Addis Ababa University

School of Graduate Studies

Center for Environment and Development

Assessing the Status of Food Security in Face of Climate Change and Variability: the case of Choke Mountain Watershed, Eastern Gojjam zone, Ethiopia.

By

Demeku Mesfin

Advisor: Belay Simane (Ph.D)

A Thesis Presented to the School of Graduate Studies of Addis Ababa University in Partial Fulfillment of the Requirement for the Degree of Master of Arts (MA) in Development Studies (Environment and Development).

Addis Ababa, Ethiopia

June, 2013

Addis Ababa University

School of Graduate Studies

Center for Environment and Development

Assessing the Status of Food Security in Face of Climate Change and Variability: the case of Choke Mountain Watershed, Eastern Gojjam zone, Ethiopia.

By: Demeku Mesfin

Approved by Board of Examination

_____	_____	_____
Chairman	*Signature*	*Date*

Graduate Committee

1.	Belay Simane		
	Name of Advisor	*Signature*	*Date*
2.	_____	_____	_____
	External examiner	*Signature*	*Date*
3.	Taffa Tuda		18/02/2014
	Internal examiner	*Signature*	*Date*

ACKNOWLEDGEMENTS

Above all, I would like to thank the Almighty God since everything is done through the help of him.

I am greatly indebted to my advisor Dr. Belay Simane who provided me limitless and considerate consultation, advice and assistance throughout the research work. His patience and prompt reaction during all phases of study of this thesis are most appreciated. My special thanks also goes to Dr. Feyera Senbeta for indispensible comments he provided during my proposal defense. I would like to thank the Addis Ababa University Climate Change Thematic Research Project for their financial support.

I am greatly indebted to my father Mesfin Adane, my mother Bizuayehu Zeferu, my brother Getnet Mesfin and my sister Etenesh Mesfin for their help, care and support throughout my thesis work from beginning up to end.

A special mention of thanks is extended to Eastern Gojjam Zone Agricultural and Rural development office for their support by giving necessary information and relevant data for the accomplishment of this study. Special thanks are also for those who have participated in field enumeration and also in time of focus group discussion by creating awareness among farmers and organizing them to make discussion easy. I am also grateful to Ato Seyoum Mengist who with no reservation shared me his knowledge and experience in the field of study and SPSS.

The last but not the least, I would like to express my gratitude to all my friends, especially Hiwot Tadesse and Fenet Belay and those people who have spent their time directly or indirectly to assist me in this work for their constant encouragement and cooperation.

Table of Contents

List of Table

List of Figure

Acronyms

AES	Agroecosystem
DFID	Discussion Paper for International Development
FANTA	Food and Technical Assistance Project
FS	Food Secure
FIS	Food Insecure
FSS	Food Security Status
GHG	Green House Gas
HFBM	Household Food Balance Model
HFIAS	Household Food Insecurity Access Scale
IFPRI	International Food Policy Research Institute
ILRI	International Livestock Research Institute
IPCC	Intergovernmental Panel on Climate Change
ITCZ	Inter Tropical Convergence Zone
Kcal/Adu.equ	Kilo Calorie per Daily per Adult Equivalent
MDG	Millennium Development Goal
NAPA	National Adaptation Program of Action
NMSA	National Metrological Service Agency
SPSS	Statistical Package for Social Science
TLU	Tropical Livestock Unit
UNDP	United Nation Development program
UNFCCC	United Nation Framework Convention on Climate change
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WB	World Bank
WFP	World Food Program
WFS	World food summit

Abstract

The main objective of this paper was assessing the status of food security in the face of climate change and variability in Choke mountain watershed. 100 sample households from five AESs were included in the sampling frame. Household survey, focus group discussion, key informant interview and direct observation were held for collecting data. Basic descriptive statistics were used for assessing quantitative data. HFBM and HFIAS were used to determine food availability and accessibility of sample households respectively. The result of the study indicates 56.0% of households are food insecure and the remaining 44.0% are food secured. The prevalence of food in security is more persistent in lowland and valley (AES1) and hilly and mountainous (AES5) respectively. Food insecure households have large number of family, small number of livestock, low level of land size ownership, low fertility status and low productivity of cultivated land with sloppy and hilly mountainous slope. Agricultural productivity varies from one agroecosystem to the other due to its climatic condition. Both temperature and rain fall vary across all AESs from 1981- 2008 and the result shows average temperature increase in all sample AESs except AES1 while in the remaining AESs increase. Whereas, annual rainfall increase in all AESs except AES2. In line with this, the study examined climatic and related factors of food production. Farmers reported that: Erratic rain fall, dependency on single harvest, drought, land degradation, pest and weed infestation, lack of non-farm activity and lack of access farm credit are the more severely constraints in self- sufficiency in food production. However the severity of all the factors was not equal in all AESs. The study also shows that, there is a statistical systematic difference between food secured and insecured households and utilization of modern farm inputs (chemical fertilizer, pesticides, improved seed and irrigation) except the use of improved seed. Decline in water quantity and quality and prevalence of disease are also the effect of climate change and variability in the study area. AES1 is most vulnerable by malaria and AES1 and AES5 are food insecured. Thus, food security interventions need to support livelihoods in ways that protect and buffer the natural resilience of households, and providing direct assistance to ensure that households remain resilient to the fragile and variable situations in which they exist.

Key words: Food security, climate change, agriculture, agroecosystem.

CHAPTER ONE

1. INTRODUCTION

1.1 Background

Roughly a billion people around the world live their lives in chronic hunger, and humanity's inability to offer them sustained livelihood improvements has been one of its most obdurate shortcomings. Although rapid improvements in agricultural productivity and economic growth over the second half of the twentieth century brought food security to broad swaths of the developing world, other regions did not share in that success and remain no better off today and in some cases worse off than they were decades ago (Burke and Lobell, 2008). Climate change posed the greatest threat to agriculture and food security in the 21st century, particularly in many of the poor, agriculture-based countries of sub-Saharan Africa (SSA) with their low capacity to effectively cope (Maxwell and Smith 1992; WFP, 2009).

