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ADAPTATION PRACTICES OF SMALLHOLDER FARMERS TO CLIMATE CHANGE IN ANKOBER WOREDA NORTH SHEWA, ETHIOPIA

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As a supervisor/co-adviser of the thesis, we certify that we have read and evaluated the thesis prepared by Tewodros Berhane Gebrehiwot entitled 'Adaptation practices of smallholder farmers to climate change in Ankober Woreda North Shewa, Ethiopia' and recommend for Open Defence as fulfilling the requirements for the degree of **Master of Science in Food Security and Development.**

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Declaration

This thesis is my original work and has not been presented for MA/MSc degree in any other University and that all the sources and materials used for the thesis have been properly acknowledged

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Contents Pages

List of Table

Acronyms and Abbreviations

CC	Climate Central
CCL	Climate Change Lobby
CGIAR	Consultative Group on International Agricultural Research
CIMMYT	Spanish: Centro International de Maiz Y Trigo (International Maize and Wheat Improvement Center)
CRGE	Climate Resilience Green Economy
CSA	Central Statistical Agency
DFID	Department for International Development
ECRC	Environment and Climate Research Center
FAO	Food and Agricultural Organization
GHG	Greenhouse Gas
GIS	Geographic Information System
ICARDA	International Center for Agricultural Research In the Dry Areas
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IPCC	Intergovernmental Panel on Climate Change
MNL	Multinomial Logit
MRS	Marginal Rate of Substitution
UNFCCC	United Nations Framework Convention on Climate Change:
USGCRP	United States Global Change Research Program
WFP	World Food Programme

ABSTRACT

Climate change is rapidly emerging as a global critical development issue affecting many sectors in the world and considered to be one of the most serious threat to sustainable development. Adaptation to climate change involves changes in agricultural management practices in response to changes in climate conditions. This study was done to investigate the contributions of different climate change adaptation strategies to increase food production by evaluating indigenous knowledge and emerging climate change adaptation strategies among smallholder farmers in Ankober woreda. Random sampling method was used to select a sample of 150 smallholder farmers. Structured questionnaires and participatory rural appraisal approach were the techniques used to collect data.

The method of data analysis was both qualitative and quantitative where descriptive statistics was used to analyses the objectives. The study identified various indigenous knowledge and emerging adaptation strategies and evaluated institutional and socio-economic and factors influencing the choice of these strategies. Terracing and mulching were the most common indigenous and emerging strategies respectively. Farmer's organization, extension services, and access to information were dynamic in assisting adaptation of reasonable handling strategies which improves small holder's food production and consequently food security. The common farmer's adaptation strategies in the study area were growing a variety of crops, feed preservation, time of planting, rearing different breeds of cattle and soil fertility management. Different adaptation strategies have been practiced both at individual and group level. Communities in the study area have developed indigenous knowledge of agricultural adaptation strategies to cope with climate variability and extreme events. Adaptations outside of agriculture are also important for livelihood diversification and increasing resilience to climate variability in study area. Government, research institutions and stakeholder need to provide climate change information to farmers through training and extension services. Research, trainings and extension on climate change issues should be provided by both the public and private sectors as they are crucial in ensuring farmers adapt to climate change. Investments in infrastructure such as roads and irrigation systems, affordable credit schemes, and climate information systems would help create the enabling conditions for adaptation to climate change. Experience with these strategies needs to be shared among communities to assure adaptation practices.

Key Words: *Adaptation practice, Climate change, Food Security, Smallholder farmers.*

CHAPTER ONE

BACKGROUND OF THE STUDY

1.1 Introduction

Climate change is distinguished as one of the most challenging and complex problem facing the agricultural improvement globally. However, the impact of climate change on this sector in Africa is more than any other socioeconomic activities. (FAO 2012).Climate change mitigation and adaptation have become influential response strategies to climate changes. Particularly, adaptation to climate change has been carried out both separately as well as being policy driven. In this regard diverse adaptation strategies have been practiced both at individual and group level. The production of crop yield in Africa will decrease up 50% due to climate change. Climate change has emerged as one of the defining scientific, political and socioeconomic issues of the twenty-first century. Due to of its complexity climate change, has attracted diverse efforts covering the full spectrum of scientific, economic, social, and political disciplines. Anita et al. (2010) argues that the major aim in this climate change debate is to identify options for reducing the extent and effects of future climate change of great importance is the need to reduce the effects of climate change on agriculture

Agriculture, rural livelihoods, sustainable management of natural resources and food security are inextricably linked within the development and climate change challenges of the twenty-first century. Indeed, not only is food security an explicit concern under climate change; successful adaptation and mitigation responses in agriculture can only be achieved within the ecologic, economic and social sustainability goals set forth by the World Food Summit, the Millennium Development Goals and the UNFCCC. (FAO 2012).

Climate change is very likely to affect food security at the global, regional, and local level. Climate change can disrupt food availability, reduce access to food, and affect food quality. For example, projected increases in temperatures, changes in precipitation patterns, changes in extreme weather events, and reductions in water availability may all result in reduced agricultural productivity. Increases in the frequency and severity extreme weather events can also interrupt food delivery, and resulting spikes in food prices after extreme events are

expected to be more frequent in the future. Increasing temperatures can contribute to spoilage and contamination. USGCRP (2016).

kulasuriya et al. (2003) have explained, climate change can affect agriculture in three different ways. First, changes in temperature and precipitation can directly affect crop production and can even alter the distribution of agro-ecological zones. Second, runoff or water availability is critical in determining the impact of climate change on crop production. Lastly, agricultural losses can result from climate variability and the increased frequency of changes in temperatures and precipitation (including droughts and floods). Through these effects, climate change can lead to erosion of the developments that people have in the past made in response effects of climate change on agriculture. Agarwal *et al.* (1997) note that climate change has resulted in some loses in biodiversity of domesticated crops as well as of dry land management and water harvesting techniques. Yet, in times of disaster and climate change people's defense lie in diversity of cultivated crops and their varieties of wild plant. Other defense mechanisms are migration, irrigation, water conservation techniques and reclamation. USGCRP (2016)

Combined, all these factors imply that climate change has the potential of enhancing the problems of food insecurity, with important implications on availability, accessibility and utilization of food items. The negative potential effects of climate change suggest the importance of integrating climate change adaptation strategies to agricultural policies. It is important to promote strategies which maintain or increase the resilience of farming systems. Effective integration of adaptation and mitigation may result in lower overall cost of food production. USGCRP (2016)

The effects of climate change vary from region to region. In particular the risk in Ethiopia becomes more severe than any other country owing to the fact that Ethiopia's economy is dependent on rained agriculture. Booming the agricultural production at the national level leads to improve overall economic growth and development. In this regard, smallholder farmers in developing countries lose their agricultural production due to climate change impacts. The frequent droughts experienced over the last three decades and the recent impacts of El Niño in East African countries in general and Ethiopia in particular, made millions of people food insecure is the result of climate change.

However, there has been little research done on evaluation of the climate change adaptation strategies and their effect on food production in Ethiopia in general and Ankober woreda in particular. The issues of climate change and food security need to be addressed and documented and relating to agricultural and livestock practices the livestock population in the study area.

1.2 Statement of the Problem

Ethiopian economy largely depends on agriculture and like other parts of the world has been experiencing pronounced climatic changes since long time ago. Since North Shewa specifically Ankober woreda's agriculture is mostly rain fed, the pattern of food production has been declining and rapidly tending towards food insecurity as noted by Berhanu (2001), Tilaye (2004) and FAO, (2016) report. Climate change and food insecurity have negatively affected livelihood of smallholder farmers in the area. However, farmers in the Woereda is believed to have adaptation strategies to counter the effects of changing climatic patterns. These strategies should be investigated and evaluated for their robustness.

The smallholder farm families in the study area face an urgent need to establish livelihoods resilient to impacts of climate change. It will be difficult, if not impossible, to eradicate poverty and end hunger without building resilience to climate change in smallholder agriculture through the well-planned adaptation through sustainable land, water, fisheries and forestry management practices.

There is an urgent need to scale up adaptation actions to reduce key vulnerabilities of smallholder farming systems to climate change risks, and assess and implement the options for enhancing resilience through sustainable intensification, diversification and risk management strategies. The costs of inaction exceed by far the cost of interventions that would make smallholder farming systems resilient, sustainable and more prosperous.

Most ecological and social systems have built-in adaptive capacity. However, the current climate variability and rapid rate of climate change are imposing new pressures that have the potential to overwhelm existing coping capacity. The indigenous knowledge of farmers, forest-dependent people can be a valuable entry point for localized adaptation. This means recognizing the advantage and capitalizing on locally adapted crop, livestock, farming systems, soil, water and nutrient management and agroforestry systems. Nevertheless, in efforts to address complex and long-term problems caused by changing climate, indigenous knowledge often needs to be complemented by scientific know-how.

1.3 General Objective of the Study

1.3.1 General Objective

To investigate the contributions of different climate change adaptation strategies to increase food production by evaluating indigenous and emerging climate change adaptation strategies among smallholder farmers in Ankober woreda.

1.3.2 Specific Objectives

1) To identify indigenous knowledge climate change coping strategies currently in use among smallholder farmers and constraints faced by the farmers and opportunities in using the various techniques.
2) Identify and evaluate climate change adaptation strategies that are developed by smallholder farmers in Ankober woreda since 2005.
3) To evaluate institutional and socio-economic factors influencing the choice of climate change adaptation strategies and practices by smallholder farmers.

1.4 **Research Questions**

1) What are the indigenous climate change adaptation strategies currently in use by smallholder farmers in Ankober Woreda?
2) What socioeconomic factors influence the choice of climate change adaptation strategies by smallholder farmers?
3) Which emerging climate change adaptation strategies (after 2000) are in use by smallholder farmers in Ankober Woreda?
4) What institutional factors influence the choice of climate change adaptation strategies by smallholder farmers?

1.5 Limitation of the Study

In the course of the research, several problems were presumed. In this regard, there was a problem with getting up-to-date literature and official Government documents, some of which are classified. Second, the research was highly dependent on the accessibility and willingness of experts and key actors responding to questionnaires and in-depth interviews. Third, the space, time and resource allotted for carrying out the research was another challenge.

1.6 Scope of the study

The climate change adaptation practices incorporates the community-based adaptation approach, which is a locally driven process of designing and implementing adaptation actions through assessments of indigenous knowledge and emerging practices, and further screening and investigation of possible adaptation strategies in a participatory manner. This study involved relevant stakeholders from different spheres, with inclusive local representation, especially of the most vulnerable stakeholder farmers in the area. The research aims to empower communities to plan for, and cope with, the impacts of climate change.

1.6 Significance of the study

It is believed that the results of the study would contribute the effort to improve the climate change adaptation and practices generally in Ethiopia and specifically in Ankober Woreda. The study, therefore, fills the gap in the existing knowledge in relation to Climate change adaptation practices thereby provides new information in the study of food security in relation to Climate change. Furthermore, it may help other researchers in undertaking further investigation in relation to the issue of Climate change adaptation practices.

1.7 Organization of the Study

The study consists of five major chapters. The first chapter is an introductory part of the study (i.e., introduction, statement of problem, objectives, specific objective, research questions, significance of the study, Scope or Limitation of the Study). Chapter two deals with conceptual framework and literature review. Chapter three touches methodology approaches for carrying out the study. Chapter four emphasized on the climate change adaptation and practices results and discussions from the case study. The last chapter provides with conclusion and recommendations.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Climate Change

According to a FAO (2002) study, about 800 million people in the developing world do not have sufficient to consume. Another 41 million people in the developed countries and countries in transition like Ethiopia also suffer from chronic food insecurity. A massive amount of water is needed to generate food. But what matter is whether the world will be able to produce sufficient food is associated with many uncertainties as noted by Bryant *et al*. (2000). Associated to the impact of climate change on food manufacturing the ongoing changes in climate and the resultant raise in harsh weather factors, and needed continual adaptation of agricultural production strategies and practices. However, as Droogers (2003) has noted, coping with extremes of climate variability remain very difficult within the context of food production.

