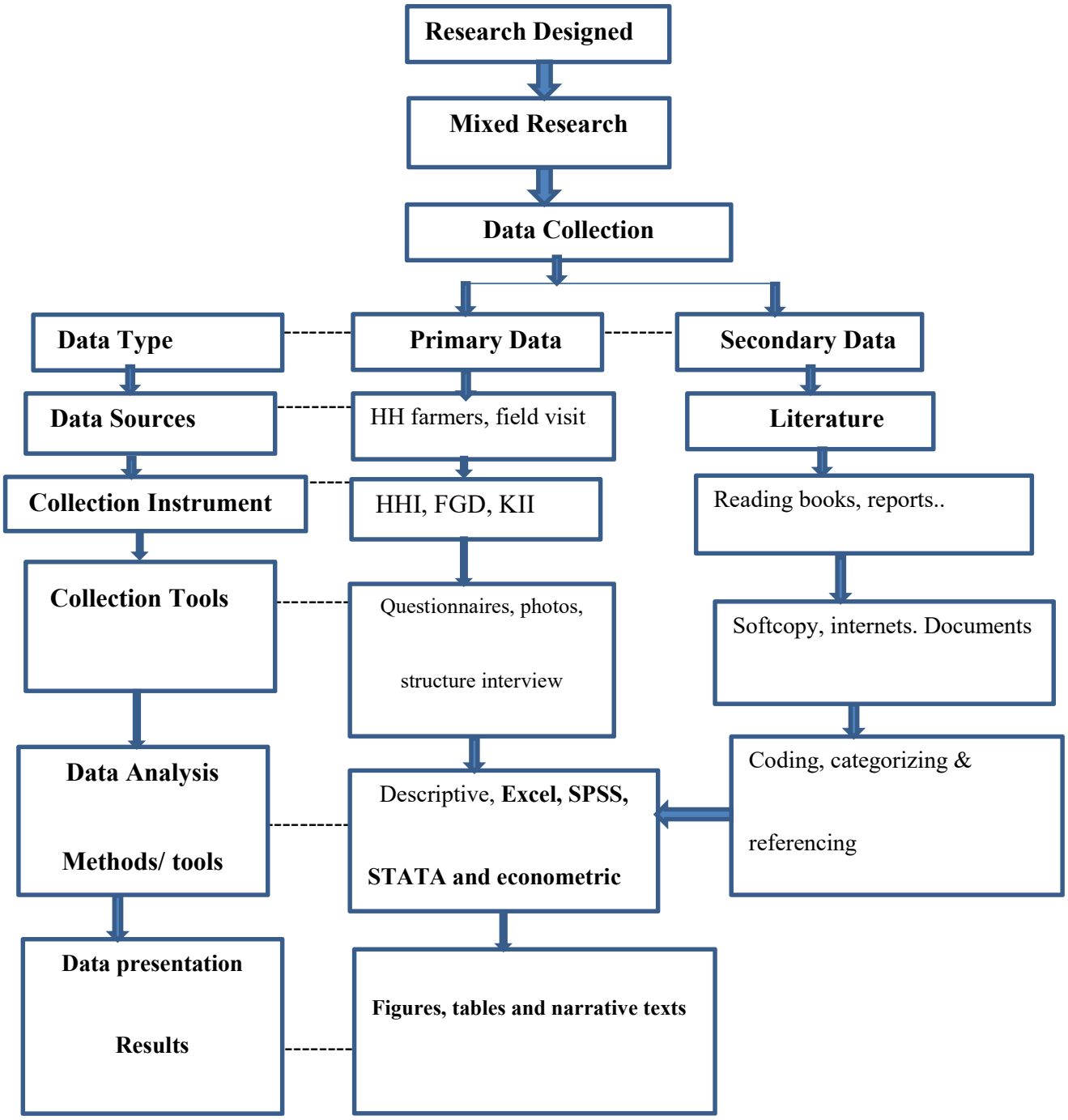
Land is the main dominant asset that determines the farm household in order to decide the sustainability of the adoption of agro-ecological farming practices. The study indicated that, out of the total of 211 household farmers, 149 (70.1 percent) households have their own farm land, but non-participant households, have only 9 (4.2 percent) have their own agricultural farm land respectively.

Regarding to farm size and land ownership, the farm households were categorized in to three. These are, an employed farmers who have land or practiced by rented from farmers, but traders, and farmers. The empirical finding indicated that, 15 and 19 out of 211 households were traders and government employees engaged in agricultural farm practices in the study areas. The restricted land ownership on average 0.125 to 1 hectare at household level. The restriction of farm size is a big factor that limits the participation of farm households in agro-ecological farming and coping mechanisms (Awi Zone Environment Protection Office [AWZEPO], 2015).

2.4 Conceptual Framework

The conceptual framework for this study is developed based on field data observation at the farm household level and from different literature reviews of the study using methods of data collection and analysis methods. Figure 2.1 presents, methods of data collection and data analysis and presentation of results for determinants of farm household adoption of agro-ecological farming practices.

Figure 2.1: Conceptual Framework



Sources: Researcher's Analysis.

CHAPTER THREE

RESEARCH METHODOLOGY

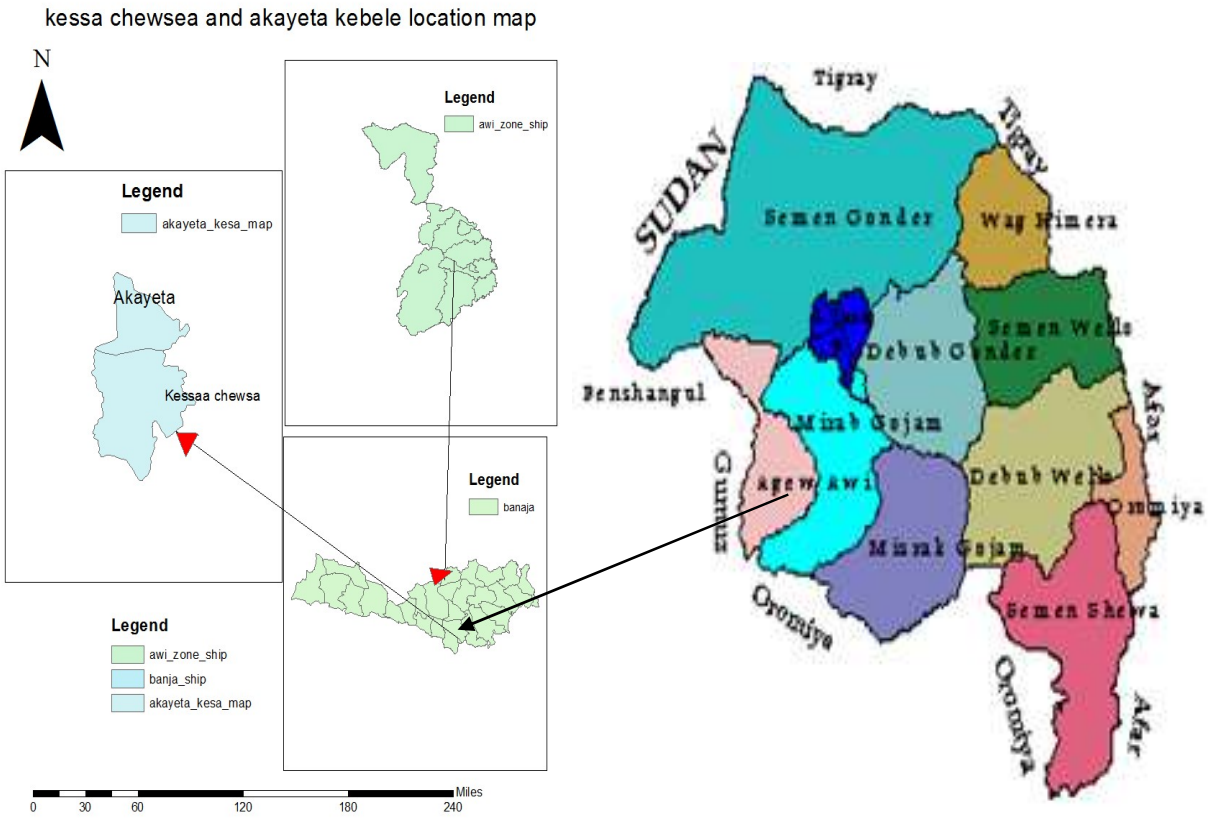
3.1 Description of the Study

3.1.1 Demography

The Banja Woreda is one of the nine woreda of the Awi Administrative zone comprises 25 rural and 02 urban kebeles and located in south, North, west and south of the Kossober (Awi Zone main town) and South of Bahirdar City and about 89 km and 465 km from North West Addis Ababa respectively (Awe Zone Finance and Economic Development Office [AZFEDO], 2017). Out of 25 rural kebels, four (04) kebeles, such as; Akayta, Banja, kessa-Chewsa and Gembeha are more severely impacted on soil erosion, land degradation and most of the landscape is exposed to environmental degradation. Communities and farmers are dependent on the plantation of exotic species of *eucalyptus globules* and *acacia decurrence* as a result of infertile soil and vulnerable to environmental degradation (Awi Zone Agriculture and Natural Resources Office [AZANRO], 2017).

The total population of the Woreda is estimated at about (315,271); 5% in towns and 95% in rural areas. From the above population (187,213) are females and (128,058) are males respectively, and average family size is 7 person per HH.

Fig 3.1: Study areas of Banaja Woreda (Akayata and Kessa- Chewesa) kebeles



Sources: Figure 3.1 Field Survey (April, 2019) and Fig 3.2 Map of Amahra Regional state, taken from yearly published (ARBCO, 2012)

3.1.2 Agro-Ecology and Landuse patterns

According to Landuse survey study (Awi Zone, 2017). The total farm size for the Banja Woreda is estimated to be 47,915.82 ha.; 80% Dega and 20% Woyena-Dega and altitude of (1700-3000) M.a.s.l and characterized by temperature (13.5 to 25.45) degree siliceous min and max, average RF is 1850 mm. Geographically, it lies in the latitude range of $10^{0}52'00"$to $11^{0}2'$ 44" N and longitude $36^{0}38'26"$to $37^{0}7'$ 8" E. The landscape is characterized by; 45% level land to 55% hilly/ mountain and the soil type more of red to brown colour, both of the Woreda kebeles are characterized by mixed farming system with the dominant crops of wheat, Woyena-Dega and potato, barely and teff in Dega.

Crop production, livestock and forest products mainly from plantation are the principal sources of livelihood for farmers. potato, teff, barely & wheat are the major crops grown in the area. While

cattle, sheep and goats are also the commonly reared livestock types in the woreda and part of the study areas. In addition to these the woreda has also a great potential for forest plantation. Especially, *eucalyptus globules*, *acacia decurrences* and *cupresses lustanica* tree species are widely planted.

3.1.3 Infrastructure

The infra-structure of the Banja Woreda, is near to the Awi Zone Administrative and little asphalted roads accounted 12 km to the West, 7 km to the North and 6 km to the South used neighboring rural kebeles benefited from the service and again which provides permanent transportation to the other woredas. Whereas 107 km dry roads temporarily providing service in dry season to the communities. The Woreda is not yet well asphalted due to its characteristic of topography and wet rainy season exposing to the muddy road including; soil erosion aggravates the land degradation and instability to the community adoption in agro-ecological farming practices including soil and water conservation activities too (Awi Zone Road and Transport Office [ARTO] , 2016).

3.2 Research Design

The research approach used to this study comprised both qualitative and quantitative method of research. In quantitative method of research, the researcher was used closed ended questionnaires, the processes of collecting, analyzing, interpreting and writing the research results. Whereas, in qualitative research method the researcher has been framed in terms of using words and open-ended questionnaires (qualitative interviews) were administered.