The Fourth Assessment Report of the IPCC has made a critical assessment of the possible impacts of climate change on agriculture, livestock and fishing, particularly in the countries of the tropics and sub-tropics (IPCC, 2007). The Food and Agriculture Organization of the United Nations (FAO) also warns about the negative consequences, in particular for smallholder subsistence farmers in what are in any case marginalized regions of Africa. This is largely because of high poverty rates, high vulnerability levels, dependency on fragile environment and low adaptation capacities. Furthermore, the rural populations of Africa for whom agricultural production is the primary source of direct and indirect employment and income are most affected because of

agriculture's direct exposure to climate change (IPCC, 2007; IFPR, 2010). Since agriculture is most sensitive sector, climate changes have serious impacts on the three dimensions of food security: food availability and stability, food accessibility and food utilization (FAO, 2008).

Ethiopia is the most vulnerable countries and the vulnerability of Ethiopia to climate change impact is a function of several biophysical and socioeconomic factors (Belay, 2011). Although the name ''Water Tower of Africa'' has been given to Ethiopia, agriculture is overwhelmingly dependent on the timely onset, amount, duration, and distribution of rainfall. Until recently, Ethiopia's agriculture met nearly the food needs of the population, at least at the subsistence level and provides about half of the gross domestic product (GDP) and 85% of foreign exchange earnings of the country. Almost 80% of the population lives in rural areas and depending on crop production and/or keeping livestock as means of livelihood (WB, 2008; USAID, 2010).

In addition to this, over 90% of the food supply comes from rain fed subsistent agriculture and rainfall failure means loss of major livelihood source that always accentuate food deficit. Due to these reason, food insecurity is an integral part of poverty in Ethiopia owing to agricultural production is to be less able to adapt to climate change. This is because of limited financial and technical resources, an inadequate infrastructure and organized governmental response to natural disasters. The absence of needed resources would be amplified by the anticipated greater impact that climate change is expected to affect food security negatively and severely (Collier et al., 2008; Abate, 2009).

That is why the issue of food security problem has become the concern of many political leaders, academicians and other professionals today. However, issues related to food security/insecurity in Ethiopia that have been done so far are very general and considers the problem from national level.

But as indicated by many scholars (Mesay, 2001; Debebe, 1995), the food security situations at national level can fail to be the case at household's or individual level. As far as this and other issues are concerned, the chief focus of this study is household's food security status in face of changing climate in East Gojjam Zone.

1.2 Statement of the Problem

Thought it is endowed with varieties of natural resources suitable to produce wide varieties of crops (sisay, 1995 cited in Markos, 1997), Ethiopia has been challenged by lack of food security and become one of food aid dependent sub-Saharan African countries. Particularly, since 1959, the domestic production of food has never been sufficient to meet the food requirements of the national population. Indeed, since the 1960s, the number of food insecure households has been increasing, whilst per capita food availability has been decreasing. The per capita food availability was, on average, 128.08kg for the period 1961- 1974, and it declined to 119.99kg in 1975-1991. Though average per capita food availability was 125.41kg during 1992-2001, still it remained far below the recommended average per capita daily requirement set by the Ethiopian government (2,100 kcal, which is equivalent to about 225kg) of grain per annum because of climate change and other factors (Markos, 1997).

For example, the increasing year-to-year variability and increases in both droughts and heavy precipitation events lowers agricultural production including frequent drought (1965, 1974, 1983, 1984, 1987, 1990, 1991, 1999, 2000, and 2002) and recent flooding (1997 and 2006) leads to negative effects on food security (Marius, 2009; Markos, 1997).

Choke Mountain farming community in East Gojjam, are highly vulnerable to both chronic and transitory food insecurity problems, driven largely by: rapid population growth and livestock pressure; land degradation caused mainly by erosion and soil fertility loss; lack of access to technology and markets and weak infrastructure (Belay, 2011). These affect the agricultural productivity and stability of food.

Choke mountain have considerable ecological and socioeconomic significance at the local, regional, and international levels. However, land degradation has impaired the capacity of the land to contribute to food security. It also has undermined local access to water supply and woody biomass, negatively impacting social stability. Erratic rain fall, increase in temperature, drought, flood, annual runoff and water availability are also exacerbate deterioration of basic services such as drinking water, sanitation, housing and health facilities which causes food insecurity in poor farm household (Belay, 2011).

Even though studies have been conducted about climate change, there is no study regarding food security in relation to climate change in Choke Mountain Watershed. Therefore, it is important to investigate the status of food security in the face of changing climate in the Choke Mountain Watershed.

1.3 Objectives

The general objective of the study was assessing the status of food security in the face of changing climate and variability in the Choke Mountain Watershed. Specifically, the study has the following objectives:-

1. To assess the perception of farmers towards food security in the study area.
2. To assess the situation of food availability in face of climate change and variability in case of Choke Mountain.
3. To assess household's food accessibility and climate change effect in the study area.
4. To identify household's food utilization situation in face of changing climate among sample kebele.

1.4 Research Questions

The accomplishment of the abovementioned objectives required answers to the relevant questions. Therefore, the study tried to find solutions to the following questions.

1. What is the farmer's view of food security?
2. How climate changes affect food availability in choke mountain watershed?
3. What looks like the food accessibility of household in face of climate change?
4. What are the main constraints of household's food utilization in different Agroecosystems?

1.5 Significance of the Study

The study will have at least the following contributions.

- As Food security and climate change is a very critical issue, studying the status of food security in face of climate change may initiate academicians and researcher to undertake an in-depth investigation of food security situations in the study area.
- Development practitioners/actors may make as an input for planning, implementing and targeting the need segment of the community in their development programs especially for agro-based industries to increase the value of agricultural produce, education, training and extension services. This will help to enhance the adoption of modern farming techniques, establishment of local market centers to open up markets for farmers produce, rural electrification to facilitate agro-processing and safe storage for produce.
- This research may also important so as to combat food insecurity with appropriate adaptation strategies of climate change and variability and to enhance resilience Green economy.

1.6 Scope and Limitation of the Study

The assessment was not cover in the whole Amhara region, as the impact varies from one AES to the other. Therefore, the researcher was preferred to delimit the scope of this thesis to only in five rural kebeles from five AES in order to manage the size of the study.