2.2 Impact of Climate Change on Agriculture

Climate change may affect agriculture through changes in temperature and precipitation, soil moisture and soil fertility, length of growing season and an increased prospect of tremendous climatic conditions. There is general agreement as noted by IPCC (2001) that climate change may lead to decrease agricultural productivity in under developing countries. Rosenzweig *et al.* (1994) have examined world food supply, food prices and the number of people at risk from hunger in developing countries. These studies have found that whilst developed countries are likely to experience some increase in agricultural output, developing countries suffer a decrease in the scenarios which were constructed.

There have of course been criticisms of the Rosenzweig studies, from those who feel the predicted yield losses are too large, as noted by Reilly *et al.* (1994) and to others who have suggested that not enough attention was paid to the likelihood of adaptation by farmers. The IPCC (2001) however, has accepted the likelihood that agricultural productivity will decrease, even as a result of small temperature increases and has suggested that a mean global temperature increase of 2.5ºC would lead to an increase in food prices.

2.3 Agricultural adaptation strategies to climate change and agriculture

Adapting to climate change entails taking the right measures to reduce the negative effects of climate change (or exploit the positive ones) by making the appropriate adjustments and changes. The Intergovernmental Panel on Climate Change (2007) defines adaptation as adjustments in natural or human systems in response to actual or expected climatic stimuli or effects, which moderates harm or exploits beneficial opportunities. It also refers to actions that people, countries, and societies take to adjust to climate change that has occurred. Adaptation has three possible objectives: to reduce exposure to the risk of damage; to develop the capacity to cope with unavoidable damages; and to take advantage of new opportunities (IPCC, 1998).

Climate has obvious and direct effects on agriculture and agricultural production and Greenhouse gas (GHG) implications of agriculture is enormous as explained by Bryant *et al*. (2000). Concerns about mitigating and adapting to climate change are renovating the drive for investments in agricultural research and other innovation concerns on adaptation strategies. This explains why in the coming years, the expansion and successful transmission of new agricultural practices and technologies will largely shape how and how well farmers mitigate and adapt to climate change.

Often, the most binding constraints in small holder farming occur at the adaptation stage, with several factors potentially impeding smallholder farmer's access to and use of emerging adaptation strategies. These include static, poorly functioning or poorly integrated input and output markets; poor infrastructure; inadequate and ineffective public extension systems; lack of credit and insurance markets. Burton (1997), explains that in recent years, the climate implications of agricultural production and practices have broadened the agricultural agenda to include responses to climate change issues. Agricultural adaptation to climate change is a complex, multidimensional and multi scale process that takes a number of forms which identifies four main components of adaptation: characteristic of the climatic stress, characteristic of the system, multiple scale and adaptive response.

2.3.1 Characteristic of Climatic Change Stress

Climatic stress includes climate signals (climate change and variability) as well as other drivers such as economic conditions, population growth, and government policies. Smit *et al*. (1996) point out that the important question that arises in the literature of climate change is whether farmers adapt their behavior in response to short-term climate variability or long-term climate change.

Some researchers argue that adaptation to short term climate variability may facilitate adaptation to long-term climate change as explained by Burton, (1997). However, Smit *et al*. (1997) notes that some adaptations taken in response to short- term climate variation may not be well suited to long term climate change. Thus, there is need to anticipate long term changes and make appropriate adjustments in addition to coping with current climate conditions.

2.3.2 Characteristic of Agricultural Production System

Bryant *et al*. (2000) explains that agricultural production system characteristics include its sensitivity, resilience, vulnerability, adaptive capacity, and other factors influencing its response to stressors. Other factors include the socioeconomic, cultural, political and institutional characteristics, which can either facilitate or hinder the adaptation process. 2.7 Agricultural Adaptation Strategies for Climate Change. Travis *et al*. (2010) indicate that the core challenge of climate change adaptation in agriculture is to produce more food and more profitably even under more volatile production conditions.

2.3.3 Exploring the Use of Seasonal Forecasts

Timely seasonal forecasts have the potential to help both governments and the local people cope with climate variability. Smallholder farmers could greatly benefit from seasonal forecasts in a number of ways. For example, knowing in advance whether the rainfall will be normal, below or above average could help them chose the right crops varieties, adjust their cropping practices or take other necessary measures like soil and water conservation strategies to maximize benefits or minimize losses as explained by Rao *et al.* (2005). As farmers and other stakeholder deals with changes in climate and more variability in weather, history becomes a less reliable guide. There is need for improvement to weather forecasts and interpretations. McCarthy *et al*. (2001) argues that long-term climate change is likely to exacerbate both the frequency and magnitude of extreme climatic events in Africa. This means that seasonal climate forecasts should have a more important role to play in the future.

Serigne *et al.* (2006) argues that one of the reasons why African farmers are reluctant to adapt to improved strategies such as high-yielding crop varieties and use of inorganic fertilizers is that they do not want to invest their scarce resources without knowing whether the rains will be adequate or not. Seasonal forecasting can significantly reduce these uncertainties. Seasonal climate forecasting could play a major role in climate change adaptation in the future, but before that happens, more research is needed to produce forecasts that are tailored

to the needs of local farmers by and effectively interpret and communicate forecasts outputs to various stakeholders.

2.3.4 Improved Crop Varieties and New Breeds of Livestock

Serigne *et al.* (2006) explains that drought is likely to be the biggest obstacle to the achievement of food security in Sub –Saharan Africa. There is a clear need to develop; test and release new crop varieties and livestock breeds that would be adapted to the changing climatic and ecological conditions of Sub- Saharan Africa.

2.4 Vulnerability to Climate Variability

Blaikie (1994) describes vulnerability as the characteristics of a person or a group to anticipate, copes, resists and recovers from the impact of a natural hazard. Vulnerability also represents the ability of, or not to modify the impacts of disaster and the means to cushion risks. On a national level, vulnerability manifests itself in poorer countries due to a lack of resources and capacity to respond. Blaike (1994) also explains that at the farm level house hold income, gender, number of children, age, level of education and access to information all determine vulnerability. Climate change researchers define vulnerability as a function of exposure, sensitivity and adaptive capacity IPCC (2001).

The term "exposure" addresses the incidence of climate impacts, that is, the degree to which actors are in the "firing line" of climate change impacts. The term sensitivity in turn addresses the capacity of actors to be wounded by climate change. Finally, IPCC (2001) describes term "adaptive capacity" or "resilience" addresses the ability of actors to shield them and to recover from adverse climate change impacts. The ability to adapt and cope with weather hazards firstly, depends on economic resources, infrastructure, technology, and social safety nets as noted by IPCC (1995). Smallholder farmers often do not have the resources for coping or adapting to weather hazards and thus are ill-prepared in dealing with them. Secondly, for many farmers, climate change is only one of the many environment problems they confront. IPCC (2001), shows that many of smallholder farmers already being under pressure from high population growth, rural to urban migration, marketing challenges and poverty.

2.5 Recovery from Adverse Impacts of Climate Change

Poorer communities also have limited means to cope with the losses and damage inflicted by natural disasters. IPCC (2007) explains that lack of insurance, savings or credit make it almost impossible to replace or compensate for the numerous assets lost or destroyed, including houses, livestock, food reserves, household items and tools. Poor farmers also risk losing crops when there is rain as crops ripen for harvest. In the longer term, poor households also risk losing wage opportunities as the disaster destroys the need for labor. Recovery strategies, like selling assets, can leave the poor without future income and thus more vulnerable. These effects contribute to long-term vulnerability leaving people more at risk to the next disaster.

2.6 Climate Change Impacts on Food Security

Climate change may affect agriculture through changes in temperature and precipitation, soil moisture and soil fertility, length of growing season and an increased probability of extreme climatic conditions. There is general agreement as noted by IPCC (2001) that climate change may lead to significant reductions in agricultural productivity in developing countries. Rosenzweig *et al.* (1994) have examined world food supply, food prices and the number of people at risk from hunger in developing countries. These studies have found that whilst developed countries are likely to experience some increase in agricultural output, developing countries suffer a decrease in the scenarios which were constructed, as noted by Reilly *et al.* (1994) and to others who have suggested that not enough attention was paid to the likelihood of adaptation by farmers. The IPCC (2001) however, has accepted the likelihood that agricultural productivity will decrease, even as a result of small temperature increases and has suggested that a mean global temperature increase of 2.5ºC would lead to an increase in food prices.

Crop varieties and livestock breeds that are resistant to drought, pests and diseases will improve smallholder farmer's ability to adapt to climate change. It is in this context that research partnerships have been built around organizations such the International Maize and Wheat Improvement Centre (CIMMYT) and the International Crops Research Institute for the

Semi-Arid Tropics (ICRISAT), both supported by the Consultative Group on International Agricultural Research (CGIAR). The emergence of these improved crop varieties and livestock has been a gigantic step forward in the development of appropriate technologies for the smallholder farming sector. While hybrid seeds and mineral fertilizer technologies have significantly boosted large scale commercial maize production, they have largely by-passed the majority of subsistence farmers in the region, who are normally cut, off from the market and credit systems.

2.7 Soil and Water Management

In the midst of increasing urban and environmental demands on soils and water, agriculture must improve soil and water use efficiency. Adding climate change to this mix only intensifies the demands on soil and water use in agriculture. CIMMYT (2004) explains that since water resources in Africa are likely to become increasingly scarce as a result of climate change, strategies that combine the improvement of soil fertility and the harvesting, storage and efficient use of water will be necessary to build resilient agricultural systems. Soil and water conservation techniques such as terracing and mulching, can significantly improve the water holding capacity of soils and mitigate the negative effects of dry spells.

Conservation tillage has the potential to improve soil fertility, reduce erosion and enhance the water use efficiency of crops as explained by Kaumbutho et al. (1999). In the semiarid regions of South Africa, for instance, sorghum producers have found a way of maintaining high yield levels by combining weed control in the off season and cultivation to store water in the sandy soils with the use of high yielding varieties and moderate to high levels of fertilization.

2.8 Agro Forestry and Improved Fallows

Agro forestry as noted by Sanchez (2000) is emerging as a promising climate change adaptation strategy to improve and sustain agricultural productivity and also to enhance rural income. Growing multipurpose tree and shrub species with crops and/or animals can provide additional benefits, like fodder for animals and wind breaks. Kwesiga *et al*. (2003) explains that products and services provided by agro forestry include the improvement of soil fertility, the provision of animal fodder; the creation of a favorable micro-climate for crops, reducing temperature stress; and fruits and wood for fuel and construction.

Kwesiga, *et al*. (2003) explains that improved fallow is without question one of the most promising strategies to improve soil fertility, control erosion and enhance the water holding capacity of soils. In this agro forestry system, fast leguminous trees or shrubs (these species fix nitrogen from the atmosphere and recycle it in the system) are rotated with maize to improve yields of the cereal crops in Sub- Saharan Africa. Another technology that has been tested along with improved fallows to enhance land productivity in smallholder's farms in Southern Africa is biomass transfer.

2.9 Theoretical Framework

vulnerability assessments (O'Brien et al. 2004; Fu¨ssel and Klein 2006), are usually conducted at a global scale or at broad regional scales (Kunstmann and Jung 2005; Parry et al. 2005; Molua 2008; La¨derach 2011; Sarr 2012). In order to isolate the effect of climate change, most other factors are assumed to be constant.