The method of research designed for the study was explanatory and descriptive research design. It employed the mixed approach research, the mixed method research is that, the quantitative data can reveal generalization of information. So these data often fail to provide specific answers, reasons, explanations or examples. On the other side, qualitative data research provides data about the meaning and the context regarding in the research area of the study.

3.2.1 Types of data

This study was relying on both primary and secondary data

3.2.1.1 Primary Data

Sources of primary data were gathered from Banja Woreda two kebeles of Akayata and Kessa-Chewesa a total of 4 (four) villages were selected through household survey including direct filed observation. Woreda Environmental protection office, Agriculture and Natural resources offices and Livestock and Development offices data were gather and analyzed. The researcher was collected necessary information through supervision of personal visit and assigning data collectors. In addition to these, necessary orientations to the data collectors had been provided before data collection. The researcher was selected individual farmers (rented and owner of the land) and observed practices and trends of the information and the data were supported in household survey for each respondents.

3.2.1.2 Secondary Data

Data were collected from different documents review, books, journal articles, annual reports of agricultural and natural resources, livestock and development, forest and environmental protection, abstracts, internet, researched documents, agricultural strategies, training manuals and guidelines of agro-ecological adoption practices and evaluation reports. On the other hand secondary data were collected from different Government institutions such as: Banja Woreda and Awi Zone (Environment, Forest and Biodiversity, Agriculture and Natural Resources, Livestock Development and Finance and Economic Development) and Amhara Regional State of Natural Resources and Agriculture office.

3.2.2 Sources of Data Collection

For the purpose of household survey assessment, the main sources of data were desk interviews, meetings, Field observations visits, and FGD and KII discussions. In addition to these, the second sources of documentations reviews of written soft and hard copies and reports were used. The researcher was used different materials of tape meters, digital photo camera, mobile phones and manual/top sheets of physical maps.

3.2.3 Methods of Data Collection

For the purpose of data collection, using open and closed ended including; pre-tested structured questionnaire through household survey and structured questionnaires were prepared in English language. To simplify the response of the communication questionnaires were translated in to Amharic and local language within face to face interviews by the enumerators. Enumerators were selected and trained half days by the researcher and a total of six enumerators' were collected household survey questionnaires within four days for all kebeles of the study.

3.2.4 Instruments for Data Collection

Quantitative tools for Household Survey and qualitative tools for KII, FGD and field observation were used.

3.2.4.1 Household Survey Schedule

Quantitative tools for households interview were administered through, semi-structured questionnaires. While, open ended and closed ended questionnaires had been prepared and used for data collection and data was collected including visit interviews. The questionnaires covered issues related to farmers' current and existing framing situations. Locally effective and acceptable farming practices and attitude and indigenous knowledge level of farmers were also interviewed to analyse the production and adoption of agro-ecological farming practices. The perceptions of the small holder farmers on determinants of farm household agro-ecological farming practices were discussed and disk interviews were also supplemented before field and at the field visit.

3.2.4.2 Focus Group Discussion

For FGD, a total of two Groups that means; containing six members for each kebeles having common interest and information were participated. All of the Focused Groups are living in the study area comprised from different professional experts of the Banja Woreda. For each profession, one expert selected from (Crop, Natural Resources, Environment and livestock Development). In addition to these, from two kebeles, four villages; three farmers for each kebele a total of six farmers for four villages were included in the selection. Among Woreda experts and HH farmers, two FTC DAs' were also participated. From twelve participants of the FGD, two were female (one from HH farmers and one from the woreda experts).

3.2.4.3 Key Informant Interview

For KII, seven persons were identified based on the knowledge of agro-forestry, crop rotation, poly culture, crop and animal mixture, green manure and cover crop. The interview questions were analyzed for the discussion points to examine and describe existing trends of farming experiences, and awareness level of indigenous farmers' knowledge for the adoption of agro-ecological farming practices applied or not. In this regard three experts of (Natural Resource, Environmental conservation and Livestock Development) and four household farmers were involved to explore and what factors determine and influence households for the choice of adoptions of agro-ecological farming practices in the study areas.

3.2.4.4 Field Observation

The researcher used field observation to know the physical condition and what factors affecting the adoption of agro-ecological farming and what has been done on the ground in the Banaja Woreda that can help to understand the real situation about problem.

3.3 Target Population of the Study

The target population is all households found in one Woreda of two kebeles permanent residents in Akayata and Kessa –Chewesa were considered for sample survey study. The total population of kebele 01(Akayata) is 237; male 212 and female 25 and kebele 02 (Kessa-Chewsa) is 249; male 237 and female 12 targeted population for the sampling techniques. The targeted population in this study is a total of 486 households considering as residing in villages (gotts) of unit's found at household level. The Development Agents from the Farmers Training Center, farm agronomic experts, Environmental experts, and Natural resources experts, livestock experts, who are residing in Akayat and Kessa-Chewessa kebeles were considered for the study. For conducting the qualitative aspect of the study, Key informant interviews, focus group discussions and Interviews, were also considered as target population.

3.4 Sample Size Determination

The sample size was determined from two kebeles of (Ackayata and Kessa-Chewesa) and derived from a total of 486 populations using simple random sample of 211 households. The household respondents were collected using simple random sampling method. The sample size was determined by using the formulas of (Yemane, 1967). Therefore, this formula was used to calculate the sample sizes a 95% confidence level and P = 0.5 are assumed.

n= N/1+ N (e2). Where n is the sample size drawn from the target population, N is the population size of two kebeles of Akayata and Kessa-Chewesa which is 486 household individual and e is the level of precision (statistically significance set (5%). Therefore, average sampling size for the study area calculated and decided for n values bellow here.

n= N/1+ N (e^2)

=486/1+486$(0.05)^2$

=486/1+1.215.

=486/1+1.215

= 228.70 = 229.

Table 3.1: Total Households Sample size Determination of the Study Areas

Kebeles		Weyena- Dega		Degaa		**Total**	**Sample size**
		HHs	Sample size	Household	Sample size		
01	Akayata	68	33	169	79	237	112
02	Kessa-Chewesa	94	44	155	73	249	117
Total		162	77	324	152	486	229

For this study, out of 229 sampled size headed HHs; 211(92.1 %) sampled headed HHs were responded during data collection on the time of survey scheduled. However the remaining, 18 (7.9%) headed HHs were not replied on time.

3.4 Sampling Techniques

The sampling technique was based on considering the total population and residential of the farm household. To decide the required sampling unit from the targeted population, the researcher was

utilized multi-cluster sampling method it includes; purposive or judgment and simple random sampling methods. The technique includes probably and non-probably sampling methods.

3.5.1 Non-Probability (Judgment or Purposive Sampling)

For the severity of the problem, purposive or judgment sampling was employed. In the first stage, one representative Banaja Woreda from nine Woredas was purposely selected. In the second stage, out of 27 (2 urban and 25 rural) kebeles of Banaja Woreda; two rural kebels were selected. The selection was done purposefully depending on the severity of the problem, farmers setting, common religious and characteristics considering same agro-ecological zone of the areas. Finally, the study areas of two kebeles four village (gotts) were purposefully selected for their considerable choices of adoption of agro-ecological farming practices.

3.5.2 Probability Sampling

In the probability sampling method, simple random sampling technique was employed. Out of 486 populations a total 229 sampled household farmers (47.12%) were randomly drawn from 486 households listed in to two kebeles of 4 villages as sampling frames. Then, a total of 229 sampled individual household heads (a sample of 106 and 105 households) Akayta and Kessa- Chwessa kebeles were samples of the study areas respectively.

Out of eight villages two villages, a total of four villages as a cluster of human settlement were selected. Based on the proximity to the main road, farming distance, social and economic attributes HHs were also divided in to four villages such as; v1 (kessera) n = 53, v2 (Barkewi) n =53, v3 (Kessa) n = 52 and v4 (Chewesa) n = 53 sampled headed HHs were taken respectively and considered in the data analysis.

By conducting household survey of the individual farmers, the selected kebeles were stratified in to adoption of agro-ecological farming practices of crop, crop and animal mixture and agroforestry and non-adopters.

Because the rationale for the selection of Banja Woreda was used based on its wide spread farming of different crops based on cultivation of highland crop and livestock and tree plantation in

different land uses. In addition to these, there are a number of people engaged in exotic tree species like; *eucalyptus globules and acacia decurrence* for their livelihood in their limited plot of land.

3.6 Procedures for Sampling

In this study different sampling procedures were used. Primarily study kebeles, sample units of village, field observation sites, and interviewed households selection were conducted. In the second stage, one day preliminary field visit survey was undertaken. In the third stage, three data collector enumerators, 2 woreda experts, 2 kebele DAs and 12 facilitator farmers were identified and explained how to collect the data. In the fourth stage different Institutions and professionals related the topic like; Department of Natural Resources, Crop Development, Livestock Development and Environmental protection experts for the purpose of the sampled were identified. The information gained from the sampled headed households is considered as the representative of the total population. In the fifth stage, from all selected villages considering equal or more than one (≥1) adoption practices of farm households were identified and categorized in to non-adopters and adopters of (crop, crop and animal mixture and agro-forestry) including; male and female households.

Finally, out of 211 total sampled size survey result, 74 (35.1 %) were female headed HHs and 137 (64.9 %) were male headed HHs. From these, 169 participants; 78 crop, 60 crop and animal mixture and 31 agroforestry adopters of agro-ecological farming practices and 42 non-adopters were identified in the study areas of Akayata and Kessa-Chewesa Kebeles.

3.7 Methods of Data Analysis

After the data sets are collected, the researcher encodes it in to SPSS and STATA Statistical analysis software tools. Both descriptive and inferential statistics and econometric model analysis of multinomial logit model were used. Socio-economic and demographic characteristics of the sampled households were analyzed by descriptive statistics like; percentages, mean, cross tabulation, frequencies, standard deviation and inferential statistics such as; t-test and chi square testes were also used. To test whether or not there is a significant difference between adopters and non-adopters different socio-economic, demographic factors and other related variables were

analyzed. The results were presented using charts, table and frequency distribution. The qualitative data collected from the KII and FGD were narrated and summarized.

To compute the unit changed and magnitude of the effect of selected variables multinomial logit model was employed. The farmers adoption preference from the six dependent variables such as; crop rotation, crop-animal mixture, agro-forestry, poly farming, cover crop and green manure were identified. Therefore, the following logistic regression model equation was used for data analysis and interpretation.

3.7.1 Model Specification

In this study, the determinants' of farm household doption decisions to agro-ecological farming practices were analyzed using a multinomial logit model. Regarding households' adoption of crop rotation, crop-animal mixture and agro-forestry and what factors determine those choices were computed. This model permits the analysis of decisions across more than two categories of combination of (crop, crop-animal mixture and agro-forestry), crop & crop-animal mixture, crop& agro-forestry, crop-animal mixture& agro-forestry, both of the three adoptions and non-adoption practices. Therefore, the generalized form of the MN logit model for the probabilities for explanatory variable with *j*- categories of socio-economic variables, the model is specified as follows.

$$\boldsymbol{P(Y_i = J)}\mathbf{P} = \frac{\mathbf{exp}(\boldsymbol{xi_{\beta i}})}{\mathbf{1} + \sum_{\boldsymbol{j=2}}^{\boldsymbol{m}} \mathbf{exp}(\boldsymbol{xi\beta_i})} - - - - - - - - - \text{(3.1)}$$

$$\text{j} = > 1$$

Let *Y* denote a random variable with values {1, 2…*J*} for a positive integer *J* and *X* set of variables. In this study, *Y* is a dependent variable and represents the adoption alternatives of ago-ecological farming and non-adoption practices. Whereas, *X* represents the factors that influence the choice adoption of farm households agro-ecological farming practices which contains household affecting farming practices. And β, represents coefficient values of variables. Therefore, Where the probability of choosing adoption practices of agro-ecological farming that

the response of the, i- th individual is given by the following variables and interpreted in the equation of (y).

$$\boldsymbol{y = \alpha + \beta_1 \chi_{1i} + \beta_2 \chi_{2i} + \cdots + \beta_n \chi_{ni} + £i} \ldots\ldots\ldots\ldots\ldots\ldots \quad (3.2)$$

Where, βi coefficients, X's independent variable and ϵ_i is random error associated with the, *i-th* observation/ the values of the explanatory variables of ''X''; X1 = Education level of Household, X2 = Farm size of the Household, X3 = Total family size of the Household, X3 = off-farm income of the Household, X4 = Remittance income of the Household, X5 = Market distance, X6 = Awareness level of the household, X7 = Extension services /days visited by DAs, X8 = Farmers Trainings provided by Woredas, X9 = Agricultural management activities, X10 = Access of Farm Land, X11 = land degradation, X12 = Environmental factors, X13 = Policy or land use factors, X14 = Technological factors , X15 = Farmers attitude level and £i = Error.