Both food security and climate change are multidimensional, dynamic and broad concept and climate change have effect on food security: on food availability, accessibility, utilization and stability. Thus only the three pillars (availability, accessibility and utilization) were under consideration. All the determinants of these pillars were not also covered in the study like

exchange and distribution from availability as it more reliable at regional and national level. Moreover, food utilization of household is concerned about nutritional value of a food based on BMI (Body Mass Index). But, in this study none of measurements was used rather it only concentrates on indicators like availability of water and prevalence of disease through household survey. In addition to these, it was difficult to get easily the recent or up-to- date data of the woreda since the local government officials and sector office heads were either on meetings or trainings. Data from NMSA was also not full what required by this thesis. Time and financial problems are also the main constraints and that is why the sample size of households is delimited to only 10% of total population.

1.7 Organization of the Thesis

The study is organized in five chapters. The first chapter has presented the problem and its settings. Chapter two reviews important literatures related with food security, climate change and agriculture. The approaches and methods applied in the analysis are presented in chapter three. Chapter four presents and discusses the results of the analysis. Conclusions and recommendation are presented in chapter five.

CHAPTER TWO

2. REVIEW OF RELATED LITERATURE

2.1 Concept and Definition

2.1.1 Definition of Food Security

The Food and Agricultural Organization (FAO) has estimated that the total number of undernourished people in the world will decline by 9.6 percent to 925 million in 2010, after continuously increasing during the preceding five years (FAO, 2010). Though this is a positive sign and a welcome respite, this number remains unacceptably high at 16 percent of the world's population and far above the hunger reduction targets set at the World Food Summit in 1996, as well as by the MDG_s. Developing countries account for 98% of the world's undernourished people and have a prevalence of undernourishment of 16%. The origin of the operative term 'food security' may be traced back to the Universal Declaration of Human Rights in 1948, under the aegis of the United Nations, which recognized the right to food as a core element of standard of living. However, the literature on food security exploded since the publication of the report of the World Food Conference held in 1974 consequently to the global food crisis of 1972-74 (Bipul, 2011).

Food security was first defined in the Proceedings of the 1974 World Food Summit as 'availability at all times of adequate world food supplies of basic foodstuff to sustain a steady expansion of food consumption and to offset fluctuations in production and prices' (WFS, 1992). In 1983, FAO expanded its concept to include a third point: 'Ensuring that all people at all times have both

physical and economic access to the basic food that they need'. In the World Bank's (1996) report of Poverty and Hunger, this concept of food security has been further elaborated in terms of: 'access of all people at all times to enough food for an active, healthy life' (WB, 1996).

The 1996 World Food Summit in its Plan of Action adopted still more complex definition: Food security, at the individual, household, national, regional and global levels is achieved when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (WFS, 1996). This definition is again refined as: Food security is a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (UNFAO, 1998, 2001; Maxwell and Smith, 1992).

The recent concept of food security has given more attention to households and individuals than its availability at international, national, regional, woreda or kebele levels. This is because increasing food production, supply and sufficiency at broader levels does not necessarily ensure that each and every individual is food securing and become food insecure (WFP, 2009; FAO, 2001; Frankenberg and Maxwell, 2008).

Food insecurity exists when people do not have adequate physical, social or economic access to food. Food insecurity is a combination of diversified factors, Degefa and Tesfaye (2008) categorized this in to six: (i) environmental (e.g. availability and quality of natural resources, including water); (ii) demographic (e.g. rapid population growth and the resultant shrinkage of land); (iii) economic (e.g. access to roads and health facilities, use of improved agricultural

practice and farm technologies); (v) social (harmful practice, feeding habits, burden on women); (vi) political/policy (participation/non-participation in the decision-making process).

Devereux, 2010; Markos, 1997 and Woldeamlak, 2009 indicate also different human and natural induced factors that made Ethiopia a food insecure country at a national level over the last few decades. These are fragile natural resources base, inadequate and variable rain fall in terms of intensity and distribution pattern, improper farming practice, inaccessibility to productive resources, diminishing land holdings and tenure insecurity, poor development of human resources, poor storage technologies that leads to high post-harvest losses, inaccessibility to transport infrastructure, lower productivity of livestock and others.

2.1.2. Climate Change

Intergovernmental Panel on Climate Change (IPCC) defines climate change as a change in the state of the climate that can be identified by changes in the mean or variability of its properties and that persists for extended periods, typically decades or longer. Various estimates of the changes in the global mean surface temperature from year to year are now available derived from many millions of metrological observations made on land and sea. They indicated since the late 19^{th} C the global mean temperature has shown irregular inter annual and decadal fluctuations, but has risen overall by about 0.5^{0}C (IPCC, 2007).

There is no scientific doubt that atmospheric concentration of GHGs capable of causing global warming have increased, so mean global temperature have been increasing since about 1850, mainly warming to the accumulation of 'GHGs'. This is caused by burning of fossil fuels (coal, oil and gas) to meet increasing energy demand, and the spread of intensive agriculture to meet increasing food demand which is accompanied by deforestation. These changes would inevitably

alert the productivity of agriculture in tropical regions that are already highly sensitive to the impacts of climate (IPCC, 2007).

A part of climate change can no longer be avoided: Anthropogenic greenhouse gas emissions accumulate in the atmosphere and have a lifetime of several decades, thus today we feel the consequences of past emissions. This leads to the undeniable fact that even if all anthropogenic emissions were to be stopped immediately, the temperature would continue to increase for some decades, by an estimated 0.5 °C, according to IPCC projections (IPCC, 2007).

However, the world is still far away from substantial reductions in greenhouse gas emissions. Global emissions have increased by more than 25 percent since 1990, with a strong acceleration since the year 2000. The increase has three main reasons: In Eastern Europe emissions have grown again after a decade of strong decline, emissions in rapidly developing countries – first of all China – grow quickly, and high gas prices have caused a strong worldwide shift from gas to coal. The world now faces the challenge to avoid a level of climate change that leads to large-scale dangerous consequences since further emissions of greenhouse gases will cause temperatures to increase 1.5^0C to 5.8^0C and precipitation patterns to shift by 2100 (UNFCCC, 2007; parry et al., 2007; IPCC, 2001).