These impact studies provide important information on how long-term change in climatic norms is likely to affect yields and food production (Lobell et al. 2008; Thornton et al. 2011). In sub-Saharan Africa, such research has suggested that overall, East Africa will experience wetter weather and Southeast Africa will become drier (Kotir 2011). Changes in rainfall patterns are expected to result in loss of cropland (Niang et al. 2014; Kotir 2011). Crop yields in most of sub-Saharan Africa are estimated to fall by at least 10–20 % by 2050 (Kotir 2011; Thornton et al. 2011). Arid and semiarid regions of the continent are expected to expand. In West Africa, it is expected that rainfall will be more variable and less predictable, which will reduce the length of the growing season. By 2050, West African yields could drop by 20–50 % (Sarr 2012).

Some scenario-based production impact studies also include hypothetical adaptation strategies in order to help understand how certain broad adaptations, such as the selection of crop varieties, might affect the estimated climate change impacts on food production (Parry et al. 2005; Crespo et al. 2011). In these analyses, theoretical adaptations are introduced in order to estimate the degree to which impacts might be moderated by widespread adjustments in crops or land use. For instance, assuming the amount of irrigated land in sub-Saharan Africa were doubled by 2050 (keeping total crop area constant), cereal production would increase by 5 % (Calzadilla et al. 2010). Other research has shown that aggregated mean crop yields are expected to decrease by 6–24 % in sub-Saharan Africa, depending on the climate scenario and the type of crop management (e.g., single cropping vs. sequential cropping) used by farmers (Waha et al. 2013).

The main question addressed in climate scenario impact studies is ‘‘How much would food production change in an average year if temperature and precipitation norms differed from the current and everything else stayed the same, or if crop selection and land use were changed to match the predicted climate regime?’’. They mostly deal with long-term temperature and precipitation norms and rarely address the interannual variability and extremes to which farmers are particularly sensitive (Smit and Pilifosova 2003; Berrang-Ford et al. 2011). The impact models do not investigate the practical feasibility of adaptations, the conditions that might facilitate or impede adoption of adaptive strategies, or the actual types of adaptations employed (Adger and Kelly 1999). Furthermore, this research conceptualizes climate change as the main driver for impacts on the human system. The approach does not substantially address how climate change interacts with other stressors, how these interactions affect people, and how people can and do behave.

Climate change impact studies of food production provide initial estimates into one aspect of food availability, but they are not designed to address the other aspects of food security, namely food access and food utilization. The implications for human well-being fall outside the scope of this work, and the consequences of climate change on human livelihoods are not explicitly analyzed.

The importance of situating climate change impacts as part of a multitude of stressors that can affect people, including their food security, has been recognized (Adger 2006; Smit and Wandel 2006; Tschakert 2007). This issue draws on the fields of poverty, vulnerability, and livelihoods in order to explicitly consider the experience of people in the analyses. This inquiries attempts to understand and document the nature of the vulnerability of a human system (e.g., a household, a community, a society, a region, or a sector) to climatic and other stresses (e.g., socioeconomic, political, biophysical) by identifying the processes through which people experience and respond to climate change. These analyses, sometimes called ‘‘bottom-up’’ or ‘‘starting point’’ vulnerability approaches, tend to be local in scale, empirical, and use ethnographic and participatory research approaches (O’Brien et al. 2004; Fu¨ssel and Klein 2006).

Vulnerability directly assesses adaptation by seeking to understand who or what adapts, to what stimuli, and how it occurs. The goal is to understand the adaptation process: how people have

adapted to past changes, and what changes or conditions are relevant and can provide insight into how they will adapt in the future. Adjei-Nsiah et al. (2010) show that in Wenchi, Ghana, farmers consider poor rainfall distribution and frequent droughts as the most important climate-related changes. They are adapting to these changes by planting early-maturing and/or drought-resistant crops, planting early, and using agrochemicals. In South Africa and Ethiopia, farmers have noticed increases in temperature and a decrease in rainfall. Yet, a large proportion of the farmers in both countries did not undertake any adaptive measures (Bryan et al. 2009). Farmers named shortage of land (Ethiopia) and lack of access to credit (South Africa) as the main barriers to adaptation (Bryan et al. 2009). Other documents the stressors to which people adapt. In northern Burkina Faso, farmers mentioned land scarcity and new market opportunities, rather than a changing climate, as the main reasons for changing their farming practices. They adapted by using micro-water harvesting techniques, storing hay and sorghum residues to feed livestock, and have adopted dry season vegetable production (Barbier et al. 2009).

Many regions in sub-Saharan Africa are heavily constrained by their limited social, political, and technical resources, which already affect their ability to cope with issues of scarcity and poverty. These constraints also hamper their ability to cope with changing environmental conditions (Downing et al. 1997; Westerhoff and Smit 2009). Community-based studies have provided insights into the various stresses that affect people and their livelihoods. In KwaZulu-Natal, South Africa, Reid and Vogel (2006) found that the multiple daily stresses in people's lives combined to increase their vulnerability to future climate change, and weak organizational support limited adaptation. Bunce et al. (2010) found that climate is an important livelihood stressor for people in Mozambique and Tanzania, and policy (and therefore institutions) is a key stressor that interacts with climate to increase people's vulnerability. In Senegal, climate change interacts with rural unemployment, poor health, and inadequate infrastructure to increase people's vulnerability (Tschakert 2007).

Climate change vulnerability studies have also been used to provide insight into how food security might be affected by climate change. In the Afram Plains region of Ghana, farmers are noticing delays in the onset of the rainy season, mid-season heat waves, and high-intensity rains that cause flooding, resulting in crop loss and low yields, and reducing the availability of household food (Codjoe and Owusu 2011). Flooding is also destroying local roads, leading to difficulty in transporting foodstuffs.

The work on climate change vulnerability and adaptation relates to food security and sustainable livelihoods through the recognition that climate change is one of numerous stressors acting upon people's livelihoods and that people's capacity to achieve food security is influenced by a variety of economic, institutional, and social conditions. In building their livelihoods and ensuring their food security, people respond to a variety of stresses, of which climate-related forces may not be the most pressing. The vulnerability work also indicates that food security involves more than food production alone.

2.10 Conceptual Framework

The vulnerability context frames the external environment in which people exists. People's livelihood and the wider availability of wealth are fundamentally affected by critical trends as well as by shocks and seasonality over which they have limited or no control. Shocks can destroy wealth directly in case of floods, drought and storm.

They can also force people to abandon their home area and dispose assets such as land, livestock and produce prematurely as part of the adaptation strategy. Trends may be dangerous, though they are more predictable. They have a particular important influence on rates of return and economics to chosen livelihood strategies. Seasonal shifts in prices, employment opportunities and food availability are one of the greatest and most enduring sources of hardship for poor people in developing countries.

The dependent variable in the empirical estimation will be the choice of an adaptation option from a set of adaptation strategies. The explanatory variables for this study includes household characteristics such as education, sex, age of the household head, household size, farm and non-farm income and livestock ownership; institutional factors such as access to information, access to credit and group membership. The interaction between dependent variables and explanatory variables are illustrated in figure1.

Human interference through activities can emit greenhouse gases into the atmosphere leading to climate change. Adaptation strategies through policy responses can result into positive outcomes of increased food production as the smallholder famers need to adapt to these climate changes. Effective adaptation mechanism coupled with policy responses lead to

outcome of increased food production, livelihood diversification, increased farm income, soil and water conservation and reduced pest and disease infections.

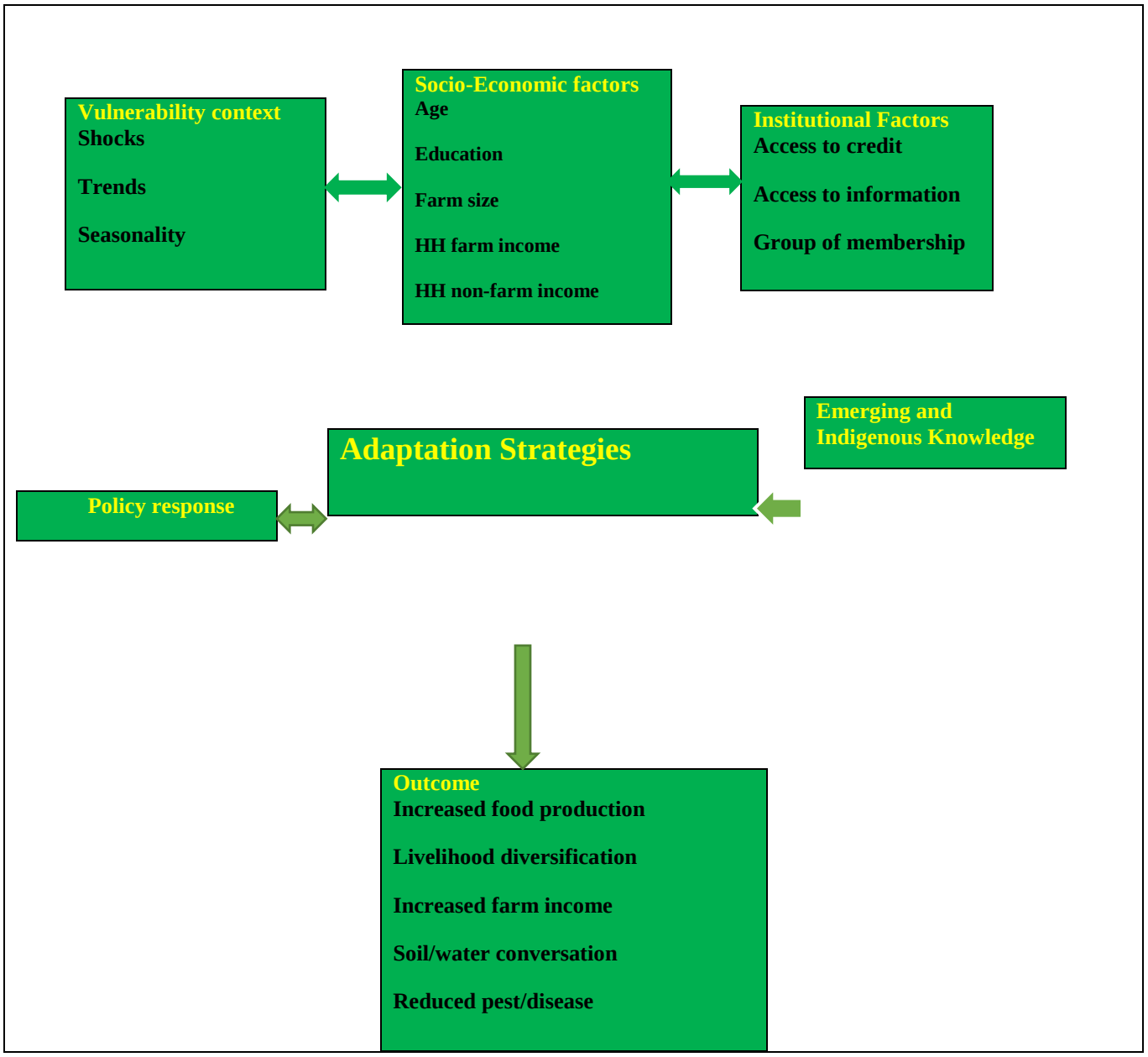

Figure 1: Conceptual framework: Source - Modified from Knutsson, DFID Livelihood, (2006).

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Description of Study Area

Ankober is one of the woredas in the Amhara Regional state of Ethiopia. Located at the eastern edge of the Ethiopian highlands in the Semien Shewa Zone, Ankober is bordered on the south by Asagirt, on the west by Basona Werana, on the north by Tarmaber woredas respectively and on the east by the Afar Region. Towns in Ankober include Haramba, Gordo, Aliyu Amba, Ankober and its Geographic coordinates (absolute location) of Ankober degree of latitudinal and longitudinal location (DMS) is from 9°35'46.5"N to 39°43'56.7"E and its elevation is 2884 meter above sea level.