According to the multinomial logistic regression model overview revised (Richard Williams, 2018). One value; typically the first, the last or highest frequency of the DV is designated as the reference category. For a DV with M - categories for N - Choices, the equation requires the calculation of M-1 and one for each category relative to the reference category. Hence, when (M>2) dependent variables requires the calculation to the references category.

If P (Y_i=1) is the probability of adoption of farm household in choosing agro-ecological farming practices and if 1-P (Yi=1) is the probability of the farm households had not adopted in agro-ecological farming practices considered as reference category. All the three adopter households are response variables but, the log odd ratios that are not adopted in the agro-ecological farming practices are considered as to the reference category. Therefore, the researcher is used to compute the M-categories of dependent variable with the factors affecting IV by the equation of the model expressed as follows.

Non- Adopter households for (the references category)

$$\mathbf{1 - P(Yi = 1)} = \frac{\mathbf{1}}{\mathbf{1 + \sum_{i=1}^{m} exp(z_{xi})}} - - - - - - - - - - \mathbf{(3.3)}$$

Adoption of crop rotation households

$$P(Y_i = 2) = \frac{\exp(z_{1i})}{1+\sum_{i=1}^{m} \exp(z_{xi})} \quad ----------(3.4)$$

Adoption of crop-animal mixture households

$$P(Y_i = 3) = \frac{\exp(z_{2i})}{1+\sum_{i=1}^{m} \exp(z_{xi})} \quad ----------(3.5)$$

Adoption of agro-forestry households

$$P(Y_i = 4) = \frac{\exp(z_{3i})}{1+\sum_{i=1}^{m} \exp(z_{xi})} \quad ----------(3.6)$$

Where, M = the categories of for (n-choice) of dependent variables from choice 1 to choice 4, X independent variables, Y the probability of the dependent variable that the households adopted or not adopted, Z_{xi} the value of the coefficient and the independent variable and exp (e-natural logarithm) which is the value of 2.71. The parameter estimates of the multinomial logit model only provide the situation of ID on DV neither the actual magnitude of change nor the probabilities. To know the analysis of a unit changed and marginal effected in an explanatory variable, marginal effected would be computed from the mean (Greene, 2000). Therefore, the MNL equation model expressed in the first equation is differentiated with respect to the identified explanatory variables.

$$\frac{dpj}{dxk} = P_j\,(\beta_{jk} - \sum_{j=1}^{J=1} P_j\,\beta_{jk}) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.7)$$

The signs of the marginal effects and respective coefficients may be different from the MNL regression model (Hassan and Nhemachena, 2008). For this reason, the marginal effect depends on the sign, the changes and magnitude of all other coefficients.

3.7.2 Definition and Hypothesis of Variables

3.7.2.1 Dependent Variables

The dependent variables is the adoption and non- adoption decision of agro-ecological farming practices assuming that the farm households choosing crop, crop-animal mixture and agroforestry and non-adopters indicating that farm households not choosing adoption practices.

Non-Adopter farmers: Farm households not adopted in adoption of crop, crop and animal mixture and agroforestry practices

Adopter farmers: Farm households participating in the adoption of the three agro-ecological farming practices of crop rotation, crop-animal mixture and agro-forestry. These adopters takes the value of ‘’1’’ for crop rotation, ‘’2’’ for crop-animal mixture and ‘’3’’ for agro-forestry.

3.7.2.2 Independent (Explanatory) Variables

The independent variables of this study were; household sex, education, access of farm land and farm size, awareness and attitude level of household, policy factors, family size, extension services provided by DAs, household age, market distance, agricultural management and intervention practices, off-farm and remittance income, access of infrastructure services and access of credit and saving were computed.

HH sx: Refers to sex of the household head and it takes ‘’o’’ for women and ‘’1’’ for men. Male and female often own different assets (Doss, Grown, and Deere, 2008). Women’s usually control very little or no amount of land (Afonja, Mills-Tettey& Amole, 2002). Therefore, whether this is true or not this was analyzed and checked in this study. It is concluded that, being male or female is not affected farm households in adoption of agro-ecological farming practices in the study areas.

HH edu: It refers to household education indicating that if, households can read and write takes the value of ‘’1’’ and not read and write ‘’0’’. Education may increase prior access to external sources of information or enhance the ability to acquire information to adopt new technologies in local communities (Weir, 1999; Kallio, 2013). In this study areas of two kebeles it is found that,

being read and write engaged more on the plantation of woodlots, farm boundaries and on farmers' plot of land. Because they can understand information early from those who cannot read and write.

Faly siz: The number of household families indicating that if, ''1'' for households have children whose age is 1-7 years, ''2'' have families of male and female whose age is 8-17 years, ''3'' for families have adult male and female whose age is 18- 55 years, ''4''for elders whose age is 70-85 years and ''5'' for elders whose age is >85 years.

Day vst: Number of days per year in which DAs visiting a given household for the provision of extension service to interact with farmers for the adoption of AEF practices. Provision of the extension service is important to know what practices are existed and further what technologies farmers want to adopt and will be practiced (Vanden Ban and Hawkin, 1988). Hence, accesses to improved extension service are important for the success of smallholder farmers whether to adopt or not to adopt agro-ecological farming practices. It is hypothesized that farmers visited frequently by DAs have aware of improved technologies and information.

Livst: Is the total number of livestock holding measured in Tropical Livestock Unit (TLU). Households, who own many cattle, need more land for grazing (Gebreegziabher et al., 2012). In this study it is hypothesized that, production and productivity of livestock are decreased year to year because of farmers who have not enough farm land, lack of grazing land have not enough livestock and engaged off-farm activities, intensification of livestock diseases; anthraces tuberculosis problem of genetic diversity and improved/ hybrid livestock.

HH age: The age of the household headed in years. Older household head and younger household's heads were analyzed in terms of land areas owned, labor availability and resource requirements. Hence, it is found that being young or older household headed there is no variation between adopters and non-adopters of agro-ecological farming practices.

Far siz: The amount of land holding in hectares. Hence, having wider land holding implies that, households have a chance to get allocating it in to diversified economic activities (Gebreegziabher et al., 2012). The survey result shows that, those households who have not enough farm land have less income and exposed to migrate in to the nearby urban areas in search of wage labor for livelihood.

Awr fact: Awareness factors that the household's perception and understanding either adopted or not adopted in practices of agro ecological farming. Those households who have aware; measured in scale indicating that takes the value ''5'' for very high, ''4'' for high, ''3'' for medium, ''2'' for low, ''1'' for very low and otherwise ''0'' respectively.

Acc infra: Access of infrastructure, the institutions that provides services to the households like, access of market, education, transport, health care services and farmers training centers. Hence, if households have access to infrastructure takes the value of ''1'' otherwise ''0''.

Mkt dst: Market distance measured in kilometers, from household's village to the nearest market center. Less access of market undermines the ability of producers to buy inputs and sale their products. It is found that HHs farmer who have near to market access reduces the cost of road transportation and labor cost by 80 birr per one day per one travel. Thus, it is found that, the farmers closer to the main road are more likely to plant more plantation of *eucalyptus globules* tree species and *acacia decurrences*.

Off inco: Off-farm income that the amount of wealth that household possesses out of farm income, livestock income and plantation income. It is found that, adopters have more off farm income than non-adopters from different income sources such as; carpenter, wage labor, blacksmith, farm trade and income from construction.

Remt inco: Remittance income, the income generated from different sources that supported to the household and families through parents and supporter in cash in Eth birr.

Agr tri: Agricultural training to promote agro-ecological farming practices and on the adoption of new technologies in Farmers training Center (FTC) in a year and Woreda agricultural offices. If the household trained takes the value of ''1'' and otherwise ''0''.

Agr mg: Agricultural management activities like, conservation of soil, degraded lands, check dams, gulley treatment and plantation of multipurpose trees on soil bunds etc. If the households practiced takes the value of ''1' and other wise ''0''.

Land pro: Land access problem that the household faced, if the household have opportunities of access of farm land takes the value of ‘’1’’ and otherwise “0”.

Land deg: Problems of farm land degradation that limits farm households for the adoption of AEF practices. If the household have problem of land degradation takes the value of‘’1’ and otherwise ‘’0’’.

Env fact: Environmental factors of the farm household that hinders the decision of farm household to adopt different AEF practices. If the household have constraints of environmental factors; like, land slide, land slop, terrains and natural factors of frost, snow etc takes the value of ‘’1’ and other wise ‘’0’’.

Poly fact: Land use policy factors that intervene farm households. This is the integrated land use management imposed by the Regional Government and experiences of farm households that different land use systems for agricultural farming. Implementation of the right adoption practices to the right farm land. If the household have constraints of land use policy factors and incentives takes the value of ‘’1’’ and other wise ‘’0’’.

HH atti: Household attitude, positive or negative attitude that farm households’ acceptance for the adoption of AEF practices in their farm land. If the household have attitude on the adoption of AEF practices takes the value of ‘’1’’ and otherwise ‘’0’’.

Tech fact: The technological factors that hinder farm households for the adoption of agro-ecological farming practices in their farm land like; problem of access of improved inputs and replicable adaptive technologies. If the household have problem of access of technological factors takes the value of ’’1’ and otherwise=’’0’’.

Table 3. 2: Summary of Variables Definition and Hypothesis

Variables	Code	Definition	sign
Household head education	HH edu	Dummy, household read& write or not	±
Farm land size of Household	Farm siz	Continues; farm land size in hectare	±
Family size	Fly siz	Continues; household head number of families	+
Off-farm income	Off inco	Continues; income out of farm in Eth. birr	±
Remittance income	Remt inco	Continues; income supported out of farm in Eth. birr	±
Market distance	Mkt dst	Continues ; market distance in kilometers	±
Awareness factors	Awr fact	Dummy; awareness level of household 1= yes, 0 = no	+
Day visited	Day vst	Continues; DAs visited farmers in days per year	-
Agricultural Training	Agr tri	Continues; training of household in days per year	±
Agricultural management	Agr mg	Dummy; management of farm land 1= yes, 0 = no	±
Land problem	Land pro	Dummy; access of farm land problem 1= yes, 0 = no	±
Land degradation	Land deg	Dummy; problem of land degradation 1 = yes, 0 = no	±
Environmental factors	Env fact	Dummy; problem of environmental 1 = yes, 0 = no	±
Policy factors	Poly fact	Dummy; problem of policy factors 1= yes, 0 = no	-
Attitude level	HH atti	Dummy; positive and negative attitude 1= yes, 0= no	±

Sources: Researcher's Analysis

The conversion factors For TLU are: Oxen/caw=1, Bull = 0.8, Heifer= 0.75, calf= 0.25, horse= 1.1, donkey/mule= 0.7, Sheep/ goat = 0.13 and hen= 0.013 (Storck*et al.,* 1991).