2.2 Climate Change and Food Security

Climate Change is the regional or global-scale changes in historical climate patterns arising from natural and/or man-made causes and resulting in intermittent but increasingly frequent extreme impacts. Climate change has become topical because of its effects on human lives and the future of the world. In particular, it affects food security, livelihoods and social safety very adversely and in

so many ways. Food security has been understood by many as the availability of food in the world marketplace (Coates et al., 2007). However, global food availability does not translate into household food security. This is because food in the world market may not be affordable to the poor and vulnerable, especially those in developing countries. Interestingly, climate change affects all the three dimensions of food security. This means that availability of food alone does not signify food security because it may not be accessible and affordable to all people and communities at all times (FAO, 2003; Mahmud et al., 2008).

2.3 Food Security and its Vulnerability

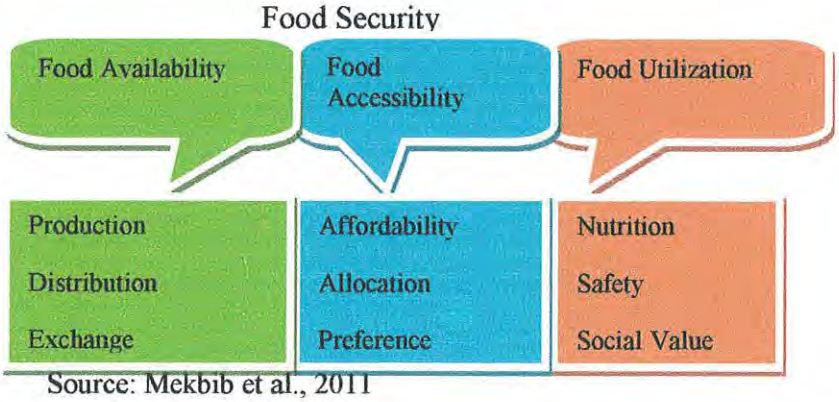
Food security contains three most important facets – food availability, food accessibility and food utilization and is vulnerable when one or more of these three components is uncertain and insecure.

2.3.1 Food Availability

Food availability is determined by the physical quantities of food that are produced, stored, processed, distributed and exchanged. FAO calculates national food balance sheets that include all these elements. Food availability is the net amount remaining after production, stocks and imports have been summed and exports deducted for each item included in the food balance sheet. Adequacy is assessed through comparison of availability with the estimated consumption requirement for each food item (FAO, 2008). **Food production** varies spatially, so food needs to be distributed between regions. The major agricultural production regions are characterized by relatively stable climatic conditions, but many food-insecure regions have highly variable climates. The main grain production regions have a largely continental climate, with dry or at least cold

weather conditions during harvest time, which allows the bulk handling of harvested grain without special infrastructure for protection or immediate treatment (FAO, 2008).

Fig 1: Basic Components of food security



Source: Mekbib et al., 2011

2.3.2 Food Accessibility

It is a measure of the ability to secure entitlements, which are defined as the set of resources (including legal, political, economic and social) that an individual requires obtaining access to food (Sen, 1989, cited in FAO, 2003). Until the 1970s, food security was linked mainly to national food production and global trade, but since then the concept has expanded to include households' and individuals' access to food. The mere presence of an adequate supply does not ensure that a person can obtain and consume food – that person must first have access to the food through his/her entitlements. The enjoyment of entitlements that determine people's access to food depends on allocation mechanisms, affordability, and cultural and personal preferences for particular food products. Increased risk exposure resulting from climate change will reduce people's access to entitlements and undermine their food security (Devereux and Maxwell, 2001).

Allocation: Food is allocated through markets and non-market distribution mechanisms. These factors include income-generating capacity, amount of remuneration received for products and

goods sold or labor and services rendered, and the ratio of the cost of a minimum daily food basket to the average daily income. Non-market mechanisms include production for own consumption, food preparation and allocation practices within the household, and public or charitable food distribution schemes (FAO, 2008).

According to Mekbib et al., (2011), **affordability** in many countries, the ratio of the cost of a minimum daily food basket to the average daily income is used as a measure of poverty. When this ratio falls below a certain threshold, it signifies that food is affordable and people are not impoverished; when it exceeds the established threshold, food is not affordable and people are having difficulty obtaining enough to eat. This criterion is an indicator of chronic poverty, and can also be used to determine when people have fallen into temporary food insecurity, owing to reduced food supply and increased prices, to a sudden fall in household income or to both. Income-generating capacity and the remuneration received for products and goods sold or labor and services rendered are the primary determinants of average daily income. The incomes of all farming households depend on what they obtain from selling some or all of their crops and animals each year.

Most food is not produced by individual households but acquired through buying, trading and borrowing. Climate impacts on income-earning opportunities can affect the ability to buy food, and a change in climate or climate extremes may affect the availability of certain food products, which may influence their price and make certain foods unaffordable. Changes in the demand for seasonal agricultural labor, caused by changes in production practices in response to climate change, can affect income-generating capacity positively or negatively. Mechanization may decrease the need for seasonal labor in many places, and labor demands are often reduced when crops fail, mostly owing to such factors as drought, flood, frost or pest outbreaks, which can be

influenced by climate. On the other hand, some adaptation options increase the demand for seasonal agricultural labor (Mekbib et al., 2011; FAO, 2008).

Preference: Food preferences determine the kinds of food households will attempt to obtain. Changing climatic conditions may affect both the physical and the economic availability of certain preferred food items, which might make it impossible to meet some preferences. Changes in availability and relative prices for major food items may result in people either changing their food basket, or spending a greater percentage of their income on food when prices of preferred food items increase (FAO, 2008).

2.3.3 Food Utilization

According to FAO, food utilization refers to the use of food and how a person is able to secure essential nutrients from the food consumed. It encompasses the nutritional value of the diet, including its composition and methods of preparation; the social values of foods, which dictate what kinds of food should be served and eaten at different times of the year and on different occasions and the quality and safety of the food supply (FAO, 2003; Maxwell, 2001).