Based on the 2013 population projection by the (CSA) Central statistical Agency of Ethiopia, this woreda has a total population of 83,285 of which 42,173 are men and 41,112 women. CSA 2013

With an area of 672.80 square kilometers, Ankober has a population density of 113.72, which is less than the Zone average of 115.3 persons per square kilometer. A total of 18,274 households were counted in this wordea, resulting in an average of 4.19 persons to a household, and 17,633 housing units. The majority of the inhabitants practiced Orthodox Church, with 92.73% reporting that as their religion, while 7.15% of the population said they were Muslim. Clay soils of different colors are the major soil types accounting for about 70% of the total land mass of Ankober Woreda. The two dominant clay soils in the Woreda are brownish clay soils (31%) and greyish clay soils (28%). The second most dominant soil type in the area is black cotton soil which covers about 26% of the total land mass of the Woreda. Other soil types cover about 4% of the total area. Environmental Impact Assessment Report, (EIAR, 2011).

According to the data obtained from the meteorological agency, the temperature ranges from 80c to 300c. The annual average temperature of the Woreda is also about 20oc. The area is characterized by two rainy seasons, namely Belg (the shortest rainy season) and Meher (the main rainy season). During these two seasons, 65 percent of the area gets about 1,250mm of annual rainfall while 35 percent of the land gets 950mm of rain. However, the erratic nature of the rain, poor distribution and quantity could not allow the Woreda to raise sufficient crop production (Ankober Woreda Agricultural Development Office, 2013).

The population is dependent predominantly on rain fed agriculture and is known for its recurrent drought and considered as structurally food insecure area. The agricultural land holding of each household is also very small as the topography of the localities is dominantly characterized by hilly and undulated/rugged and mountainous features (Ankober Woreda Agricultural Development Office, 2013). The poor agricultural production is exacerbated by severe environmental degradation, erratic rainfall, poor infrastructure, etc.

Though farmers practice mixed farming, crop production is by far the main system to earn a living in the Woreda. Major crops grown in the Woreda include Teff, barley, millet, sorghum and maize. Although the Woreda is considered relatively better in moisture holding characteristics, it is not saved from the threats of drought and famine mainly due to the unreliable and erratic rainfall pattern (Ankober Woreda Agricultural Development Office, 2013).

Second to crop production, livestock production also plays a substantial role in the community's economy. Apart from providing food and draught power, livestock selling is one of the coping mechanisms of households at times of drought (Ankober Woreda Agricultural Development Office, 2013).

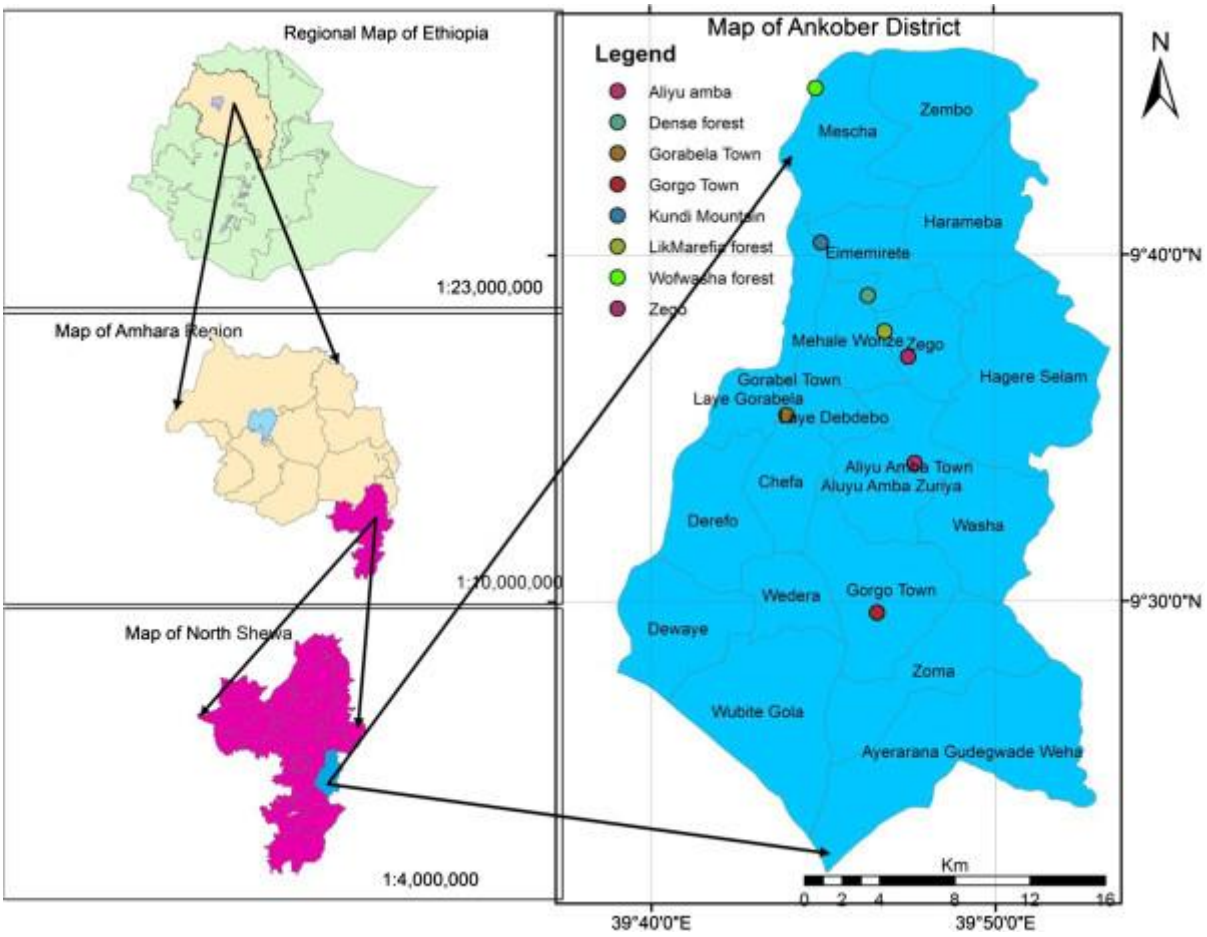

Figure 2: Map of the study area (Own construction from Arc GIS version 10.1)

3.2 Research Design and Approach

The study employed descriptive survey design which is a scientific method involves observing and describing the behavior of a subject without influencing it in any way using both qualitative and quantitative approaches. Using this design, the investigator measured the variables and described the situation as it was at a particular point in time. This design, therefore, enabled the researcher to assess farmer's climate change adaptation practices.

a, **Data Sources**

1) **Review of secondary data** includes review of documents related to the study. including reports and documents produced by different organizations WFP, FAO, ILRI, CICAF, IPCC, CCL, CC and other local and international organizations related to climate change adaptation practices are viewed.
2) **Household Survey Questionnaire** The survey questionnaire included a total of three sections, many of which were designed to gather information on

background household members including on demographics, education, health, and occupation, as well as household well-being. climate change, extension services, institutional factors

3) **Key Informant Interview (KII)** – this was administered especially in-depth interviews conducted with experts in the areas or people that have ample information using purposive sampling techniques. 3-5 Key informants' interview was conducted with very knowledgeable individual in the area including model farmers, experts and others.
4) **Focus Group Discussions (FGDs**) – focus group discussions with different categories of had been conducted 3 FGD in the woreda. And discussed on Weather variability, Climate change, Indigenous climate change coping strategies, emerging climate change adaptation strategies and so on.

3.3 Sampling Technique

The population of the study was consisting of all smallholder farmers in Ankober woreda. Purposive sampling was used to select agro ecological zones in the woreda, households. Systematic sampling is a type of probability sampling method in which sample members from a larger population are selected according to a random starting point but with a fixed, periodic interval (the sampling interval). Using sampling interval method 150 randomly selected from 3 kebeles such as Lay Gorebela (Dega), Aliyu Amba (Temperate) and Washa (Lowland). The second stage was employed systematic random sampling to select proportional number of farmers from each of the kebele. Systematic random sampling was used to select respondents from a list of Ministry of Agriculture.

3.4 Sample Size Determination

The sample size was determined using statistical formula for a population size (N) that is greater than or equal to 10,000 recommended by Kothari (2004).

Determination of the sample size was based on the formula given by Kothari, (2004)

$$n = \frac{pqZ^2}{E^2}$$ …… equation 1

Where; **n** is the sample size, **Z** is confidence level 95% (Z=1.96), p is the proportion of the population of interest, smallholder farmers in the study area p= 50%. Variable q is the

weighting variable and this is computed as (1 – p) and e is an acceptable error (e=5%). P is set to 0.5 since statistically, a proportion of 0.5 results in a sufficient and reliable size particularly when the population proportion is not known with certainty. This led to q (1- 0.5) = 0.5. None response rate of 10% the sample size is n=**150**

I.e. n= z $(1.96)^2$) p (0.5) q (1-0.5) / e (0.08^2)

n= z (3.8416) * p (0.5) * q (0.5) / e (0.0064)

n=150 *10% = 15

n=150+15= 165

3.5 Data Collection

The study was used both primary and secondary data. Primary data collected by use of questionnaires and a checklist. Structured questionnaire was employed in the individual interviews and data was collected by use of a checklist. This was also employed in two steps. Firstly, model smallholder farmers and agriculture experts in focal groups was asked to identify and categorize indigenous and emerging climate change adaptation strategies which is currently in place in the study area. Secondly, by evaluating these strategies using a checklist.

3.6 Data Analysis and Analytical Framework

Based on the collected data qualitative and quantitative data analysis techniques were used to analyze the data. In this regard, Exploratory, descriptive, analytical and critical methods of data analysis were employed to analyze the data collected. Data collected from the house hold survey through the close-ended questionnaire method was encoded, categorized and analyzed by the latest Statistical Package for the Social Sciences (SPSS version 20.1) software to produce required outputs from the survey**.**

Data collected from qualitative interviews analyzed through the following five steps. First, the data from the original form was transcribed from notes onto paper. Second, comes the checking and editing of the transcripts for further analysis. Third, data interpretation and analysis have been followed. This involves coding, data reduction, identifying trends in data, and developing categories. The fourth step is when the findings of the individual interviews are generalized and differences and similarities identified, allowing the development of typologies. The final step

was verification, which involves a process of checking validity of interpretations. This step helps to verify or modify hypotheses already arrived at previously.

Findings from the case studies used to establish and strengthen explanations on the theory and practice. The data collected from secondary sources are carefully analyzed, especially for the qualitative part of the report, and used to supplement the survey from the survey and interviews. Lastly, data from the aforementioned research methods, namely surveys, observation, case studies and desk research are interpreted and summarized, taking the research questions and study objective into account, relevant findings drawn.

The specific objectives are analyzed using descriptive statistics. This involves the use of percentages, tables, graphs and means to describe the indigenous and emerging climate change adaptation strategies, and Multinomial Logit (MNL) model used to evaluate the socioeconomic and institutional factors that influences the choice of indigenous and modern coping strategies by smallholder farmers. This also used to analyze the determinants of farmer's choice of adaptation strategy in the study areas. Kurukulasuriya *et al*. (2008) and Nhemachena *et al*. (2007) noted that this method could also be used to analyze crop and livestock choices to adapt to the negative impacts of climate change. The advantage of MNL is that it permits the analysis of decisions across more than two categories, allowing the determination of choice probabilities for different categories as explained by Woodridge (2002) and it is also computationally simple Tse, (1987).