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Demographic Characteristics of Sample household

In this section, both descriptive statistics and econometric model results are presented and discussed. In addition to descriptive statistics, inferential statistics such as t-test and chi square testes are also used to compare AEF Adopters and non-adopters with respect to different variables. The econometric model has been also employed to analyze whether or not there is statistically significant variation between adopters of agro-ecological farming practices and non-adopters.

Table 4.1 presents summary statistics of proportional difference between adopters and non-adopters in terms of household sex, farm land and education status. From the total sampled households, 64.9 percent are male headed HHs and 35.1 percent are female headed HHs. Regarding to the educational level, 62 percent and 38 percent of the sampled households were read and write and not read and write respectively. However, with respect to land ownership out of the total of AEFP, 149 (70.1 percent) households have their own farm land. But, non-adopters households, have only 9 (4.2 percent) that is only 6.3 ha have their own agricultural farm land respective.

As shown from the table 4.1, 53 households have not enough their own agricultural lands. This number accounts 23.1 percent of the small holder farmers set without production. Therefore, the findings indicated that, non-adopters of agro-ecological farming practices were less land size owned, less production and less per-capita income with the comparison of those adopters in the study areas.

Table 4.1: Summary Descriptive Statistics of Adopters and Non-adopters

Variables	Ch01(N=78)		Ch02(N=60)		Cho3(N=31)		None(N=42)		Total (N=169)	
	N	%	N	%	N	%	N	%	N	%
Sex :Male	54	25.6	29	13.7	28	13.3	27	12.8	137	64.9
Female	25	11.8	31	14.7	3	1.4	15	7.1	74	35.1
Education: NRW	36	17	22	10.4	13	6.16	9	4.3	131	62.1
RW	42	19.9	38	18	18	8.54	33	15.6	80	37.9
Land size: Yes	67	31.2	55	26	27	12.8	9	4.3	168	74.9
No	11	5.7	5	2.4	4	2.9	33	15.6	53	25.1

Remark: ‘’NRW’’& ‘’RW’’ indicate that, (Not Read and write and Read and Write).

Sources: Household Survey result.

Regarding to the summary descriptive statistics of the mean, minimum and maximum difference in terms of age, farm size, family size, total livestock, extension days visited by DAs, market distance and total production the result indicated that, adopter households have large land holding, livestock holding visited frequently by DAs and short distance market center to households’ home farm than non-adopters. Table 4.2 presents the summary descriptive statistics of average mean difference between responses of adopters and non-adopters.

The result revealed that, household age is almost the same and the lowest age is 25 for all adopters and the highest is recorded 91 years old in crop rotation and animal mixture adopters. The family size of the household indicated that, non-adopters have on average 6.6 families followed by crop and animal mixture 5.8 families per household respectively. But agro-forestry adopters have less family size from all participants which is recorded 5 persons per household. Interns of land size and total livestock, crop rotation adopter households have showed the highest

result which is on average 0.92 hectare and 1.74 livestock number respectively. While, non-adopter households have less farm land size which is 0.15 hectare and 0.68 livestock number. Whereas, extension services of crop-animal mixture adopter households were visited more on average 1.96 days per year followed by crop rotation which is 1.84 days per year. However, non-adopter households were the lowest visit result recorded 0.31 days per year.

The provision of extension service adopters were visited by DAs more than 1. 39 days per year than non-adopter. Regarding on distance to market center is nearest for adopters of crop rotation and far for non- adopters which is on average 2.9 km to 4.92 km respectively. It is indicating that, the maximum market distance is 13 km for non-adopters and minimum 1km for all households. Therefore, the market distance of adopter households is less than twice of non-adopter households which is on average 2.02 km.

Regarding to production result produced in a year in quintal non-adopters were less in production which is on average 9 quintal in a year. But, contrast to non-adopters the adopters' for crop-animal mixture on average 54 quintal which is followed by crop rotation 53 quintal and agro-forestry practices 50 quintal respectively.

Therefore, it is concluded that, adopters have higher production because of greater farm size, have higher livestock, have got higher extension services and have less market distance than non-adopters. Because of the nearest market center adopters have information on the variation of agricultural products, variation of input and prices. With these opportunities adopters can earn income from crop, livestock and agro-forestry adoption practices

Table 4.2: Summary Descriptive Statistics of Mean difference on Continuous variables

Variables	Unit	Crop rotation (N=78)			Crop- animal (N=60)			Agroforestry (N=31)			Non- adopters (N=42)		
		Mean	SD	Min-max	Mean	SD	Min-max	*Mean*	SD	Min-max	Mean	SD	Min-max
HH age	Years	56.2	18.4	(25, 89)	56.2	18.4	(25, 91)	55.2	19	(5, 88)	49	15.0	(25, 82)
Family size	No	5.4	2.6	(4, 11)	5.8	2.5	(0, 12)	5	2	(1, 11)	6.6	25	(3, 11)
Land size	Ha	0.92	0.5	(0, 2.5)	0.36	0.3	(0, 2)	0.28	0.45	(0, 2)	0.15	0.35	(0, 0.1)
Livestock	TLU	1.74	0.9	(0, 7.83)	1.44	2.6	(0, 7.08)	1.34	0.72	(0, 7)	0.68	0.37	(0, 0.52)
Day visited	Days	1.84	1.91	(0, 6)	1.96	2.04	(0, 6)	1.3	0.7	(0,5)	0.31	0.98	(0, 0.32)
Market distance	Km	2.9	2.1	(1, 9)	4.5	3.6	(1, 10)	4.5	3.6	(1,12)	4.92	3.9	(1, 13)
Land production	Quintal	53.9	36.9	(15, 163)	54	37.9	(0, 179)	50	22.4	(0, 108)	9	22	(0, 110)

Remark: parenthesis under ‘’Min-max’’ indicate, the minimum and the maximum value results for the response variables of adoption and non- adoption for each practices

Source: Survey result (April, 2019).

According to the summary descriptive statistics of the average mean income of the adopter and non-adopters crop-animal mixture adopters are higher mean total income than adopters of crop rotation, agro-forestry& non-adopters. The Total Income (TOTINCO) generated from different sources of agricultural production such as; Crop Income (CRINCO), Plantation Income (PLINCO), off-farm Income (OFFINCO) and Livestock Income (LSINCO) of the households result values are calculated by comparing the minimum and the maximum for each explanatory values. In addition to these, different expenditures related to the cost of input spending for Modern Agricultural; Input Spending (INSPN), Educational and Health care spending (EDUSPN & HEASPN) results are described. Table 4.5 presents the summary statistics of the average mean income of adopters and non-adopters. The summary statistics of the average mean income indicated that, the income generated from adoption of crop-animal mixture is birr 5,452 to 33 percent, agro-forestry is birr 4,368 to 26.4 percent and crop rotation is birr 4,273 to 26 percent respectively. In contrast to adopters, the no-adopters income is 2,405 to 14.6 percent, which is less than by (18.4 and 11.4) percent from average income of adopters of crop-animal mixture, crop rotation and agro-forestry. Similarly, the income generated from the off-farm income of the non-adopters is less than adopters of crop rotation, crop-animal mixture and agroforestry.

The income generated from the off-farm income of crop rotation adopters is birr 8,227 to 68.3 percent followed by adopters of crop-animal mixture birr 2,235 to 19.3percent. While, the off-farm income of adopters of agro-forestry is less than crop rotation and crop-animal mixture, which is birr 769 to 6.4 percent. In comparison to adopters, the non-adopters off-farm average income is less than which is birr 720 to 6 percent. The income of non-adopters is less than by (70.1%, 69.6% and 67.5%) from adopters of crop rotation, crop-animal mixture and agro-forestry respectively.

The findings indicated that, adopters can generate off-farm income more than non-adopters due to the sources income of daily wage rate, benefits from different sources of off-farm income; such as, blacksmith, local alcoholic drinks known as ‘’Areke’’ & construction of small furniture bamboo, charcoal and animal products in this study kebels of kessa-Chewess.

Table 4.3: Summary Descriptive Statistics of Income Mean Difference on Explanatory variables

Variables	Ch01 (N=78) Crop rotation			Cho2 (N=60)crop-animal			Cho3 (N=31) agro-forestry			Cho4non-adopters (n=42)		
	Mean	SD	Min-max	Mean	SD	*Min-max*	*Mean*	SD	Min-Max	Mean	SD	Min-Max
TOINCO	4273	4025	(12321,36011)	5452	6878	(4567,45753)	4368	2780	(1223, 35777)	2405	2627	(2345,23456)
CRINCO	5755	11625	(4678,23456)	6620	1242	2345, 23031	10492	2651	(7456,11701)	4035	4276	(900, 13379)
LSINCO	588	1637	(0, 4912)	971	1278	(500, 3497)	414	1011	(0,8914)	90	426	(0,4745)
PLINCO	5315	1453	(0,24234)	4667	5671	(0,3781)	3929	1025	(0,3456)	2692	2504	(0, 2700)
OFFINCO	8227	10387	(530,11234)	2325	2930	(345,2123)	769	994	(500, 12542)	720	2827	(345, 12234)
INPSPND	1287	1905	(0,3845)	805	984	(0,4000)	1198	480	(0,15990)	359	615	(0,1625)
EDUSPN	68	232	(0,700)	122	379	(0,2456)	0	0	(0, 1500)	123	136	(0,400)
HEASPN	59	379	(0,1450)	36	120	(0, 570)	8	36	(0,750)	2	12	(0,500)

4.2 Ecologically Effective and Locally Acceptable Agro-ecologica Farming Practices

The major AEF practices falls under the type of mixed farming. From this study the survey result indicated that, the three main practices such as, livstock farming, crop farming, agro-frestry practices with tree plantation are widely known. With respect to the main farming activities, the main crop farming activities grown in the study areas are; barlly, local teff, wheat and potato. Secondly, the main dominant tree planataion species (PTSS) such as; *eucalyptus globules, acacia decurrense, eucalyptus camaldulensis, cuprusses lustanica species* are planted as commmercial planation in the form of wood lot. But the most importnat dominant tree planatation practices are *eucalyptus glbules* and *acacia decurrenses* species respectivelly.