Nutritional value: Food insecurity is usually associated with malnutrition, because the diets of people who are unable to satisfy all of their food needs usually contain a high proportion of staple foods and lack the variety needed to satisfy nutritional requirements. The main impact of climate change on nutrition is likely to be felt indirectly, through its effects on income and capacity to purchase a diversity of foods (Schmidhuber and Tubiello, 2007).

The social and cultural values of foods consumed will also be affected by the availability and affordability of food. The social values of foods are important determinants of food preferences,

with foods that are accorded high value being preferred, and those accorded low value being avoided. In many traditional cultures, feasts involving the preparation of specific foods mark important seasonal occasions, rites of passage and celebratory events. The increased cost or absolute unavailability of these foods could force cultures to abandon their traditional practices, with unforeseeable secondary impacts on the cohesiveness and sustainability of the cultures themselves (Burke and Lobell, 2008). In many cultures, the reciprocal giving of gifts or sharing of food is common. It is often regarded as a social obligation to feed guests, even when they have dropped in unexpectedly. In conditions of chronic food scarcity, households' ability to honor these obligations is breaking down, and this trend is likely to be reinforced in locations where the impacts of climate change contribute to increasing incidence of food shortages. Food safety Increasing temperature may cause food quality to deteriorate, unless there is increased investment in cooling and refrigeration equipment or more reliance on rapid processing of perishable foods to extend their shelf-life (FAO, 2008).

2.4 Food Security/insecurity Situation in Ethiopia

The globally adequately available food is not found evenly distributed among or within countries. Hence, millions of people are suffering from malnutrition, under-nourishment and famine in different parts of the world. Several countries in the developing world, majority of which are found in Africa, are currently unable to provide their population with adequate food requirement. Most of the people in sub Saharan African countries within which Ethiopia is identified in particular have been suffering from both chronic and transitory food shortages. In this sub-continent per capita food production has been decreasing while the demand for food has been increasing at an annual rate of 2.9% per year over the past three decades (Markos, 1997).

As part and parcel of the sub-Saharan African countries, the food security situation in Ethiopia is not better than the general picture of the region. According to the food security strategy document (1996) of Ethiopia, over 52% of Ethiopian population are food insecure or found below the poverty line. Moreover, about half of the children fewer than five years age are suffering from malnourishment. And the situation has been further made complex by the current very fast population growth rate and the resulting declining per capita food production in the country. Therefore, let alone in a position to feed the thousands of people that have been added annually, the country has become increasingly dependent on foreign food aid to meet its ever-increasing food requirements (Tekolla, 1997 cited in Mesay, 2001).

2.5 Household Food Security Indicator and Measurement

Food security, as with poverty, is a cross-cutting, complex and multifaceted phenomenon. Conceptually, food security is generally broken down into three different components – availability, access and utilization – each capturing different, but overlapping, dimensions of the phenomenon. Indicators have traditionally focused on specific, easily measured aspects, such as current food supply, individual caloric intake, and so on, often without capturing the complexity of the concept. Widespread consensus exists that no single indicator can capture all aspects of food insecurity while also providing policy makers with relevant and timely information in a cost-effective manner. For this reason, efforts have been put into finding easy to implement and reliable alternative indicators which complement each other (FAO, 2008).

Maxwell and Frankenberg (1992) list 25 broad indicators and a host of other indicators related to the different aspects of food security. They distinguish between "process indicators" - capturing food supply and food access - and "outcome indicators" - describing nutritional status. Gero et al.,

(2005) note that even a single composite indicator can come with many different permutations and list some 450 variations of testable indicators. They make the distinction between "generic" indicators applicable to a variety of settings and "location-specific" indicators.

A first indicator can be labeled undernourishment, a measure commonly identified with the Food and Agriculture Organization of the United Nations (FAO). This FAO method begins with the estimate of per capita dietary food energy supply, derived from aggregate food supply data. Assumptions regarding the distribution of this supply across households are made based on income or consumption distribution, or other available data. The proportion of undernourished in the total population is then defined as that part of the distribution lying below a minimum energy requirement level (Gero et al., 2005).

A second indicator measures the amount of food actually consumed at the individual or household level. Food consumption is usually measured indirectly through household surveys. Household-level data can be used to construct a number of measures of food insecurity, including food energy deficiency and poor diet quality and diversity. The level and depth of household food energy deficiency can be measured based on household consumption (Gero et al., 2005).

As the same source indicates, a third approach deficiency is to measure food utilization through nutritional status. Anthropometric measures of children are regularly collected in random sample surveys in many countries. Anthropometric measures, as outcome measures, are well suited for monitoring and evaluating interventions, and can be collected with socio-economic information in order to analyze the determinants of malnutrition. Anthropometric attainment, however, is a nonspecific indicator, because it is the result not only of food intake, but also of factors such as sanitation, health and child care practices.

2.6 Review of Empirical Studies

2.6.1. Impact of Climate Change on Agricultural Systems and Food Security in Africa

Agriculture in Africa is important to produce food for people to eat and it provides the primary source of livelihood for two-thirds of the working population in sub-Saharan Africa. If agricultural production in the low-income developing countries of Asia and Africa is adversely affected by climate change, the livelihoods of large numbers of the rural poor will be put at risk and their vulnerability to food insecurity increased (IPCC, 2001). For rain fed agriculture there is naturally a greater exposure to climate variation in tropical areas. The precise timing and severity of monsoon rain is particularly crucial. These factors define the growing season and crop varieties and agricultural practice employed. Even small changes in rain fall levels and patterns could have strongly negative effects on productivity in areas where agriculture is currently adapted to the rain fall. Agricultural production, including access to food, in many African countries is projected to be severely compromised. Projected reductions in yield in some countries could be as much as 50% by 2020, and crop net revenues could fall by as much as 90% by 2100, with small scale farmers being the most affected (IPCC, 2007).

Climate change affect agriculture in different ways: (i) higher temperatures affect plant health, increase the occurrences of pests, and lower water availability; (ii) modified rainfall patterns reduce water availability and shift rainy seasons, with consequences both for irrigated and rain fed agriculture and for farming systems; (iii) enhanced frequency of weather extremes worsens supply variability; (iv) enhanced carbon dioxide (CO2) concentration in the atmosphere may improve yields and crop productivity in some cases; and (v) the rise in sea level and frequent flooding disturb global agricultural production patterns, generating losses for some farmers and countries.