To describe MNL model, let y denote a random variable taking the values (1, 2,…,j) for j, a positive integer, and let x denote a set of conditioning variables. In this case, y denotes adaptation category and x contains different socioeconomic and institutional attributes. The question is how other factors remaining constant, changes in the element x affect the response probabilities (P (y = j/x), = 1, 2,….,j. Since the probabilities must sum up to unity, P(y=j/x) is determined once we know the probabilities for j = 2,..,j. Let x be a 1 x k vector with first element unity. The MNL model has response probabilities:

$$P\left(y=\frac{j}{x}\right)=\frac{\exp(x\beta j)}{[\,1+\sum_{h=1}^{j}\exp(x\beta_{h,j=1,\ldots..j}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textit{equation 2}$$

Unbiased and consistent parameter estimates of the MNL model in equation 2 required the assumption of independence of irrelevant alternative (IIA) to hold. More specifically, the IIA assumption requires that the probability of using a certain adaptation method by a given

household needs to be independent from the probability of choosing another method (that is P_jP_k is independent of the remaining probabilities). The premise of the IIA assumption is the independent and homoscedastic disturbance terms of the basic model in equation 1. The parameter estimates of the MNL model provide only the direction of the effect of the independence variables on the dependent (response) variable. Differentiating equation 1 with respect to the explanatory variable provides marginal effects of the explanatory variables given.

$$\frac{\partial P_j}{\partial X_k} = P_j\left(\beta_{jk} - \sum_{j=1}^{j-1} Pj\beta_{jk}\right) \quad \text{.....equation 3}$$

The structural form can be reduced to the form:

$Y_i = \alpha + \beta_1$age $+\beta_2$educ.$+\beta_3$far sze$+\beta_4$hhinc.$+\beta_5$hhnn far inc$+\beta_6$acc to credt$+\beta_7$exte ser. β_8 train + $\beta_9$gpmesp + β_{10}Acc inf. ……..equation 4

Where:

Y_i are the climate change adaptation strategies that are currently being used to deal with climate change and others are institutional and socio economics factors.

The marginal effects or marginal probabilities are functions of the probability itself and measure the expected change in probability of a particular choice being made with respect to a unit change in an independent variable from the mean (Green, 2000). The variables, measurements and hypothesis that are going to enter the model are shown in Table 1.

Table 1: Description of variables used in the MNL model and their expected signs

Variable	Description	Unit of measurement	Expected sign
Age	Family head's age	Years	+/-
Children	Number of children in the farm family	Number in age categories	+/-
Sex	Gender of the farm family head	1= male, 0= female	+/-
Experience	Farm family head's years experience in farming	Years	+
Education	Number of years of education attained by the farmer (from primary to secondary)	Years	+
Land size	Number of acres owned by household	Number in acres category	+
Income	Total amount of farm and non-farm income	Birr	+
Group membership	Farmer belonging to a group	Number of groups in which he or she is active	+
Training	Trainings being offered to the farmer and lengths of training	Number of trainings attended by farmer	+
Extension services	Extension services being offered to the farmer	Number of visits by extension officers	+
Information	Farmer access to information	Number of times farmer receives Information	+
Credit	Farmer access to credit facilities	Birr	+
Climate Change	Farmer's perception of the Expected climate situation.	1=increased, 2=no change, 3=decreased	+, 0 -

3.7 The Assumptions and Hypothesis

3.7.1 Socio-economic Factors

Socioeconomic factors affecting adaptation of climate change strategies are those experiences that help shape one's personality, attitude and lifestyle. These factors, can also define region and neighborhood. According to Elizabeth *et al.* (2009) socio economic factors include the following:

- Level of education
- Gender of household head
- Age of the household head

- Household head
- Farm size
- Farm and non-farm income

3.7.2 Institutional Factors

Institutional factors affecting adaptation of climate change strategies. These are Structures that have attained high degree of resilience. Scots (2001) notes that social structures are composed of cultural, cognitive, normative and regulative elements that together with associated activities and resources provide stability and meaning to social life. They include the following

- Extension, Training and Access to Information
- Access to Credit
- Group Membership

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter presents findings from the study and this is divided into five sections. The first section presents clarifications in the study site. The second section shows descriptive results on household characteristics. The third section presents results on smallholder farmer's indigenous climate change strategies, which were strategies the farmers have been using. They were categorized into two groups; crops and livestock strategies. The fourth section presents farmer's choice of emerging crop and livestock climate change adaptation strategies which were farmers have been using. Finally, the fifth section presents the Multinomial Logit results on socioeconomic and institutional factors hypothesized to influence adaptation of climate change strategies.

4.1 Awareness of weather and climate

Smallholder farmers in the study area had various awareness on weather and climate. While they found it hard to explain weather and climate phenomenon but they understood changing regular weather parameters like rainfall and temperature.

4.1.1Climate Change

Majority of farmers in the study area agreed that climate is changing due to variability of rainfall and temperature. Those who strongly agreed were 48.7% while 45.3% agreed that climate is indeed changing. Only 9% were undecided. No farmer strongly disagreed to the notion that climate is changing.

Table 2: Climate is changing due to variability of rainfall and temperature

Alternative		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	73	48.7	48.7	48.7
	Somewhat agree	68	45.3	45.3	94.0
	I Don't Know	9	6.0	6.0	100.0
	Total	150	100.0	100.0	

4.1.2 Environment is changing due to human activities

An overwhelming majority of farmers in the study site observed that environment is changing due to human activities, those who strongly agreed were 28.7% while 58% agreed. Only 9.3% and 4% were undecided and disagreed respectively. This showed that farmers had started relating human activities such as deforestation, overexploitation, desertification, invasive species, pollution, and overharvesting. This means that people can have control over the environment if they change their actions.

Table 3: The environment is changing due to human activities

	Alternative	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	43	28.7	28.7	28.7
	Somewhat agree	87	58.0	58.0	86.7
	I Don't Know	14	9.3	9.3	96.0
	Somewhat disagree	6	4.0	4.0	100.0
	Total	150	100.0	100.0	

Source: SPSS –Version 20.1

4.1.3 Rising Temperature

Most of the farmers, 27.3 % and 53.3% strongly agreed and agreed respectively that temperature is rising. Those who were undecided are 18.0% while 1.3% disagreed that temperature is rising. Farmer's perception was subjective as they related wilting of crops, drying of streams and rivers, sweating and outbreak of diseases like malaria as signs of rising temperature.

Table 4: Rising Temperature

	Alternative	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	41	27.3	27.3	27.3
	Somewhat agree	80	53.3	53.3	80.7
	I Don't Know	27	18.0	18.0	98.7
	Somewhat disagree	2	1.3	1.3	100.0
	Total	150	100.0	100.0	

Source: SPSS –Version 20.1

4.1.4 Decreasing Rainfall

An overwhelming percentage of smallholder farmers in the study area, 34.7% and 59.3% of strongly agree and agreed respectively that rainfall amount is decreasing. Their perception was due to drying up of streams and rivers and unpredictability and unreliability of rainfall pattern in the study site. Only 4.0% and 2.0% of farmers were undecided and disagreed respectively that rainfall was decreasing.

Table 5: Rainfall is decreasing every year

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	52	34.7	34.7	34.7
	Somewhat agree	89	59.3	59.3	94.0
	I Don't Know	6	4.0	4.0	98.0
	Somewhat disagree	3	2.0	2.0	100.0
	Total	150	100.0	100.0	

Source: SPSS –Version 20.1

4.2 Descriptive Results of climate change adaptation strategy of Smallholder Farmers in the Study Area.

Crop/Livestock adaptation strategies that are currently being used by smallholder farmers to deal with climate change and some alternative strategies are listed below. Farmers practices most of the crop/livestock strategy refereed as 'Adapters' where as farmers who practices limited activities or not implement any strategy refereed as 'Non adapters'.

Characteristics that can be measured quantitatively are presented using t – test of difference while those that are ordinal were subjected to chi – square.

4.2.1 Household Characteristics of Farmers

Table 6: Socioeconomic characteristics of farmer

Characteristic	**Mean**		**Overall**	**t-ratio**	**Probability**
	Adapters	**Non-adapters**			
Age	40.28	51.60	41.70	-3.549***	0.001
Number of children	3.72	6.60	4.1	-3.906***	0.000
Education (years)	13.83	12.85	13.70	1.471	0.143
Land size	4.06	5.29	4.22	-1.66	0.245
Experience(Years)	13.40	20.00	14.28	-3.031***	0.003
Income (ETB)	22423.32	284717.05	228995.82	-1.053	0.294
Extension(Contacts)	1.21	0.100	1.06	1.946*	0.054
Training(Contacts)	2.44	2.75	2.48	-0.366	0.715
Credit	32976.92	16500.00	30780.00	1.245	0.215

***** Significant at 1%; and * significant at 10 %**

Results show that adapters of climate change strategy in age were significantly ($t = -3.49$, $p \leq 0.001$) younger than non-adapters. The mean number of children per household was also found statistically significantly different between adopter and non-adopter households, ($t = -3.906$, $p \leq 0.000$), with adapters having fewer children compared to non- adapters. Farming experience was statistically significant ($t = -3.031$, $p \leq 0.003$), indicating that the longer the experience of farming the less the adaptation. Extension services were statistically significant
($t = 1.946$, $p \leq 0.054$), indicating that adapters had more extension service contacts than the non-adapters.

4.2.2 Categorical characteristics of the smallholder farmers

Table 7: Categorical characteristics of the smallholder farmers

Characteristic	Category	Percentage			Chi-square	Probability
		Adapters	Non-adapters	overall		
Sex	Male	74.62	80.00	75.33		
	Female	25.38	20.00	24.67		
	Total	86.67	13.33	100	0.270	0.603
Group Membership	Yes	62.3	45.00	64.7		
	No	37.7	55.00	40.0		
	Total	86.67	13.33	100	2.163	0.141

For the farmers who adapted the strategy, 74.62% were males while 25.38% were females while for non- adapters, 80% were males while 20% were females. In terms of group membership, 62.3% of the adapters of climate change adaptation strategy belong to a farmer group while 37.7% were not in farmer groups. Among the non-adapters the strategy, 45% were in farmer groups while 55.00% do not belong to a farmer group.