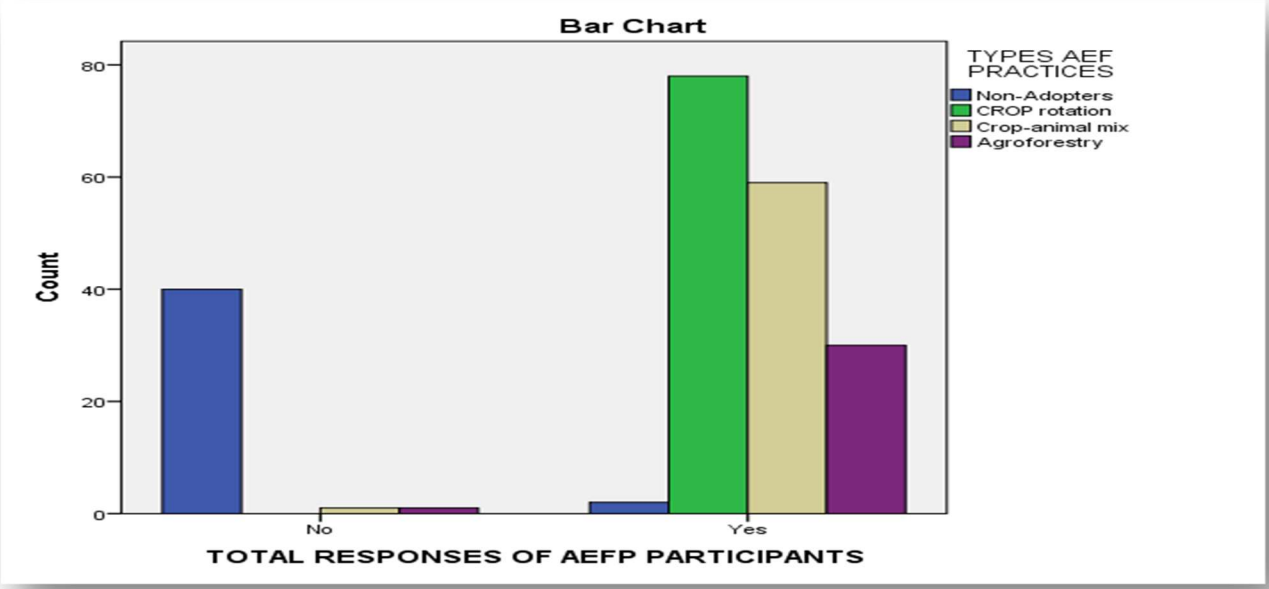
Acording to the sampled survey result, the crop rotation, crop-animal mixture and agro-forestry adoptions are parcticed in the two study kebels of Akayata and Kessa-Chewesa. Out of six agro-ecological farming practices such as; crop rotation, crop-animal mixture, agroforestry, poly culture, cover crop and green manure, none of the sample households adopt crop cover, green manure and poly culture practices. The result indicated that, 169 participants were adopters and 42 were non-adopters of agro-ecological farmining practuices. Figure 4.1 presents the descriptive statistics of the comparision of main types of agro-ecological farming practices of adopters and non-adopter. The survey result revealed that, 36.9 percent of crop rotation, 28.4 percent of crop-animal mixture and 14.7 perecent of agro-forestry were adopters, but the remaing 42 were non-adopters of agro-ecological farming pactices.

Therefore, depending on the adoption and non-adoption of agro-ecological farming practices adoptrers are categorized and grouped in to three such as; crop roation, crop-animal mixture and agro-forestry practices. The fourth one is grouped under the category of the non-adopters considered as reference category.

Table: 4.4 Comparision of Adopters & Non-adopter on Agro-ecological Farming Practices

Response		Adopters of AEFP				Total
		Non-Adopters	Crop rotation	Crop-animal mixture	Agro-forestry	
	No	42(19.91)	0	0	0	42 (20%)
	Yes	0	78(36.9)	60(28.4)	31(14.7%)	169 (80%)
Total		42	78	60	31	221(100%)

Figure 4.1 Comparision of Adopters & Non-adopter on Agro-ecological Farming Practices



Sources: Survey result Analaysis.

Regarding on the the ecologically efffective and locally acceptable farming practices, Croprotation farming, crop-animal mixute and agroforestry farming practices are the main sources of income and livelihood for the small holder farmers in the studya rea of the Banja woreda. Table 4.5 presents the main farming practices of ecollogically effective and locally acceptable. Therefore, out of 211 household sampled survey result 86.7 percent, 54.03 percent and 18.96 percent are ecologically effective for crop rotation, crop-animal mixture and agro-forestry practices respectively. Similarly, 72.04 percent, 63.03 percent and 33.2 percent are locally acceptable for crop rotation, crop- animal

mixture and agro-forestry practices respectively. In contrast to effectiveness and acceptability, the remaining 81.04 percent, 46 percent and 25.1 percent are not ecologically effective for agro-forestry, crop-animal mixture and crop rotation. On the other hand sampled households reported that, 27.96 percent for crop rotation, 28.43 percent for crop-animal mixture and 33.18 percent for agro-forestry are not locally acceptable in practices of agro-ecological farming in the study area of Akayta and Chewessa- Kessa kebeles.

Table 4.5: Response of Households on Locally Effective and Acceptable AEFP

Variable		Effectiveness (N=211)				Acceptability (N=211)			
Crop rotation (N= 78)	Rank(0…3)	0	1	2	3	0	1	2	3
	Number	45	124	34	8	52	110	42	7
	%	21.3	58.8	16.1	3.8	24.6	52.1	19.9	3.3
Crop-animal (N=60)	Number	61	71	43	36	44	80	53	16
	%	28.9	33.6	20.4	17	20.9	30.7	25.1	7.6
Agro-forestry (N=31)	Number	51	9	31	114	55	25	45	86
	%	24.2	4.3	14.7	56.8		11.8	21.3	40.8

Remark: ‘0”, ‘’1’’, ‘’2’’, & ‘’3’’ indicates, the importance of effectiveness &acceptability ranking (no response, important, very important and not effective or not acceptable) respectively.

Sources: Survey result

To understand the effectiveness and acceptability of the major agro-ecological framings practices whether these practices are adopted or not an independents t -test was employed. The result revealed that, there is statistically at 1% significant level variation between adopters and non-adopters in terms of ecologically effectiveness and locally acceptable for crop rotation, crop-animal mixture and agro-forestry practices respectively. Table 4.6 presents, the effectiveness and acceptability of the three major agro-ecological farming adoption practices result of the independent t-test. Therefore, t-test for equality of mean indicates the test result values of adopters of crop rotation, crop-animal

mixture and agro-forestry practices taking for each comparison responses of adoption with non-adoption of the household.

Table: 4.6 Independent t-test on Effectiveness and Acceptability of Agro-ecological Farming

Variables		Effectiveness		Acceptability		t-test for equality of mean			
		Mean	SD	Mean	SD	S-2tl	Mdf	SD error	t-test
Effecti veness.	Crop rotation	1.02	0.72			0.000	-1.21	0.09	-13.09***
	Crop animal mixture	1.27	1.08			0.000	-1.58	0.15	-10.41***
	Agro forestry	2.30	1.51			0.000	-2.76	0.17	-15.47***
Accept ability	Crop rotation			1.01	.761	0.000	-1.27	0.09	-1.98***
	Crop animal mixture			1.44	1.13	0.000	-1.79	0.15	-11.80***
	Agro forestry			1.85	1.35	0.000	-2.32	0.17	-13.65***

Remark: ‘’S- 2tl’’ and ‘’***’’ indicate signed 2-tailed test and significant at 1% level for each adopters choices versus none adopters choices of households respectively.

Sources: Survey result.

4.3 Farmers’ Atitude& Awareness level on Agor-ecological farming Practices

Farmer’ awareness and indigenous knowledge were tested and investigated using commonly known parameters of farming experience indicators. To understand and investigate the attitude, awareness level of the small holder farmers knowledge at HH level ten (10) common indicative parameter were identified and equally employed for both non-adopters and adopter farmers during the study to understand the significance variation of the agro-ecological farming practices. Table 4.7 presents the independent t-test for the farmers’ indigenous knowledge level in the study area of Akayata and Kessa-Chewessa kebeles. The result shows that, as it is ($P \leq 0.05$) there is statistically at 1%

significant variation between agro-ecological farming adopters and non-adopters in terms of farm and crop diversity, Plant animal genetic diversity, soil quality, plant healthy, sign of land degradation, dependence on external inputs, food self-efficiency, bio resources flow between farm components and resilience of external disturbances. From the survey result there is a significant variation at 10 % level between adopters and non-adopters in terms of landscape diversity. Similarly, there is a negatively and significant at 1% and 10% level variation between crop-animal mixture and agro-forestry practices in terms of farm and crop diversity and sign of land degradation.

The result indicated that, 4 out of 10 indicators had influenced and showed the variation on the gaps of non-adopters awareness and the knowledge level of households in practicing agro-ecological farming in the study areas. This is indicating that, non-adopters had limited in trends and experiences of farm and associated farming inputs compared to adopters of crop rotation, crop-animal mixture and agro-forestry practices.

All of the parameters were employed to investigate the farmers' attitude and indigenous knowledge level in their farming areas of the study in comparison to non-participants. This is because of adopters have adopted their experience through time and continuously adopted than non-adopters. While non-adopters were not experienced in farm crop, diversified, agro-forestry and crop-animal mixture in terms of their farm characteristics like; landscape (slope, plantation patterns, soil type and potential availability of farm land for production and farm component.

The result indicated that, the extension services provided from the total sampled of adopters and non-adopters 8.5 percent and 13.2 percent were reported that, they have never contacted with the Agricultural Development Agents in the year 2018/2019. Out of the total respondents, 69.2 percent of the respondents obtained extension services. From respondents and non-respondents, on average 30.2 percent and 3.2 percent of farmers were obtained extension services respectively ranging from 1-10 days per year. The household survey result revealed that, there is statistically significant variation between the adopters and non-adopter farmers in terms of extension service provided by the DAs at 5 % significant level.

Table 4.7: Independent t-test on Attitude &Awareness level of Households in AEF Practice

Variables	(N=78) crop rotation		(N=60) crop animal		(N=31) Agroforestry		(N=42) Non adopters	
	Mdf	t-value	Mdf	t-value	Mdf	t-value	Mdf	t-value
landscape diversity	-.08(.07)	-1.2 (.23)	.05(.07)	.71(.47)	-.03(.09)	-.36(.7)	-.6 (.32)	1.8(.06*)
Farm &crop diversity	-.13(.07)	-1.8 (.07**)	.01(.08)	.23(.81)	-.28(.10)	2.7(.01***)	-.8(.22)	-3.7(.00***)
Plant-animal genetic diversity	-.08 (.07)	-1.2(.22)	-.00(.07)	-.05(.95)	.01(.09)	.16(.16)	-1.2(.3)	3(.002***)
Physical soil quality	-.01(.08)	-.17(.86)	-.10(.08)	-1(.21)	.18(.11)	1.6(1.6)	-1.5(.3)	-5.5(.00***)
Plant healthy	-.09 (.06)	-1.3(.16)	.17(.07)	2.4(.01***)	-.06(.09)	-.64(-.64)	-1.7(.3)	-5.8(.00***)
Sign of land degradation	-.16 (.06)	2.4(.001***)	.08(.007)	1.2(.22)	.02(.09)	.28(.28)	-.9(.27)	-3(.00***)
Dependence external inputs	.13(.1)	1.1(.25)	-.09(.12)	-.77(-.43)	-.09(.15)	-.59(-.59)	-1(.3)	-3.5(.00***)
Food self-efficiencies	-.07(.06)	-1.2(.23)	-.02(.06)	-.31(-.75)	-.04(.08)	-.53(-.53)	-1(.28)	-4(.00***)
Benefit b/n farm components	-.19(.06)	2.7(.006***)	-.10(.07)	-1.3(-.17)	.12(.09)	1.21(.27)	-1.6(.3)	-5(.00***)
Adapt of external disturbance	-.11(.07)	-1.5(.13)	-.08(.07)	-1.08(-.27)	-.07(.10)	-.77(-.77)	-2(.29)	-8 (.00***)

Remark: Parenthesis under Mdf and T-test indicate, values of SD. error and (2-tailed test) for adopters versus non-adopters of each choices and '***', '**' &'*' significant at (1%, 5% &10%) level respectively.

Sources: Household Survey (April, 2019).

4.4 Determinant Factors Affecting Farmers' Choices of Adoption in Agro-ecological Farming Practices.

The main factor that affecting choices of farm households adoption in agro-ecological farming practices were; lack of access of farm land, limitation of land use policy (lack of provision of incentives; like; credit and saving opportunities), lack of ecologically acceptable technologies, limitation of extension services, limitation of trainings, land degradation and some limitations of environmental factors.

The results of the data analysis revealed that, out of 42 non-adopter farmers, (35.8 percent and 28.5 percent) farmers were agreed that, there is problem of access of land ownership and land use policy affecting the participation of farm households very high, (16.7 percent) agreed that, farmers were highly affected because of the lack of the modern technology and finally (11.9 percent) farmers were revealed that limitation of agricultural extension services affected farm households medium not to participating for the adoption of AEFP. The reason of variation is adopters had practiced in different farming interventions, had got training and more visited by DAs, have greater owned land size and increased per capita income than non-adopters. Whereas non-adopters had not more exposure to provision of training, owned less land size and experience on the trends of the AEF practices in their livelihood. This is due to the limitation of access of land ownership, policy intervention such as; credit and saving, modern technology dissemination were not addressed. Therefore, the survey result indicted that, the AEF participants have positive attitude and have understanding knowledge than non-agro ecological farming adopters.