While the magnitude of the impact on global agricultural production is uncertain at this time, countries in the temperate zones of North America, Northern Europe and Asia are expected to benefit from increased agricultural productivity. In contrast, regions around the Mediterranean and especially in tropical zones are expected to be net losers from declining productivity (Elbehri; Genest; Burfisher, 2011).

2.6.2 Climate Change and Food Security Implications for Ethiopia

Food insecurity is an integral part of poverty in Ethiopia. At present agriculture dominates the Ethiopian economy, accounting for nearly half of gross domestic product (GDP), dominated by small scale farmers who employ largely rain-fed and traditional practices, therefore climate change will have a far reaching implication on food security. Desertification, brought on by human land use pressures and recurrent drought has consumed significant land area and continue to threaten arable land. Climate change is projected to reduce yields of crops like wheat by 33%. Agro-pastoral and pastoral households, which are reliant on livestock for their livelihoods also suffer severe losses during droughts couple with seasonal reoccurring shortages due to diminishing grazing lands. This situation has forced some pastoral farmers to choose for crop production (Tsegaye, 2009). Although Ethiopia has relatively abundant water, it has one of the lowest storage capacities in the world: 50 cubic meters per person (UNDP, 2007).

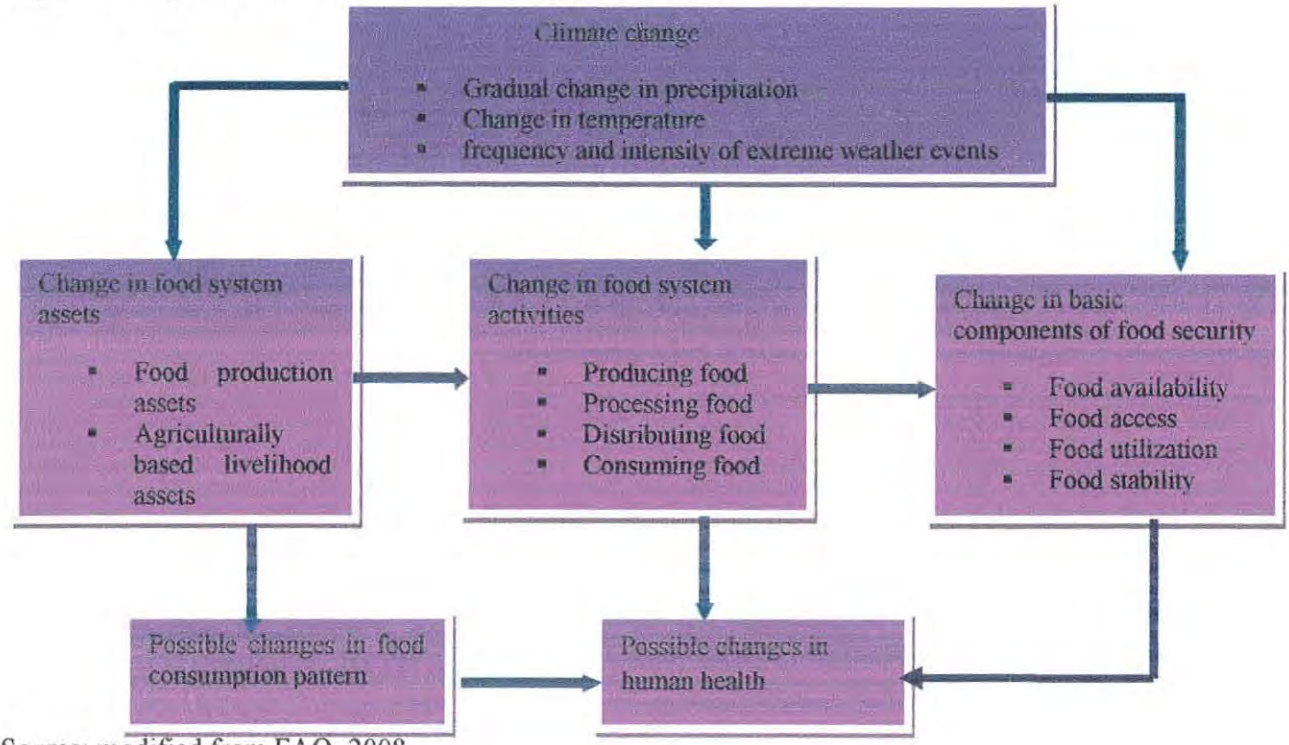
Climate change is projected to cause the drying up of wetlands and run-off to Nile tributaries (Abay and Awash Rivers) would be reduced by up to one third (WB, 2007). These will have serious impact on the farmers' productivity due to water shortages. One of the most strategically important issues in the context of environment - human relationship is the geography of insecurity in terms of resource availability and utilization. Climate variability, specifically rainfall patterns

resulting from climate change may result in decrease yield of crops. The reduction in crop yields may lead to higher prices for food, which could trigger regional food crises. These would lead to greater food insecurity causing political instability, increasing the stakes for control over productive agricultural land. Consequently, climate change by redrawing the map of water availability, food security and disease prevalence and loss of income source could increase forced migration, raised tensions and trigger conflict. Therefore the pattern of vulnerability to climate change on food security is worrisome (Hamza and Iyela, 2012).

2.7 Conceptual Framework

To understand the status of food security in face of climate change, this thesis was modified and uses FAO, 2008 conceptual framework on the concepts climate change and food security.

Fig 2: Conceptual framework: climate change and food security.



Source: modified from FAO, 2008

The framework shows climate change and food security outcomes on the three components of food security – food availability, food accessibility and food utilization.

For the poor - agricultural production is both a source of food and a source of income; climate change affects three pillars of food security in various direct and indirect ways (Schmidhuber and Tubiello, 2007). Availability of agricultural product is affected by climate change directly through its impacts on crop yields, crop pests and diseases, and soil fertility and water-holding properties.