4.2.3 Practices of emerging crop adaptation strategies to adapt climate change

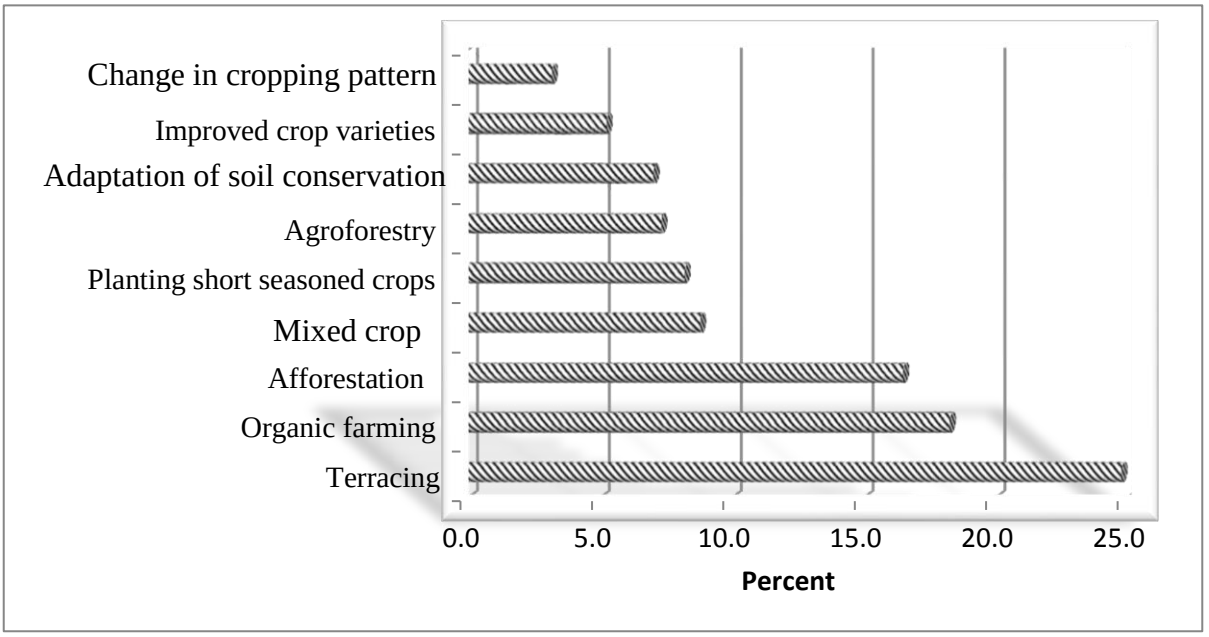

Figure 3: Practices of emerging crop adaptation strategies

Terracing was the most common emerging crop adaptation strategy with 25.1 % of farmers choosing it. This has been due to terrace farming prevents the washing away of soil nutrients by the rainfall, farmers considered one of the most successful techniques for conserving soil and water during cultivation on steep slopes. 18.0 % of small holder farmers used organic farming as a strategy, farmers were sharing their experience on how to make organic manure using locally available materials by Farmer organization/Cooperative.

Farmers who used afforestation as strategy were 17.5 %. This was because afforestation is highly used to maintain biodiversity and ecological balances and to prevent global warming, soil erosion and pollution. Mixed crop was selected by 9.0% of farmers alleviating against climate change. Planting short seasoned crops were selected by 8.5%. Agroforestry strategies were selected by 7.0%. Adaptation of soil conservation was chosen by 6.8 % of the farmers. Planting improved crop varieties and Change in cropping pattern strategies were chosen by 5.3 % and 3.3% respectively by farmers in the study area.

4.2.4 Emerging Livestock Adaptation Strategies to adapt climate change

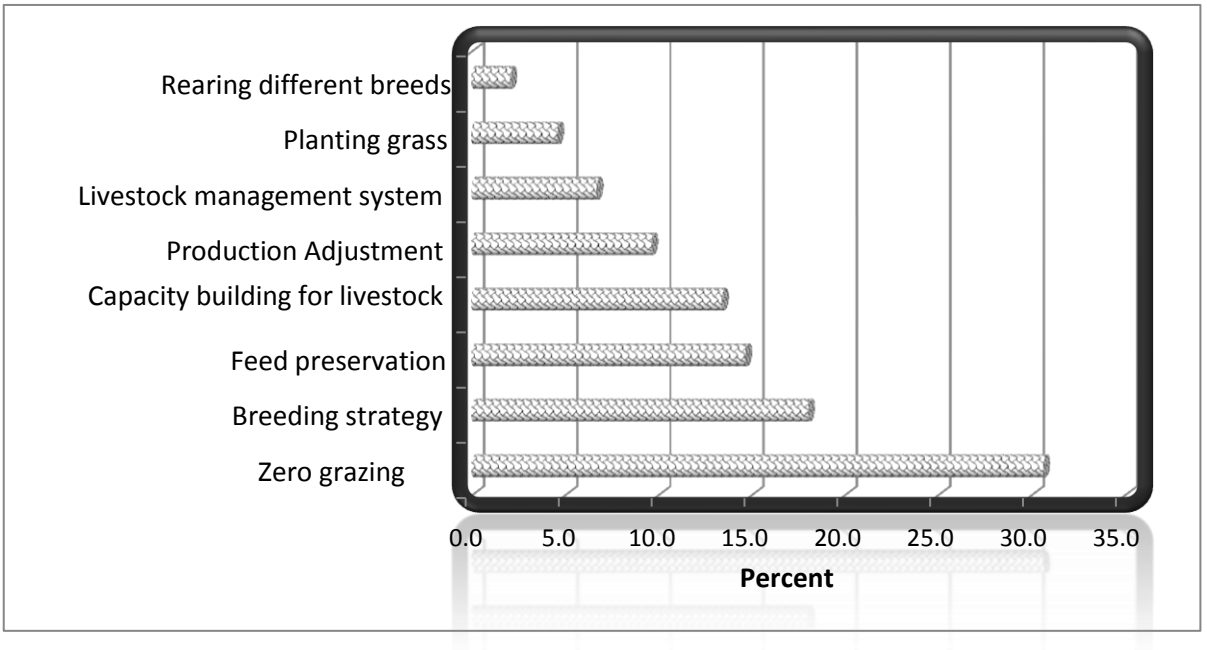

Figure 4: Emerging Livestock Adaptation Strategies

29.5 % of farmers were practices zero grazing as emerging livestock adaptation strategy. Breeding strategy was practiced by 17.4 % of smallholder farmers in the study area. This was because of NGOs like ICARDA, encourages fair use, sharing and distribution of this information

for noncommercial production and breeding strategies and practices of sheep farming communities. Feed preservation strategy was selected by 13.9% of farmers. Capacity building for livestock were selected by 13.4% of farmers and because farmer organization improving their knowledge and skills. Production Adjustment were selected by 9.8 % of farmers. Livestock management system were selected by 8.7% of farmers keep track of their livestock from birth all the way to sale. Planting new grass and rearing different breeds were emerging livestock adaptation strategies in 4.8 % and 3.8 % of farmers.

4.2.5 Practices of Indigenous knowledge of cropping strategies to adapt climate change

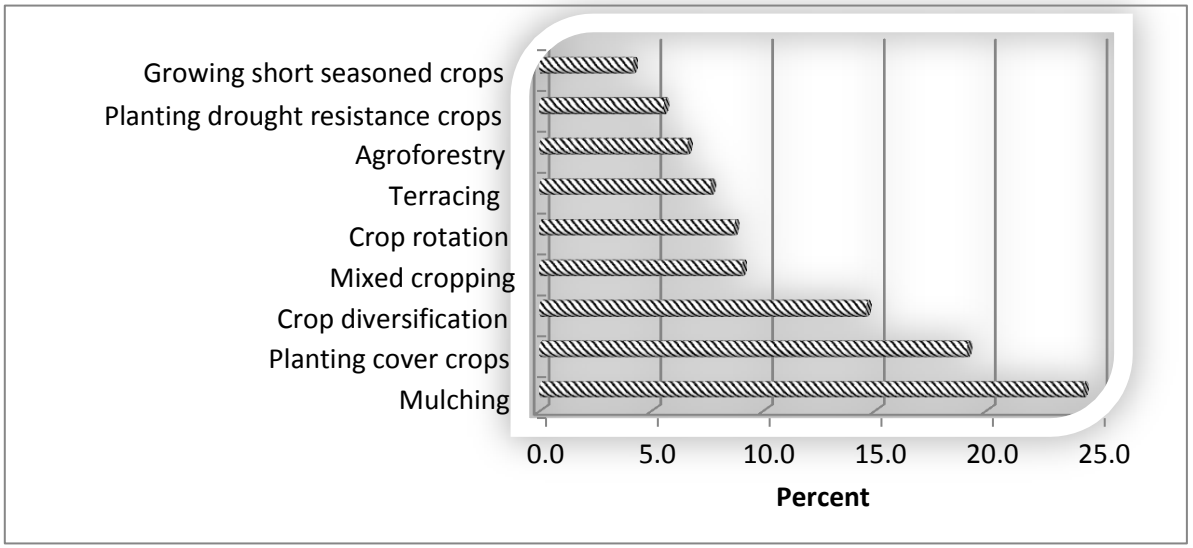

Figure 5: Crop adaptation strategies

From the result, 24.8 % of smallholder's used mulching as a strategy to retain moisture in the soil, keep the soil cool and organic mulches help to improve the soil's fertility, as decompose. Mulching materials as they were locally accessible and most of them have local awareness on how to practice the strategy. Planting cover crops was the second strategy and was used by 19.1 % of farmers. Crop diversification was used as a strategy by 14.4% of the smallholder farmers, Crop diversification can serve as insurance against rainfall variability. This was because of availability of diversities of crops. Mixed coring involves growing two or more crops in proximity in the same field. Crops like peas, beans and sorghum was practiced by 9.1%. Crop rotation, terracing, agroforestry, planting drought resistant crops, and growing short seasoned crops strategies were at 8.7%, 7.7%, 6.6%, 5.6% and 4.2% respectively.

4.2.6 Practices of indigenous knowledge of livestock Strategies to adapt climate change and variability

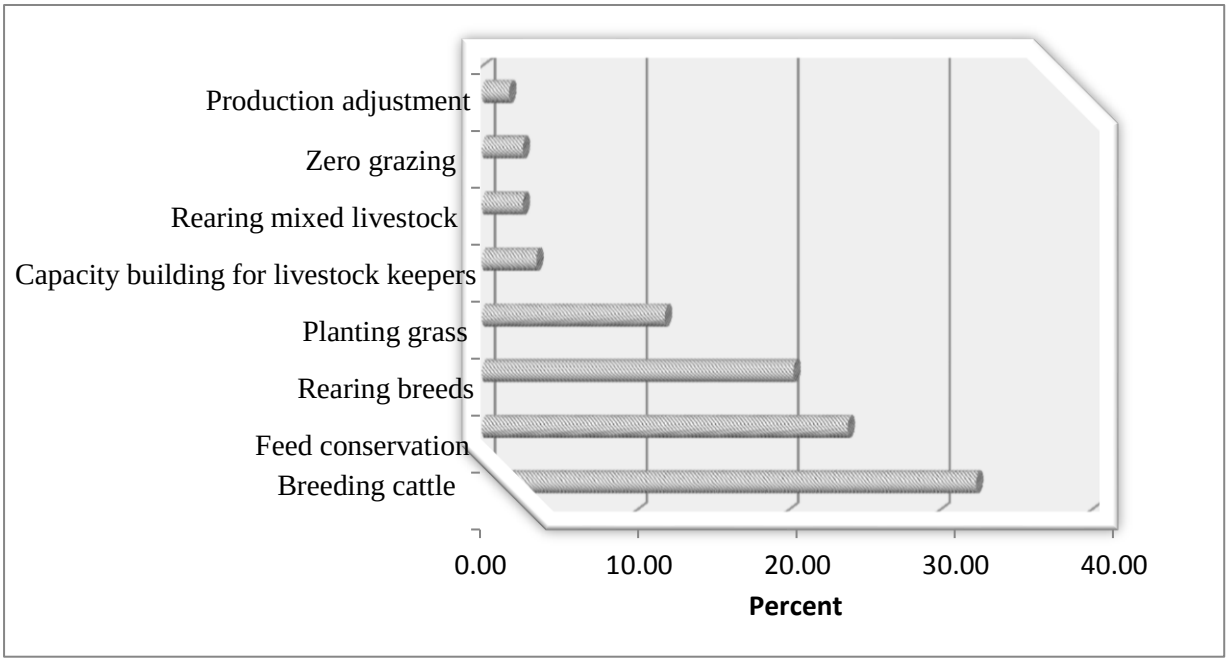

Figure 6: Practices of livestock adaptation strategies

Breeding was done by 33.74 % of farmers as a strategy of improving breeds so as to increase productivity. This was done by experienced experts with organization from public officers from department of veterinary services in the woreda. Livestock feeds were articulated and preserved as a livestock adaptation strategy by 22.64 % of farmers which they did during satisfactory climatic situations to be utilized during severe climatic situations. Farmers were qualified by extension officers on how to use locally accessible materials during feed preparation and preservation. Rearing breeds, planting grass, Capacity building for livestock keepers, Rearing mixed livestock, zero grazing and Production adjustment strategies were 18.05%, 12.57%, 5.68%, 4.68 and 3.57 % respectively.