Furthermore, to examine what factors determine the farmers choices in adoption of agor-ecological farming practices was analyzed by by MNL logit Robust model. The result of the MNL regression model indicated that, 15 out of 18 explanatory variables used in the model were statistically sgnificant at 1%, 5% and 10% leve respectivelly. From the regression model result, the chi-square value of -150.50719 indicated that, the likelihood ratio statistics are highlly significant with ($P < 0.0001$) estimating that the model has showed a stronglly explanatory power result. For this regression result the Pseudo-R square was 0.4631 showing that, the explanatory variable explained about 46% of the variation in the choice for the adoption of the agro-ecological farming paractices in the study areas. From the regression estimated result, a positive estimated coefficient of predictors in the model showed that, an increase in the likelihood of a

household choice in the response of the agro-ecological farming practices as compared to non-adopters (the reference category).

To know the change of the magnitude of the marginal effect, with respect to a unit change in an independent variable from specific unit of change were measured. The adopters of crop rotation, crop-animal mixture and agro-forestry practices were computed using Marginal effect of the robust model in comparison to non-adopters. Table 4.8 presents the MNL regression result of the likelihood of the significance variation between adopters and non-adopters with respect to a unit change in an explanatory variables. The result indicated that, the explanatory variables in terms of household education, farm size, family size, off-farm and remittance income, market distance, level of farmers awareness, extension days visited by DAs, agricultural training provided by Woredas agricultural office, intervention of agricultural management and conservation activities, problem of access of farm land, land degradation problems, environmental factors, land use policy factors and attitude of the household there is a variation between adopters of the response variables (crop rotation, crop-animal mixture and agro-forestry) and non-adopters were statistically significant.

Table 4.8: The Marginal Effect of Multinomial Logit Regression Result on Explanatory Variables

Variables	Cho1(Crop rotation=78)			Cho2 (crop animal mix=60)			Cho3 (agro-forestry=31)			Cho4 (non-adopters=40)		
	dy/dx	Sd.Err	P-level	dy/dx	Sd.Err	P-level	dy/dx	Sd.Err	P-level	dy/dx	Sd.Err	P-level
HH edu	-0.015	0.009	0.112	0.015	0.009	0.101	0.010	.004***	0.012	-0.011	0.007	0.119
Farm siz	0.234	0.057***	0.000	-0.013	0.052	0.802	-0.121	0.035***	0.001	-0.099	.044**	0.027
Fly siz	-0.005	0.012	0.661	-0.014	0.010	0.168	0.005	0.007	0.448	0.014	.008*	.084
Off inco	1.080	3.880***	0.005	3.850	3.510	0.272	-9.450	2.110	0.654	-1.4	4.51***	.002
Remt inco	0.002	0.001***	0.000	0.001	.0004***	0.001	0.0004	.0001***	0.004	-0.003	.001***	.000
Makt dst	0.034	0.010***	0.001	0.015	0.008*	0.075	-0.044	.009***	0.000	-0.006	0.006	0.354
Awr fact	-0.002	0.059	0.968	-0.025	0.060	0.666	0.086	0.039**	0.03	-0.058	0.035	0.101
Day vst	0.025	0.019	0.18	0.011	0.016	0.477	0.002	0.007	0.731	-0.040	.019**	0.037
Agri tri	0.050	0.023**	0.032	0.041	0.022*	0.063	-0.062	.018***	0.001	-0.029	.018	.111
Agr mg	-0.017	0.022	0.437	-0.037	0.020*	0.071	-0.001	0.009	0.848	0.056	.014***	.000
Land pro	0.291	0.144**	0.043	-0.113	0.128	0.376	-0.225	.054***	0.000	0.047	.072	0.51
Land deg	0.188	0.068***	0.006	-0.019	0.062	0.761	-0.065	.031**	0.037	-0.103	.050**	.039
Envt fact	0.919	0.143***	0.000	0.267	0.146*	0.069	0.310	.060***	.000	-1.496	.210***	.000
Poly fact	0.141	0.171	0.409	0.079	0.162	0.625	-0.230	.081***	.005	0.009	.090	0.913
HHs atti	-0.108	0.062*	0.082	0.132	0.053***	0.012	0.038	0.038	0.309	-0.063	0.046	0.177

Remark: Number of observations: 211; LR chi2 (51) = 259.63; Prob > Chi2: 0.0000; Pseudo R2 = 0.4631, Log likelihood = -150.50719, ‘’***’’, ‘’**’’ &‘’*” significant at (1%, 5% &10%) level respective.

Sources: Researcher’s Analysis.

The marginal effect of decreased a unit changed found that the farm size, problem of access of farm land and extension days visited had negatively changed the likelihood of non-adopters on the choices of AEFP significant at 5% level respectively. Similarly, off-farm income and problem of environmental factors had negatively affected the likelihood of non-adopters on the choices of crop rotation, crop-animal mixture and agro-forestry at 1% significant level respectively. For each independent variables a magnitude of significant a unit changed that determined the choices of farm households in agro-ecological farming practices are described here in details.

4.4.1 Education Level of the Household

An increased in education level by 5 years, increased the probability of choosing adoption of households' agro-forestry practices by 5 %. While, the education level of the households in choosing the probability of crop rotation, crop- animal mixture and non-adoption had not increased. An increased education level of the factor is that, an increased education level by years provide farmers ability easily to understand adoption of AEF practices and interpret new technologies and respond information faster than the counter parts.

4.4.2 Farm Size of the Household

The household farm size had influenced negatively the choice of agro-forestry practices and non-adopters significantly at 1% &5 % significant level respectively. A decreased in farm size by 1 and 5 hectare decreased the probability of the likelihood of farmers choosing non-adoption and adoption of agro-forestry practices by 22.2% and 9.9 % respectively. While, the farm size of the household had changed positively the choices of crop rotation adopters significant at 1 % level. An increased farm size by 1 hectare, increased the probability of the likelihood of farmers choosing crop rotation practices by 23.4 %. Small size farm land hinder the efficient utilization of farm inputs and technologies compared to large land holding. It was found that, the non-adopters had decreased their choice and had not adopted in the choice of crop rotation practices due to changed effect of household's preferences. And the households were shifted to engage in off-farm income (wage labor) generating activities than participating in adoption practices.

4.4.3 Family Size of the Household

The effect of household size had influenced positively for non-adopters significant at 10% level. An increase in the household size by one member of family per household increased the probability of the likelihood of choosing non-adoption by 1.4 %. It is indicated that, the effect of an increased household family size by 10 persons per household increased the probability of the likelihood of choosing the non-adopters households not to adopt the AEF practices by 1.4 %. However, households' size increased with less farm size; large families may be forced to divert part of the labour force to off-farm activities for the other alternative to earn income for livelihoods in order to reduce the consumption by large family (Tizale, 2007; Yirga, 2007).

4.4.4 Off-farm Income of the Household

The household income of off-farm had affected adopters of crop rotation and non-adopters positively and negatively significant at 1% level compared to the crop-animal mixture and agro-forestry practices respectively. The effect of a decreased, off-farm income of non-adopter's by 1 unit change decreased income of off-farm, decreased the probability of likelihood of non-adopters choosing AEF practices by 108 birr from the total income. While, compared to crop rotation adopters, increased income of off-farm had affected the household by one unit change of birr for the total income of off-farm, increased the probability of likelihood of farmers choosing adoption on crop practices.

4.4.5 Market Distance of the Household

The market distance influenced positively crop rotation and crop-animal mixture and negatively influenced agro-forestry practices. The marginal effect of the market distance had negatively changed the households of agro-forestry practices significant at 1% level. Whereas, market distance had positively influenced crop rotation and crop-animal mixture significant at 1% &10% level respectively. An increased market distance level of the agro-forestry adopters by 1 kilometers, decreased the probability of the likelihood of choosing the households agro-forestry practices and reduced adoption by 4.4%.

While the decreased level of the market distance for the crop rotation and crop-animal mixture adoption practices by 1 and 10 kilometer increased the probability of the likelihood of choosing the adoption practices of crop rotation and crop- animal mixture by 3.4 % and 1.5 % respectively.

4.4.6 Awareness Level of the Household

The awareness and perception level of the households influenced positively the agro-forestry practices significant at 5% level compared to the adoption of crop rotation, crop-animal mixture and non–adopters. An increased awareness and perception level of households by 5 persons can increased the probability of choosing the likelihood of adopting agro-forestry practices by 3.4 %. The more aware of the farmers on the practices of agro-ecological farming easily can help farm household to understand dissemination of technologies, agricultural management and conservation interventions.

4.4.7 Extension services of the Household

The number of days visited by the DAs had negatively influenced the households of non-adopters significant at 5% level. Decreased contact of DAs by 5 days a year reduced the probability of the likelihood of choosing crop rotation, crop-animal mixture and agro-forestry adopters by 4.01 %. An increased extension contact by one visit by DAs has an effect for the decrease of non-adopter households and increase adopters households to adopt AEFP. Farmers visit increase the chance of the probability of the likelihood of choosing the non-adopters to adopt AEFP.

4.4.8 Agro-ecological Farm Training Practices of the Household

Trainings of AEF practices provided by the Wreda experts had positively influenced households of crop rotation, crop-animal mixture significant at 5% level. While, trainings of household negatively affected adopters of agro-forestry practices significant at 1 % level. An increase trainings of household on AEF practices of crop rotation and crop-animal mixture by 5 times per year increased the probability of the likelihood of choosing adopting farm practices by 5 % for crop rotation and 4.1 % for crop-animal mixture respectively. Whereas, the decrease of training of households by 5 times per year decreased the probability of the likelihood of choosing agro-forestry practices by 6.3%.

4.4.9 Agricultural management and intervention activities of the Household

The households of agricultural management activities positively affected the non-adopter households and significant at 1% level. Households increase management of the agricultural

farm land conservation activities by 1% hectare from the total farm land size, decreased the probability of the likelihood of choosing the non-adopter households by 5.6 %. While, agriculture management activities influenced negatively for crop-animal mixture significant at 10 % level. In comparison to non-adopters, a decrease agricultural management activities by 10 % hectare decreased the probability of the farm households had not adopted by 3.7%.

4.4.11 Farm land access and opportunities of the Household

Farm land access of the households had negatively and positively affected non-adopters and adopters of crop rotation significant at 1% and 5% level respectively. In comparison to the non-adopter households, an increase of access of farm land by 5 %, increased the probability of the likelihood of households choosing crop rotation practices by 29.11%. While the decrease access of farm land by 1 % decreased the probability of the likelihood of choosing non-adopters by 37%. The findings indicated that, the problem of access of farm land had mainly implication for the constraints that non-adopters had not practiced on AEF practices and further limited the crop rotation, crop-animal mixture and agro-forestry practices fully had not practiced in the study areas.

4.4.11 Problems of Land degradation of the Household

Farm land degradation of households had negatively influenced non-adopters and agro-forestry practices significant at 5 % level. But positively influenced households of crop rotation practices significant at 1% level. The increase of farm land degradation by 5 % hectare out of the total of farm land of non-adopters and agro-forestry practices, decreased the probability of the likelihood of farm household choosing agro-forestry practices and non-adoption participants had not practiced in AEFP by 6.5% and 3.7% respectively. In contrast to agro-forestry practices and non-adopters, adopters of crop rotation decrease land degradation by 1% hectare, increased the probability of the likelihood of choosing crop rotation practices by 18.8 %.