Physical and economic access to food would be affected negatively by climate change as agricultural production declines, food prices rise, and purchasing power decreases. This is due to poor infrastructure and low utilization of modern technology that climate change and variability cause. More frequent and more intense extreme weather events (droughts and floods) and increasing irregularities in seasonal rainfall patterns are already having immediate impacts on not only food production, but also infrastructure, incidence of food emergencies, livelihood assets and human health. Last but not least, climate change poses threats to food utilization through effects on quantity and quality of water and human health. In general, climate change has an impact in the overall livelihood system of the vulnerable societies, as they are highly dependent on rain-fed climate sensitive economic activities and overall household food consumption pattern changed.

CHAPTER THREE

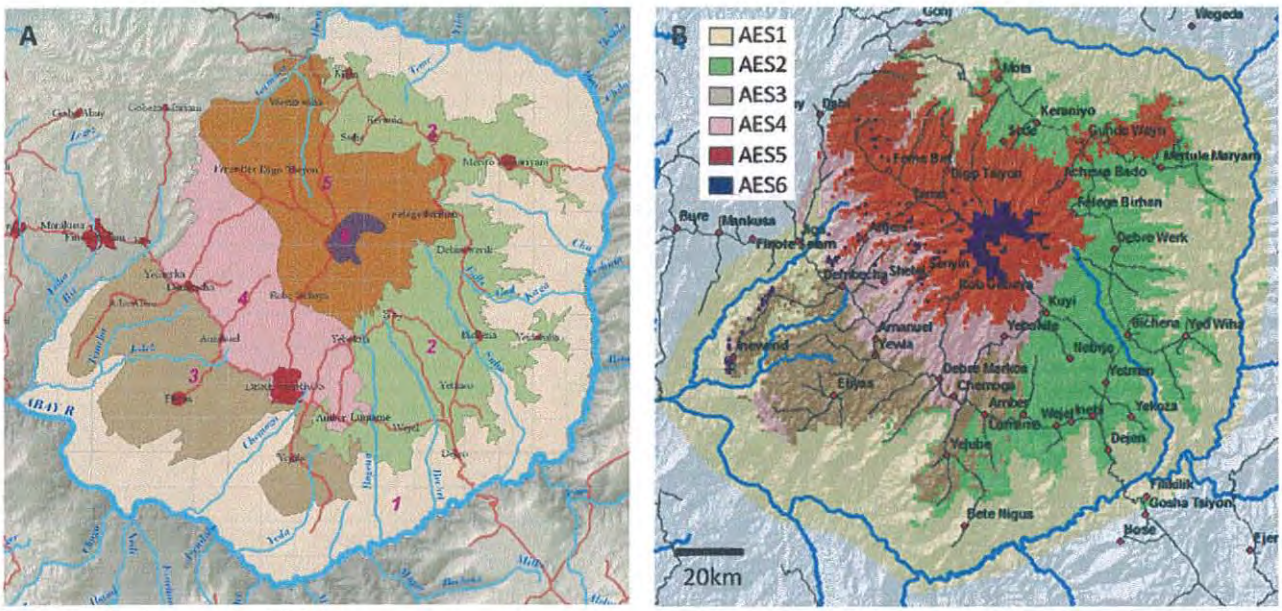
3. RESEARCH METHODOLOGY

3.1 Description of Choke Mountain Watersheds

3.1.1 Location

The Choke Mountains is a large block of highland found in central Gojam, Amhara Regional State. It is located on plateaus that rises from a block of meadows and valleys and have elevation ranging from approximately 800 - 4200 meters above sea level. The central peak is located at 100 42' N and 370 50' E. The mountains were formed by volcanic activity about 30 million years ago in the middle of late tertiary. While the central cone of the mountain chains of Choke occurs in six woredas of East Gojjam, namely Hulet Eju Enesie, Enarj Enawga, Sinan, Debay Telatgin, Bibugn and Machakel, the Mountain watershed includes all East Gojjam and part of West Gojjam.

Fig 3: Map of study area



Source: Belay et al., 2013

3.1.2 Agroecosystems of Choke Mountain Watersheds

According to Belay et al ., (2013), the definition of Agroecosystems was based on the overlay of three inputs: an agro-climatic zoning based on precipitation and temperature, a soil and terrain analysis, and a map of the distribution of farming systems and they classify in to six Agroecosystems.

Lowland and valley fragmented Agroecosystems (AES 1; 7200 km^2): This Agroecosystem includes the lowlands in the eastern part of the Choke Mountain watersheds and fragmented valleys along the Blue Nile gorge, with an altitude range of 800 to 1400 m. AES1 is characterized by relatively unfavorable agro-ecologic conditions: rugged terrain, lower and more sporadic rainfall than the other AES, and extensive land degradation. Kurar is one of the sample kebele classified under the first Agroecosystems. Production in Kurar is constrained by shallow soil depth, low soil fertility and sloping terrain. The annual temperature falls between 21°C and 27.5°C and the growing period ranges between 61 and 120 days. Dominant crops grown in Kurar are sorghum, maize and teff, and soils include Leptisols and Cambisols. Even though these soils are fertile and are generally suitable for a wide range of agricultural uses, the prevalence of long, steep slopes leads to high rates of erosion. Oxytenathera abysnica and Accacia spp. are the dominant natural growing trees. The zone has potential for forest and agroforestry, sorghum and haricot bean production. Malaria is a major health related constraint in this area.

Midland plains with black soil (AES 2; 3200 km^2): AES 2 is found on the eastern toe of Choke Mountain, extending from the town of Dejen to the town of Mota. This Agroecosystem represents midland plains with black soil with an elevation ranging from 1400 to 2300 m. The annual temperature varies between 11 and 15°C. The growing period is between 121 and 180 days.

Heavily textured Vertisols dominate the area. These soils have considerable agricultural potential, on account of their high fertility and their physiographic setting on extensive level plains amenable to mechanized cultivation. There Prunus africana, Hagenia abyssinica, Erythrina brucei and Arundinaria alpina species are vegetation types seen very sparsely. M/Birhan is located in the AES 2, more suitable for agriculture and is potential for input-intensive teff, durum wheat and chickpea production, provided appropriate Vertisol management practice is in place.