Smallholder farmers in Ankober woreda rear livestock because the area is more suitable for growing crops. This was the reason that farmers did not adapt to any emerging livestock adaptation strategy. Feed preservation strategy, zero grazing practiced by smallholder farmers in the study area. This was because of low acreage of farms owned by these farmers. Breeds were kept by smallholder farmers due to their high productivity compared with indigenous cattle. Planting new varieties of grass and rearing different breeds were emerging livestock adaptation strategies of farmers.

4.3 Factors Affecting Climate Change Adaptation Strategies

The factors affecting adaptation of climate change strategies were divided into socioeconomic and institutional factors.

4.3.1 Socio Economic Factors

Age: For most of the adaptation strategies, age did not significantly increase or decrease the probability of adaptation of climate change strategies. There was both positive and negative relationships between increase in age and adaptation strategy.

Sex: Male headed households were more likely to adapt to soil fertility strategies than female headed households. This was consistent with Tenga *et al*. (2004) who maintained that having female headed household may have negative effects on adaptation of soil and water conservation strategies, because women may have limited access to information, land, and other resources due to traditional barriers.

Education: Norris (1987) argues that higher level of education was believed to be associated with access to information on climate change strategies and higher productivity. Evidence from various sources indicates that there was a positive relationship between the education level of the household head and improved adaptation strategies as noted by Igoden *et al.* (1990) and adaptation to climate change (Madison, (2006). Education of the head of household growths the possibility of adapting to climate change strategies. A unit increase in one level of education would result to a decrease of 7.05 % in adaptation of soil fertility strategy. This was opposing to anticipation where higher level of education was believed to be positively related to adaptation to climate change.

Number of children: Increasing household size did not significantly increase or decrease the likelihood of adaptation to climate change strategies.

Land size: a unit increase in land property had a positive and significant impact to adaptation of crop varieties strategies. Growing of different crop varieties require more land.

Farming experience: Farming experience had both positive and negative relationship on adaptation to climate change strategies. This was consistent with both Kebede *et al.* (1990) and Shiferaw (1998) .A unit increase in one year of farming experience results in an increase by 0.59% and 0.64% in breeds of cattle and no adaptation strategies respectively while a unit

increase in one year of farming experience results in an decrease by 1.10%, 0.76% and 0.47% in time of planting, soil fertility and feed preservation strategies respectively.

Income: Farm and non-farm income and livestock ownership represents wealth. The study hypothesized that adaptation of climate change strategies requires sufficient financial wellbeing. Farmers with high incomes have more access to information on climate change and could easily afford various climate change strategies. For most of the adaptation strategies, income did not significantly increase or decrease the likelihood of adaptation of climate change strategies. Though it was expected that higher income would significantly increase the adaptation strategy as indicated by Franzel, (1999) this was not the case in the study area.

4.3.2 Institutional Factors

Group membership: Group membership had a significant and positive impact on the likelihood of using time of planting strategy. This meant that farmers in groups planted their crops in specific times as they did this in groups.

Extension: Access to extension services had significant and positive impact on crop varieties, breeds of cattle and feed preservation adaptation strategies and significant and negative impact on no adaptation strategy. A unit increase in 1 extension contact to farmers increased the likelihood of adaptation of crop varieties, breeds of cattle and feed preservation strategies. This result implies the important role extension services in promoting the use of adaptation strategies. This was consistent with Yirga (2007) which reported a positive relationship between access to information through extension and adaptation strategy.

Credit: Availability of credit eases the cash constraints and allows farmers to buy purchased inputs such as fertilizer, improved crop varieties and irrigation facilities. Access to credit has a negative and significant impact on the likelihood of using no adaptation strategy of climate change. A unit increase in access to credit decreases the probability of no adaptation strategy by 0.80%. Availability of credit eases the cash constraints and allows farmers to purchased improved crop varieties, breeds of cattle, and plant timely, purchase facilities for soil fertility management and feed preservation. Research on adaptation of climate change strategies as explained in Yirga (2007) showed that there was a positive relationship between the level of adaptation of climate change strategies and availability of credit. This result implies the

important role of increased institutional support in promoting the use of adaptation of climate change strategies.

Training: Training on crop and livestock production and information on climate represent access to information required to make the decision to adapt to climate change. Training had a significant and positive impact on adaptation of time of planting, soil fertility and no adaptation strategies. A unit increase in 1 of training contacts increased the probability of adaptation to time of planting, soil fertility and no adaptation by 5.00%, 3.54% and 2.41% respectively. Training had a significantly and negative impact on adaptation of crop varieties and breeds of cattle strategies by 6.94% and 5.93 %. Training of farmers may have been geared towards growing specific varieties of crops and rearing specific breed of cattle.

Table 8: Multinomial logit result of climate change strategies

Explanatory variables	Crop Varieties		Time of Planting		Breeds of cattle		Soil Fertility		Feed Preservation		No Adaptation	
	Coeff.	P-level	Coeff.	Pvalue	Coeff.	Pvalue	Coeff.	Pvalue	Coeff.	Pvalue	Coeff.	Pvalue
Sex	-0.1225	0.212	-0.0187	0.823	0.0356	0.445	0.0788*	0.067	0.0088	0.934	0.0280	0.371
Age	0.0709	0.551	-0.1109	0.406	-0.0092	0.905	0.0685	0.423	-0.0827	0.614	0.0434	0.492
Number of Children	-0.0444	0.106	0.0205	0.346	-0.0134	0.369	-0.0050	0.727	0.0275	0.344	0.0146	0.129
Education	0.0706	0.289	-0.0268	0.630	0.0322	0.350	-0.0705*	0.060	-0.0102	0.883	0.0049	0.853
Experience	0.0110	0.125	-0.0110*	0.096	0.0059*	0.089	-0.0076*	0.089	-0.0047*	0.047	0.0064*	0.063
Land Size	0.0208*	0.064	-0.0081	0.438	0.0057	0.346	-0.0127	0.277	-0.0078	0.547	0.0021	0.621
Income	-0.0386	0.370	0.0401	0.303	-0.0113	0.608	0.0011	0.964	0.0354	0.452	-0.0266	0.128
Extension	0.0661***	0.004	-0.0379	0.129	0.0304**	0.010	-0.0233	0.181	0.0100*	0.089	-0.0453***	0.005
Training	-0.0694*	0.091	0.0500**	0.035	-0.0593***	0.003	0.0354**	0.037	0.0193	0.567	0.0241*	0.068
Group Membership	0.0677	0.501	0.1449*	0.087	-0.1215	0.103	-0.0171	0.768	0.0033	0.977	-0.0707	0.161
Credit	-0.0036	0.723	0.0088	0.321	0.0018	0.700	-0.0029	0.620	0.0039	0.726	-0.0080*	0.079

Notes: *, **, * = significant at 1%, 5%, and 10% probability level, respectively**

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Agriculture is the economic mainstay in most African countries, except in oil-exporting countries, contributing 20-30% of Africa's gross domestic product (GDP) and 55% of the total value of African exports, with 70% of the continent's population depending on the sector for their livelihood (Organization for Economic Cooperation and Development (OECD), 2009). In most African countries, crop farming is mainly subsistence and rain-fed, but due to climate change frequent and untimely raining affects harvest of produce and thus, food production. This makes Africa particularly vulnerable to the impacts of climate change. The vulnerability of the region is further worsened by the fact that the climate is already too hot as it is tropical in nature. Climate change was a new phenomenon in the study area though smallholder farmer's opinion of climate change was that temperatures were rising while level of precipitation was declining.

Those who did not use any of the methods considered lack of information on adaptation methods and lack of money as major constraints to adaptation. The smallholder farmers in the study area were predominantly crop growers. Climate change had adversely affected production of teff, maize, beans, sorghum, peas which were their common crops and in terms of maturity period (maize and beans), drought tolerance (maize and sorghum), input requirements (cereals and legumes) and end users of the product (e.g. maize as food and sunflower for cash).

The major finding of the research has been a general lack of sharing knowledge and experience, expertise and data on climate change issues; a lack of specific climate change institutions to take on climate change work and the need for a better institutional framework in which to implement adaptation. Actions to address these gaps include: training programmes for local government officials, dedicated research activities and the initiation of specific institutional frameworks for climate change. Proactive adaptation can improve capacities to cope with climate change by taking climate change into account in long term decision-making, removing disincentives for changing behavior in response to climate change (removing subsidies for maladaptive activities), and introducing incentives to modify behavior in response to climate change (use of market-based mechanisms to promote adaptive responses). Furthermore,

improving and strengthening human capital, through education, outreach, and extension services, improves decision-making capacity at every level and increases the collective capacity to adapt.

Different strategies recognized for both crop and livestock production. Famers keep the remains of maize and other crops on top of the soil as the mulch breaks down, it provides material that keeps the soil from getting hard. This improves the growth of roots and increases the movement of water through the soil and also mulching materials were cheap, locally available and most farmers had local knowledge on how to use the strategy. Planting cover crops, crop diversification, mixed cropping, crop rotation and terracing were some of the other indigenous crop strategies. Breeding was the most common livestock strategy. The cross breeds produced more milk compared to local breeds and were also disease resistant and manageable in terms of feeds compared to pure breeds. Feed preservation, rearing mixed livestock and planting grass were other indigenous livestock strategies.

Terracing, organic farming, afforestation/tree planting, mixed crop, planting short season crop, agroforestry, adaptation of soil conservation are some of the emerging crop adaptation strategies. Zero grazing, breeding strategy, feed preservation, capacity building for livestock, production adjustment are some of the common emerging livestock adaptation strategies.

Furthermore, access to credit was found to be a very important factor in assisting household's adaptation to the adverse effects of climate change. Households with more livestock are likely to adapt to climate change since these resources enable them to adopt other means of agricultural livelihoods than households without or with few resources at their disposal. Households with increased access to information on climate change and adaptation techniques through access to extension services were likely to adapt climate change adaptation strategies. However, the study revealed that households realizing already higher farm incomes have lesser incentives to adapt to newer ways of farming since their current farm practices might already be optimum. This means that if the available methods and technologies offer no better incentives, farmers are not willing to adopt them. The findings underscore the importance of improving farmer’s access to resources such as information and better technologies that would enable them to realize optimum benefits in their mitigation efforts to climate change.

There is need for farmers to have access to financial resources to increase adaptation to climate change. Policies aiming at promoting farm level adaptation must improve households' access to affordable lines of credit so that farmers may utilize adaptation techniques. Furthermore with access to financial resources households can purchase quality inputs on time. In addition the results also underpin the importance of access to information and extension services. Improved access to extension will increase household knowledge on climate conditions, the adaptation strategies and the benefits of adaptation techniques. Extension plays an important role in farmer adoption of technologies. There is therefore need to strengthen the existing extension service provision and also bring in the private sector on board.

5.2 Recommendations

Communities in the study area have developed traditional/indigenous agricultural adaptation strategies to cope with climate variability and extreme events. Experience with these strategies needs to be shared among communities. Strategies such as diversification of herds and incomes, practice of forest products induced crop failure, soil fertility enhancement techniques, soil moisture and water conservation practices, decentralization of governance of resources and the management of land use leading to land use adaptation. However, some of these techniques may need to be adjusted to face additional climate risks associated with climate change. Effective adaptation will involve greater access to information and assistance through extension services, trainings, access to information. Adaptation of different and suitable farm strategies necessitates knowledge and experience.