4.4.12 Environmental factors of the Household

These environmental factors had negatively affected non-adopters significant at 1% level. Indicating that, a decrease 1% hectare of the total farm land of the non-adopter households decreased the probability of the likelihood of choosing households to participate in adoption practices by 149%. Whereas, in caparison to non-adopters adopter households positively

affected crop-animal mixture and crop rotation practices significant at 5% level and agro-forestry practices at 1% level respectively. The result revealed that, an increase a unit change of 5% and 1%, positive response of environmental factors increased the probability of the likelihood of households choosing crop-animal mixture by 26.7%, the crop rotation by 91.9% and agro-forestry practices by 31% respectively.

4.4.13 Land use policy and incentive opportunities of the Household

For the adoption of agro-ecological farming, the land use policy for agro-forestry practices had negatively affected and significant at 1% level. The decrease land use policy and implementation practices by 1% of a unit change decreased the adoption of agroforestry practices by 23.03%.

4.4.14 Attitude level of the Household

The households' attitude level had negatively influenced the crop rotation practices and significant at 10% level and positively affected households of crop-animal mixture practices significant at 1% level respectively. The result indicated that, a decrease the attitude level of 10 persons from total adopters of crop rotation decreased the attitude of the adoption of farm households not to adopt AEFP by 10.8%. While an increase the attitude of household level 1 persons from the total of crop-animal mixture practices increase the participation of farm households by 13.2 %.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

This study has tried to present and address determinants of farm household and the factors affecting the choices of households' adoption in agro-ecological farm practices. The study was conducted using cross sectional data sets by structured questionnaires drawn from a total of 211 sampled households. For purpose of the analysis and interpretation, the econometric multinomial regression logit and the robust models were used. To know a unit changed magnitude in a variation between for each dependent explanatory variables were computed using marginal effect. The marginal effect of the data analysis was computed taking a reference category of non-adopters as a control choice and adopters as response variables. The emperical result of the MNL regression logit model found that, 15 out of 18 explanatory variables used in the model were statistically significant at 1% , 5% and 10% leve respectivelly.

The descriptive statistics analysis results shows that, statistically there is a significant variation between adopters and non-adopters in terms of total income earned from crop, livestock, tree plantation, off-farm, land size, agricultural extension service, household education level, and used expenditures. Adopters of AEF practice have higher total income earned from, crop farming, livestock production and tree plantation products. Similarly, adopters have higher land size, access of agricultural extension service, expenditure spending for education and health care and better understanding of modern agricultural input used than non-adopters. The findings indicated that, explanatory variables are statistically significant with ($P \leq 0.05$). It is concluded that, there was statistically variation between non-adopters and adopters of crop rotation, crop-animal mixture and agro-forestry practice respectively.

The main factors that hindering and influencing the decision of farm households for the choice of adoption in AEF practices were; primarily problem of access of farm land, limitation of land use policy and incentives opportunities (agricultural incentives, credit and saving, cooperatives information communication), lack of locally acceptable technologies, problem of provision of

agro-ecologically farming trainings and problem extension services provided by DAs. The households of non-adopters there is negatively influenced in terms of farm size, off-farm & remittance income, extension service, land degradation and problem of environmental factors were the main factors that limited the households not to adopt in AEFP in the study areas of Akayta and Kessa-Chewesa kebeles.

Finally, education level, awareness level and environmental factors of the households positively and significantly influenced for the adoption of agro-forestry and the main contributing factors that household's adoption. While, policy intervention (land use management, credit, incentives), access of land ownership, farm size, land degradation, market distance and trainings of the households were influenced and hindered the probability of the adoption of households to choose agro-forestry practices compared to the crop rotation and crop-animal mixture adoptions. The findings concluded that, households who have productive and potential land holding are more likely adopters of agro-ecological farming practices than non- adopters.

Accordingly, the findings of this study indicated that, the main factors that hinder households did not adopted in AEF practices were primarily problem of access of farm size and unemployment. Second problem of Regional Government to internalize to the farmers to manage the land use and policy incentives; lack of government commitment facilitating opportunities for incentives and credit and saving. Thirdly, lack of improved locally acceptable technologies. The findings indicated that, crop-animal mixture needs extra land for grazing, forage production to feed livestock and families'. The result found that, the production of agro-forestry practices takes time to get production from plantation at least 3 to 5 years to earn income compared to the practices of crop rotation and crop- animal mixture.

Generally, the main findings of this study concluded that, problem of farm land, policy incentives, technology, training and extension service, less awareness level of farm households, land degradation and environmental factors (frost, potato let blight and rust), expansion of planation of exotic species, limitation of institutional infrastructure and market distance are major factors faced adoption of AEFP found in Banja Woreda specially, in the study kebels Akayata and Kessa-Chewesa. As it is concluded that, the adoption of AEFP in the study kebeles had brought to positive effect on the livelihoods' of adopter farmer households. However, for

non-adopter farmers and Land use policy problems (LUSP), farm land size and access, lack of provision of modern agricultural technology and timely provision of agricultural extension service had brought a negative significantly factor. Specifically, education status, income from plantation and off-farm, market distance, provision of AEF trainings and per capita income of households had brought a negative significant effect to non-adopters.

5.2 Recommendations

Assessing the determinants of farm households' adoption of agro-ecological farming practices is significantly important to understand the awareness and indigenous knowledge level of small holder farmers, investigate locally acceptable farm technologies and examine what factors affecting the farmers' choices in adoption of AEFP at household level. Clearly, identifying the main limitation of farmers, awareness, external and internal factors and the existing situation of indigenous knowledge needs to be primarily taking in to account. Since for each farming areas; the attitude, awareness, farming experiences, trends and interventions might be agro-ecologically different to adopt at each farm household level.

Therefore, the researcher has recommended some possible recommendations based on the results of the findings drawn from FGD, household survey, KII, field observation and better improvement ideas of small holder farmers for the adoption of agro-ecological farming practices particularly; Akayat and kessa-Chewessa kebeles. On the first hand, it is better to understanding, the trends, experiences of farming situation of the attitude and awareness level of farmers' indigenous knowledge. Understanding of farmers perception and awareness helps to decide and put the expected solutions for the limitations of the findings either developer's or policy decision makers, important further to scale up and update/ formulate policies, programs and projects, helps to prioritize and set criteria's for identification of farm households in certain areas of the intervention to improve food security and helps to understand gaps of awareness and perception in adoptions technologies to provide training best suited in the adoption AEFP in the study areas.

Secondly, it has to be considered important to practicing certain farm management interventions. Particularly; application of natural fertilizers (green manure, composting and agronomic practices), integrated pest management has play a great role for improving land productivity at

household level. Hence appropriate attentions have to be given by the concerned Government bodies, NGOs, Practitioners and Research Institute centers to aware the adoption of agro-ecological farming practice with farm management interventions. Thirdly, it has to be priority given to adoption systems for practicing the trends of multipurpose farming practices especially, small ruminant animals and high land fruits with farm size to generate income. Because the likelihood of household practice is positively and significantly affected by farm land and land ownership.

Fourthly, provision AEF training based on the level of understanding and perception of local language can more contribute household participation. This helps to understand farmers to adopt easily and implement farming practices. Because, the educational status of the household head is also another significant factor which affects household farmers' adoption of technologies to. Some understanding of skill and educational level produces changes in perception, attitudes, beliefs, and behavior of farmers. Education can help farmers to acquire experiences of understanding information, to adopt locally effective technologies, to estimate expected amount of appropriate input quantities for production decided to choose appropriate and type of input use, to practice timely available agronomic and cultivation techniques in accordance with the farm land management system.

On the fifth, it is important continues provision of farmers extension services DAs and more focus to non-adopter has to be supported every season without time and place boundaries. Since, extension services enables the household to be forecasted local and seasonal weather condition with respect to their farming and harvesting seasons. Therefore, more attentions have to be given to provide extension services, incentives opportunities (credit and saving), off-farm income and establishment of small micro enterprises to farmers so as to increase the awareness level of households.

Lastly, access of infrastructure, needs to be important and taken in to account. Long distance from home farm land to the nearest market increases uncertainty of the households choices decided to adopt in agro-ecological practices. Therefore, more focus has to be given access of infrastructure like; access of road, telecommunication, clinks, local weather forecasts stations, market, FTC of communities' residence home has to be required.

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APPENDIX

Addis Ababa University

Center for Environment and Sustainable Development Studies

Household Survey Questionnaires

Enumerators name _____signature_____

Questionnaires code _____date of interview _____

Purpose: Dear respondents, I am Getnet Amare and I am a student in Addis Ababa university Center for Environment and Sustainable Developmental studies, in the department of Environment and Sustainable Development. The main objective of this questionnaire is to assess house hold survey study to get data on the challenges of agro-ecological based farming practices in your Wereda, for the thesis as a partial fulfillment of MA in Environment and Sustainable Development. This questionnaire is prepared for the purpose of collecting data in Amhara, Region Awie zone; Banja woreda /Achakyat &Chewsa kebeles. The study is conducted for academic purpose and your identity will be kept confidential.

Your responses are importantly contributing to achieve the ultimate objectives of this study. Therefore, you are kindly requested to give your honest responses for the provided questionnaires.

Thank you in advance for you cooperation!

I. General Information

Woreda_____

Kebele_____

Village _____

1. Main occupation _____
2. How many years you lived here? _____ years

Demographic characteristics

3. Household head sex: 1. Male ☐ 2. Female ☐
4. Age of house hold head: _____(years)
5. Marital status of the house hold head: 1. married ☐ 2. Single ☐ 3.Divorced. ☐ 4. widowed ☐
6. Education level of the house hold completed _____(years)
7. Religion: 1. orthodox ☐ 2. Muslim ☐ 3. Protestant ☐ 4.Ccatholic
8. Family size: ---------- (please indicate your family size in the table below)

Family categories	Sex	No. of families	Age of families in years				Educated level	
			Less than 7	7-17	18-35	>35	Read &write	Highest Level of education
Adult	male							
	Female							
Attending school	Male							
	Female male							
Labor	Female							
	Male							

II. Economic Characteristics

9. What are the main economic activities of your livelihood?

Activities	Did you practiced/engaged in the activities (1= yes, 0= no)	If yes, income earned in the last 12 months in birr	Accesses to infrastructure, market and credit	Do you have Accesses to infra-structure, (1= yes, 0= no)	If yes distance to farm land in kilometers	Assets	Do you have assets (1=yes,0 =no)	Number of owned assets	Cost of estimate current value in birr
planting			Road			Television			
Crop farm			Tell			Radio			
Livestock			Mill			Cellphone			
off farm			Market			Urban house			
Trade			Farm school			cart			
Salary			credit			Bicycle			
Remittance			Public water			Motor bicycle			
Others			electricity			Solar pumps etc.			

10. What is the type of house you constructed and live in? 1. Corrugated iron roofed ☐ 2. Grass roofed ☐ 3. Dependence on family ☐

11. What are the sources of energy for your livelihood (multiple answers possible)?

1. Fuel wood ☐ 2.Animal products ☐ 3.crop residuals ☐ 4.Electricity ☐ 5.Solar energy ☐ 6.Animal dung ☐ 7.Biogas ☐ 8.Kerosene ☐ 9. Charcoal ☐

12. How many months your agricultural products income (purchase of food) can feed you and your families? _____.

III. Land ownership and Agricultural Farming Situation

13. Do you have farm land? 1 Yes. ☐ 2. No ☐

14. Where did you get farm land? .1. Possession ☐ 2.land holding ☐ 3. Family gifts ☐ 3. Rent ☐

15. Do you have Irrigation land? 1. Yes ☐ 2. No ☐

16. Please indicate total area of farm land. _____and irrigated land_____ in ha (either land ownership or land rented HHs).