Techniques include: diversification of herds and incomes, use of forest products as a buffer against climate induced crop failure, soil fertility improvement techniques, soil moisture and water conservation practices, decentralization of governance of resources and the manipulation of land use leading to land use conversion. However, some of these techniques may need to be adjusted to face additional climate risks associated with climate change.

Government officials and NGOs such as Environment and Climate Research Center (ECRC) which develop domestic capacity on the economics of climate change and environment, thereby improve Ethiopia's longer-term capacity to deliver on the CRGE goals, . Can assist adaptation of the most favorable practices and technologies in some ways like increasing access to credit which can inspire the adaptation of practices and technologies that compromise multiple profits and enhanced output. Inspiring agricultural strengthening to avoid the expansion of cultivated

area, through investments in agriculture such as the provision of inputs, capacity development, and additional research and development would further facilitate the adaptation of climate change adaptation strategies.

Variation of income sources is a vital adaptation strategy that should be encouraged advance. This contain targeted efforts to widen income-generating prospects by generating chances for off-farm employment.

Main modifications within the agricultural structure may be necessary in order to keep livelihoods and ensure food security. Responses to climate change are essential to include livestock and crop adaptations, mutual achievement at the farmer's organization/cooperation and supportive practices, strategies and policies at national, regional, and global levels. Every major sector of the economy (water, agriculture, infrastructure/settlement, human health, transport, and energy) has specific options to adapt to climate change. In the water sector, essential strategies to implement adaptation measures are the storage of water, the expansion of rainwater harvesting, as well as the improvement of irrigation efficiency. To adapt in the health sector, improved climate-sensitive disease surveillance and control is needed. Adaptation in the transport sector include design standards and planning for roads, rail, and other infrastructure to cope with warming and drainage. Finally, the energy sector needs to reduce the dependence on single sources of energy. The adjustment of planting dates and crop variety is a core strategy in the agricultural sector. Piloting research on practice of crop diversities and livestock that are appropriate to drier situations and investing in irrigation would be better policy/strategy interventions.

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Ethiopian Population projection values of CSA 2013 at zonal and woreda level by urban and rural residence and by sex.

College of Developmental Studies
Center for Food Security

Appendix I

Focus Group Discussion

1. What are your understanding on the following concepts?
    a) Weather variability
    b) Climate change
    c) Indigenous knowledge climate change coping strategies
    d) Emerging climate change adaptation strategies
2. Discuss impacts of weather variability on your livelihood.
3. List and rank on livelihood areas where there is threat due to climate change.
4. Name crop and livestock diversifications brought about by climate change.
5. Name livelihood diversification brought about by climate change.
6. Name any emerging crop or livestock introduced due to climate change.
7. Describe how socio-economic factors have affected climate change adaptation strategies.
8. Describe how institutional factors have affected climate change adaptation strategies.
9. List challenges that you have faced while dealing with climate change.

Appendix ii

1. What are your understanding on the following concepts?
    a) Weather variability
    d) Climate change
    e) Indigenous knowledge climate change coping strategies
    f) Emerging climate change adaptation strategies
2. What are your perceptions of climate change in the study area?
3. Identify indigenous knowledges on climate change coping strategies in the study area in:
    a) Crop production
    b) Livestock production
4. Identify emerging climate change adaptation strategies in the study area.
    a) Crop production
    b) Livestock production
5. What are impacts of climate change on your livelihood?
6. List and rank on livelihood areas where there is threat due to climate change.
7. List and rank of perceived hindrances to adaptation of emerging climate change strategies.
8. Name crop and livestock diversifications brought about by climate change.
9. Describe how socio-economic factors have affected climate change adaptation strategies.
10. Describe how institutional factors have affected climate change adaptation strategies.
11. List challenges that you have faced while dealing with climate change.
12. List possible solutions of climate change challenges named abov

Appendix iii

Structured Questionnaire

Questionnaire No.

You are one among the residents in this area who have been selected for this study. The study seeks to understand the smallholder farmer's climate change adaptation implication to food security. The information you will give will therefore be strictly confidential.

Date… …

A. General Information

(A1) Geographical Location

District…… Kebele……

Village…… Agro-ecological zone ……

(A2) Respondent

i) Sex 1= Male 2= Female

ii) Are you originally from this Village 1. Yes □ 2. No □

iii). were you raised in this village? 1. Yes □ 2. No □

(**A3) Profile of the Head**

	sex	Marital status	Education level	Experience in farming
HH				

CODES for ------ Sex	Marital Status,	Education Level, 1=No	Experience in
1=male 2=female	1= Married, 2= Single	formal education 2=Primary level	farming 1= < 5
	3= Divorced	3=Secondary level 4=Tertiary	2= 5-10
	4= Separated,	level	3=10-15

	5= Widowed;		4= >15

Number of children (if any) ……

(**A4)Land Ownership**

	Size in hectare	**Approximate Value Per hectare**
1. Own		
2.Rented		
3. Leased		
4.Others (specify)		

(**A5) Land Use**

1. Land use, (specify)	**Size in hectare**	**Years in Same use**	**Rank : 1 for major**
2. Homestead			
3. Forest			
4. Crops			
5. Livestock			
6. Others (specify)			

(A6) Sources of income

		Rank
a	Livestock and livestock Products	
b	Crops	
c	Agro forestry products	
d	Off-farm employment	
e	Others, Specify…	

A7. The following questions for all crops produced in the last season

Crop	Seed costs	Fertilizer costs	Harvesting costs	Total labor Costs

Crop codes	8= cowpea leaves	15 =Avocado
1= beans	9 = maize(Dry)	16= Local vegetables
2= bananas	10 = Maize (Green)	17= onions
3=Watermelon	11 = sorghum	18= cassava
4= Soya beans	12= finger millet	19= sweet potatoes
5= Green peas	13=Tomatoes	20=groundnuts
6= pigeon peas	14 = mangoes	21= Oranges
7= sugarcane	15=Teff	24=Other(specify)------

A8. Ask the following questions for all livestock reared in the last season

Livestock	Input costs	Vet drugs Costs	Treatment costs	Total cost

Livestock codes

1. Dairy cattle 2. Beef cattle 3. Goats 4 Sheep 5. Poultry 6. Bees 7.Other (Specify) ……..

A9. Do you have any off-farm employment? 1 = Yes [ ] 2 = No [ ]

If yes what are they? (list) ----------

And what is the range of income per month from agricultural /Livestock

products? Through current price market

(1) =Less than 500.00 (2) = 500 – 1000.00 (3) = 1100 – 1300.00

(4) = 1300-2 000.00 5= > 2,000.00

A11. Does the family receive any remittances? 1= Yes [ ] 2 = No [ ]

A12. If yes, what is the average amount per month? _____

Section b. Institutional Factors

B1**) Who is the main service Provider of the following IF's?**

a) Crop production extension ☐

b) Livestock production extension ☐

c) Climate change information ☐

d) Marketing information ☐

Code: 1=Public extension agent 2= NGO
3=Neighbor/Farmer 4= Private extension

5=radio/Television 6=Mobile phone

7=Farmer organization/Cooperative

B2) For the last one year have you been visited by: 1. Yes 2. No

a) Public extension agent ☐

b) NGO ☐

c) Neighbor/Farmer ☐

d) Private extension ☐

e) Farmer organization/Cooperative ☐

C1**)** Do you belong to any group in your area?

1. Yes ☐ 2. No ☐

C2) If yes, fills the details in the table

Group type	No. of female members	No. of male members	Year started	Group activities	Meetings per month	Savings per month

C3. What benefits do you derive from membership in the groups?

1. Information on credit [ ] 2. Welfare [ ] 3 . Advice on farming [ ]

Others (specify) ----------

C4. What are your farming objectives? ----------

(D1) For the last one year have you attended any training on climate change adaptation?
1. Yes □ 2.No □

(D2) If yes, which of the following

1. Workshop/seminar □ 2. Field day □ 3. Group training □

(D3) Who normally attend such training? (Tick)

Head □ Spouse □ Daughter/son □ Worker □

(D4) Did you seek advice on climate change adaptation? 1. Yes □ 2. No □

(D5) Did you implement the advice? 1. Yes □ 2. No □

(D6) If no, why didn't you succeed? 1. Yes □ 2. No □

E, Extension services

E1.Have you ever received any form of extension services on climate change? Yes [ ] No [ ]

E2. How often do you meet with extension agents? 1. Weekly [ ] 2. Fortnightly [ ] 3.Once a month [ ] 4.Once in three months [ ] 5.Once in six months [ ] 6.Once a year [ ]

7. Others (Specify) ……..

E3. Do you express your views to the extension providers? Yes [ ] No [ ]

E4. Rank indigenous coping strategies that are currently being used to deal with climate change:

Crop	**Livestock**
1.	1.
2.	2.
3.	3.

E5. Rank emerging adaptation strategies that are being used to deal with climate change:

Crop	**Livestock**
1.	1.
2.	2.

3.	3.

E6. a) Have there been any diversification in crops/livestock as a strategy in dealing with climate Change? Yes [ ] No [ ]

b) If yes, name the diversifications c) If No, Why?

E7. a) Have there been any diversification in livelihoods as a strategy in dealing with climate change?

b) If yes, name the diversifications

c) If No, Why?

E8. a) Do you have any crops/livestock introduced due to climate change?

Crop	**Livestock**
1.	1.
2.	2.
3.	3.

b) If yes, who introduced the crop/livestock? [ ]

Code: 1=Public extension agent 2= NGO 3=Neighbor/Farmer 4= Private extension 5=radio/Television 6=Farmer organization/Cooperative

Section F: Climate Change

F1. Kindly use the options below to answer the following Questions according to your level of agreement or disagreement:

1–Strongly Agree, 2–Somewhat Agree, 3–I Don't Know 4–Somewhat Disagree, 5–Strongly Disagree

	Issue	**Select**
A	The environment in this area is changing due to human activities.	
B	The Climate is changing	
C	Temperature is rising.	
D	Rainfall is decreasing every year	
E	There is rainfall variability	
F	The weather is becoming drier every year.	
G	The yearly rains are not supporting crop production as before	
H	Climate change has led to crop pest infestation and diseases	

I	Food production has been affected by climate change	
J	The cost of food is increasing because of climate change.	
K	The Environment suffers from decreased vegetation due climate change.	
L	There is now Fuel wood scarcity.	
M	Climate change has led to rural-urban migration	
N	Climate change has led to the decline of forest resources	
O	Climate change has led to the change of livelihood system	
P	There have been increase incidences of floods during the raining season	
Q	There have been increase incidences of droughts during the dry season	
R	The incidence of climate change will affect the Sustainability of our environment.	
S	There is serious awareness on climate Change	

F2) who are the people seriously affected by climate change? A. The poor B. The rich c. didn't know (have no opinion) d. other specify …….

F3) The threat of climate change is more on;

1. Health [ ] 2. Food production [ ] 3. Fuel wood availability □

4. Businesses [ ] 5. Prevention of disasters □

F4: What are the strategies to adapting to climate change?

	Rank
a. Planting Different Varieties of crops	[ ]
b. Different (staggering) time of planting	[ ]
c. Rearing different breeds of livestock	[ ]
d. Soil fertility and water management	[ ]
e. Feed preservation	[ ]
f. No adaptation method used	[ ]

F5: What are the perceived hindrances to adaptation of emerging techniques of combating climate change?

	Rank
a. Lack of improved seeds/breeds	[ ]
b. Lack of access to water for irrigation farming	[ ]

c. Lack of current knowledge on adaptation methods [ ]

d. Lack of information on weather incidence [ ]

e. Lack of money to acquired modern techniques [ ]

f. There is no hindrance to adaptation [ ]