IV. Agricultural production

17. What are the main crops grown in farm land? (Please list the main ones)

Crops grown	Land area crop grown for (12 months) in ha.		Amount produced(in Quintal)		Amount sold in (Quintal)		Income earned (in birr) For the last 12 months	
	Rain feed	irrigation	Rain feed	Irrigation	Rain feed	Irrigation	Rain feed	Irrigation
1.Teff								
2.Wheat								
3.Barley								
4.potato								
5.Bean								
6.maize								
7. Others (specify).								

18. How is the trends of production a year to year for the last 5 years (2004- 2010)? 1. Increasing ☐ 2. Decreasing ☐ 3. constant ☐

19. If your answer is increasing or decreasing what can you suggest the reason for the situation.

1. Trends of production is increasing:

_____

2. Trends of production decreasing

_____

V. Agricultural inputs

20. From where you are supplied Agricultural inputs? 1. Agricultural Office ☐ 2. Cooperatives ☐ 3. Private market ☐ 4. By credit &saving ☐

21. What type of agricultural inputs used in the last cropping season? ([Hint: for both rented and land ownership

Agricultural inputs	Did you used in the last cropping season (1=yes &0=no)	If yes, amount in quintal	Unit price	Expense in birr	Is it affordable at current price(1 =yes &0=no)	Is there any problems encountered using chemical inputs in your farm land (1=yes&0=no)	If yes what problems faced (1= yield reduction, 2= healthy problem, 3=pollution, 4= food contamination, 5, others, specify)
DAP							
UREA							
NPK							
OM/FTM							
Improved seeds							
Herbicides							
Insecticides							
Pesticides							

22. What is the trend of using Agricultural inputs (chemical fertilizers) for your farm land? 1. Increasing ☐ 2. Decreasing ☐ 3. Constant ☐ 4. Not yet used

23. If your answer is increasing or decreasing what can you suggest the reason for the situation.

1. Trends of using inputs is increasing

   _____

2. Trends of inputs using is decreasing

   _____

VI. Livestock production

24. Types of livestock resources and products

Livestock type	Do you own livestock(1=yes&0=no)	If yes, did you sold in the last 12 months (1=yes&0=no)	If yes, number of livestock sold	Income earned in birr	Livestock products	Do you have livestock products (1=yes&0=no)	If yes, income earned in birr for the last 12 months
1.Ox					Milk		
2.Caw					Butter		
3.Bull					Honey		
4.Heifer					Wax		
5.calf					Skin		
6.others (specify)					Hide		
1.Donkey					Egg		
2. Horse					Others(Specify) if any ___		
3. Mule							
3.goat&sheep							
4.poultery							
6.Honey/beekeeping							

25. Where do you get the sources of livestock feedings? 1. Fodder plantation on farm land ☐ 2. On farm products ☐ 3. Grazing from communal land ☐ 4. Both.☐

26. How can you suggest the trends of livestock Production for the last 5 years? 1. ☐ Increasing 2 decreasing ☐ 3. Constant ☐

27. If your response is increasing or decreasing, please specify the reason?

1. **Increasing**

   _____

2. **Decreasing**

   _____

VII. Small holder farmer participation in agro ecological farming practices.

For this study purpose, classifying households whether they are participant in agro ecological farming practices or non-participant is important. Based on this households survey, having diversified participation of agro ecological farming practices to understand the trends, experiences, practices and perceptions of farmers clearly identifying the type of livelihood including; crop farming, crop farming with planted trees, crop farming with livestock, and crop farming with livestock and tree planted farming systems that to be considered. This data collection also mainly considers main practices of ecological framings within livelihood.

Therefore, with the area cover of above or equal to 0.125 ha. (Locally 0.5plot/) is considered as a participant of one of the six selected agro-ecological farming practices. While households who did not participated/engaged in one of the selected six farming practices at all or with area cover bellow 0.125 hector (0.5 plot) is considered as non-participants of agro ecological farming practices.

28. Please indicate locally effective and acceptable technologies in your farming that you participated.

Practiced technologies	Locally effective	Locally acceptance
	1= highly effective, 2=effective, 3=less effective and 4=not effective	1= highly acceptable, 2=acceptable, 3=less acceptable and 4=not acceptable)
1.crop rotation		
2.polyculture		
3.agroforestrysystem		
4.covercrop&mulching		
5.Greenmanure		
6.crop-livestock mixture		
7.waterharvesting		
8.improved goat sheep		
9.plantation/woodlot		
10.beekping		
11.SWC/		
12. poultry		
13. Specify if any...		
13.1		

29. Please choose and rate AEFP in your adoption (hint: for land owner and not owner

No.	Main Types of diversified AEF practices	Are you practicing diversified AEFP currently (1=yes&0=no)	If yes, rate your participation (1= highly , good 0.5 , o 25= less and < 0.25 have been participated but abundant now	If you are abundant now please specify your reasons
1	Crop rotation			
2	Poly culture			
3	Agro forestry system			
4	Cover crop and mulching			
5	Green manure			
6	Crop-livestock mixture			
7	Specify if any.			

30. Please choose and ordered the type of tree species that are being used for the Agro-ecological farming practice

Types of tree species	Have you participated in plantation of tree species, (1=Yes & 0=no)	If yes, area covered in ha.	No. of trees counted in ha.	Types of plantation choose (1= farm boundary, 2=home steed, 3 = woodlot, 4 cultivation area & 5= multipurpose/SWC, area closure.../	Rank in terms of rate you practice it (1=first,2=sec, 3=third)dominant& 0=otherwise	Age of plantation in years	Income earned for the last five years in birr
Eucalyptus globules							
Acacia dicurrence							
.Eucalyptus camldulnesis							
Cupresses lustanica							
Cordia africana							
6.Others (specify)							

31. If you have had not participated in ecological farming practices (EFP) what is your perception regarding the following factors

No.	Reasons/factors for not participated	Is it a reason for how you If you had not participated (1=yes,0=no)	Rank ratings, (3=very highly, 2= high, 1= medium & 0= low)	Suggested solutions
1	Shortage of farm land			
2	Lack of attitude and awareness level of indigenous knowledge/ cultural, education, training, extension services/			
3	Lack of improved technology/,crop, livestock, tree species and /			
4	Land degradation(infertile soil, erosion, land slope)			
5	Fear of natural/environmental factors/ frost, land slide...			
5	Lack of labor			
6	Lack of Dissemination of extension service			
7	Policy intervention and incentives/ land tenure, credit access,			

32. Please, rate your attitude and knowledge level for the following agro-ecological practices that are implemented at small holder farmers in your area.

VIII. **Agricultural Extension services**

Types of Agro-ecological farming principal indicators	Do you have knowledge in AEF Principal indicators(1=yes&0= no)	If yes rate it your knowledge (1=.v/ high, 2=. high,3= medium, 4= low, 5= v. low & 6= poor)	Why you prefer to choose one anoth er?	Do you have attitude in AEF Principal indicators (1=yes& 0=no)	If yes rate it your attitude ((1=.v/ high, 2=. high,3= medium, 4= low, 5= v. low & 6= poor)	Why you prefer to choose one over the?
Land scope diversity						
On-farm crop and diversity						
Genetic diversity						
Soil quality						
Sign of degradation						
Plant health						
Dependence on external inputs						
Level of food self-efficiency						
Interaction / bio resources flow between farm component						
Resilience of external disturbances						

33. Is there any agricultural extension services (DAs) in your FTC? 1. Yes 2. ☐ No ☐

34. How often how many days you were visited and contacted by extension services by DAs (hint: from January, 2010 to January, 2011 production season _____ (in years)?

35. What trainings you were received by the DAs for the last 12 months?

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36. How do you rate the level of extension service provided for the last 12 months (January, 2010 to January, 2011 E.C. 1 very good ☐ 2. Good ☐ 3.Poor ☐

37. How do you rate the level of trainings provided on Agro-ecological based farming practices by woreda agricultural offices for the last five years (2005-2011) E.C? 1. Very good ☐ 2. Good ☐ 3. Poor ☐ 4.Not yet trained ☐ .

38. What interventions currently practiced in your farm land regarding environmental management? 1. Soil and water conservation (soil bund, stone, terrace, gulley...) ☐ 2. Environmental protection (protection of deforestation, degraded lands...) ☐

3. Water harvesting (runoff harvesting, small ponds, roof top harvesting, plantation pit...) ☐

4. All are practiced ☐ 5. Not yet practiced ☐

39. Indicate main intervention activities practiced for the last three years in your farm land (hint all house hold participants)

Types of intervention activities	Do you have practiced in these intervention activities in your farm land for the last three years? (1= yes, o= no)	If yes, what is the area of land covered in ha?	Rate your intervention activities(1= very high intervene, 2=high intervene, 3 medium intervene & 0 low intervene)	Labor/days or money invested for the intervention work in birr for the last three years?	Please specify your reason for your preference?
.soil bund					
Stone bund					
Gulley control/check dam					
Terrace					
degraded land afforestation					
plantation pits /WHT					
surface run off harvesting					

VIII. Expenditure

40. How much you spent and amount of purchase for different expenses at the HH level (hint: June, 2010 - June 2011) E.C.

Expenditures	Did you purchase and spent money for the last 12 months? (1= yes, 0=no)	If yes, put codes (1= for numbers, 2= in kinds, 3= in quintals &4= for services)	rank amount purchased and expenses in the last 12 months (1=high, 2= less, & Otherwise=0)	Expense for the last 12 months in birr
1.Education				
2.Transport				
3.Healthy services				
4.Food consumption				
Nursery/seedlings, seeds				
Livestock				
sheep and goat				

Ix. Questionnaires for the FGD

1. What are the main food crops, farm animals and tree species that are currently exist in your kebeles?
2. What agricultural inputs used to increase food production and where did the communities get these inputs?
3. What are the main practices that exist in the community at the small holder farmers' level
4. What interventions practiced to conserve the environment and manage natural resources (soil and water conservation measure) communities at the kebele level?
5. How can you explain the role of women (gender balance) land ownership in participation of agro ecological farming practices in these kebeles?
6. What environmental problems very common that hinders farming the community in the kebeles? (Please put in order of the severity) 1. Soil erosion 2. Deforestation 3. Climate change 4. Land degradation 5. Water pollution 6. Specify other if any _____.
7. What technologies and innovation trainings provided by the Government to promote agro ecological farming practices for the small holder farmers?
8. What kind of petty trade and means of income generating agricultural off farm activities in the kebele?
9. What is the source of seedlings for tree plantation in the communities?
10. How can you categorize the income level of farmers (poor, medium and rich) in these kebels?
11. What is the main indicator criteria used for these categorizations
12. What pros and cons exist in the communities in these kebeles?
13. What are the main challenges faced to practice AE farming practices in these kebeles?
14. What opportunities to encourage the participation of farmers in agro-ecological farming practices in the communities?
15. What do you think the main solutions that promote the practices of agro ecological farming in these kebeles?

X. Annexes: Questionnaires for the KII

1. How do you explain the overall existing trends, awareness and indigenous knowledge level of small holder farmer in agro ecological farming practices?
2. How do you explain the adoption and coping mechanisms at the small holder farmers' level?
3. Do you think that the ecology of Banja woreda is suitable for the agro ecological based farming practices?
4. What are locally effective and accepted agro-ecological farming technologies that improve food security at household level?
5. Do you think that the existing land tenure and land use policy, especially ADLI (Agricultural development lead industrialization) benefited small holder farmer for the intervention of agro-ecological farming practices for the last 10 years? (1. Agree 2. Disagree. If not agree would you please explain the reason why? ----------
6. What are the main environmental friendly exotic/indigenous trees species available in the area?
7. Is there any disaster risk for the last three years regarding on problem of climate change?
8. What development practitioners (NGO, Research institutes...) supported small holder farmers in areas of agricultural farming practices, and environmental conservation?
9. What affordable agricultural inputs are available in the area?