Midland plains with brown soils (AES 3; 1600 km^2): AES 3 is found on the western and southern toe of Choke Mountain toe. It is a midland plains area dominated by Nitosols, a brown soil very suitable for agriculture, and Alisols, with some Cambisols as well. Yemezegn kebele is included in this Agroecosystem and the elevation of AES 3 varies between 1400 and 2400 m. The annual temperature varies between 16 and 21°C, and the growing period is between 121-180 days. Maize and wheat based farming systems dominate in Yemezegn (AES 3). It is also a potential area for pulses and oil crops. This system is potentially suitable for input-intensive, mechanized agriculture and irrigation that could contribute to rapid increases in productivity.

Midland Sloping Lands (AES4; 1300 km^2): AES 4 is located at the foot-slope of Choke Mountain with elevation ranging from 2400 to 2800 m. Soils are Leptosols, Alisols, and Nitosols, and the terrain is sloping. The annual temperature varies between 11°C-15°C and the growing period between120–180 days. There is no dominant natural plant species. Eucalyptus globulus is extensively grown as a plantation and some of the residents of the area have become dependent on it for their livelihood. Enerata is found in AES 4 which is constrained by low natural fertility due to leaching of base ions and high level of soil acidity. Sloping terrain is more difficult to cultivate than flatland, and is subject to higher rates of water runoff and soil erosion in Enerata. The main

crop types produced are wheat, maize, teff, and a range of pulses. The highly rugged landform, associated land degradation and soil acidity present major constraints for crop production. Enerata does have potential for more intensive production system, but soil and water conservation measures are critical.

Hilly and Mountainous highlands (AES5; 2400 km^2): These hilly and mountainous highlands are found on the back-slope of Choke Mountain. Soils are predominantly Leptosols and Luvisols and altitude varies between 2800 and 3800 m. The annual temperature ranges from 7.5°C to 10°C and the growing period is between 61 and 120 days. D/kelemo is one of sample kebele in this AES and the major crops grown in the area are potato, wheat, barley, Endigo and pulses that are local varieties and there is virtually no use of chemical fertilizer. The dominant plant tree species are the Juniperus procera, Erica arborea, Hagenia abyssinica, Hypericum revolutum and Olea europae. The major constraints on production in AES 5 (D/Kelemo) are low temperature, soil erosion and deforestation leading to water management problems. Rangeland (grazing or pasture land) degradation is also common due to overstocking. D/Kelemo is not appropriate for high intensity agriculture, but it does have high potential for traditional forestry, including bamboos and potato and barley production with appropriate mountain agricultural land management.

Afro Alpine (AES6; 250 km^2): The Afro Alpine is the Choke Mountain summit. Elevation ranges from 3800 to 4200 and soils are predominantly Cambisols, Andosols, and Phaozems, with some Luvisols. Given the important functions of AES6 as a reservoir for biodiversity and a soil and water retention zone, combined with the area's relatively low agricultural potential due to low temperatures, the most appropriate use of AES6 is as a protected bioreserve (Belay et al., 2013).

3.1.3 Climate

The prevailing climate can be described as "tropical highland monsoon". Seasonal precipitation is tightly correlated with the movement of the Inter-tropical Convergence Zone (ITCZ), with most rain falling during the May-October kiremt rainy season. The distribution of precipitation within the Choke is far from uniform; average annual precipitation ranges from 600 to 2000 mm yr^{-1}, and exhibits strong local variability associated with topographic gradients. Precipitation events are convective in nature, and are characterized by short, sometimes intense erosive bursts with notably large raindrops (Belay, 2011).

3.2. Research Approach

This research has attempted to integrate the use of quantitative and qualitative data. The qualitative approach of this study was comprised by key informant interview, focus group discussions, direct observation, whereas the quantitative approach was employed through household survey.

3.3 Data Sources

Both primary and secondary data was used in this study. Primary data was collected through household survey, key informant interviews, focus group discussion and direct observation. The study also include secondary data from published and unpublished materials like, books, maps, national and regional manuals and guide lines related to the topic to be studied.

3.4 Sampling Procedure and Sample Size

There are six agroecosystems in the Choke Mountain Watershed. These are lowland and valley fragmented (800-1400m), mid land and plains with black soil (1400-2300m.), mid land and plains

with brown soil (1400-2400m.), mid land and sloppy land (2400-2800m), hilly and mountainous highland (2800-3800m) and Afro-alpine (above 3800m) (Belay et al., 2013). But the last Agroecosystem (Afro-alpine) is protected or it is bio reserved zone. So for the purpose of this study, the researcher selects five agro-ecosystems purposively. Accordingly, five kebeles-one from each agroecosystem were selected using simple random method. Then five villages, one from each kebele were selected purposively by considering their proximity to the main road. Finally, in order to fulfill this research with full information and data, the researcher select a sample households from each village using simple random method as people living in one village is homogenous in terms of economic activity, technological development and other socio economic conditions. The selected villages have a total household population of 1000.

Therefore, 10% of the total households from those villages were selected. Accordingly, probability proportion to sample size technique was used to distribute the sample households for each sample villages.

Table1: Proportion of sample HHs by kebele and villages

AES	Kebele			
		Village	Population	Sample size (10%)
Lowland and valley fragmented	Kurar	Mekni	230	23
Mid land plain with black soil	M/Birhan	Dinda kutir.2	211	21
Mid land plain with brown soil	Yemezegn	Tembol	170	17
Midland sloping land	Enerata	Digil	179	18
Hilly and mountainous highland	D/kelemo	Addis Amba	210	21
Total			1000	100

Source: CSA, 2007

3.5. Data Collection Methods

According to Eshetu (2007), multiple approaches, which combined both qualitative and quantitative data collection method, were important to collect necessary information and data. By taking this in to account, both methods were used for this study. Specifically, the methods employed to gather the necessary data were household survey, key informant interview, focus group discussion, observation and documentary sources.

Household survey

For the primary data that was collected through household survey, open ended and closed ended questionnaires were organized. The survey generates both qualitative and quantitative data pertains to: demographic characteristics, socio economic condition, food status of households and effect of climate change which was prepared for 100 households.

Key informant interview (KII)

Based on the likely data availability, the researcher taken a total of two individuals in each kebeles with various background who have had deeper and better knowledge about the issue. The interviewees were consists of one agricultural expert and one religious leader.

Focus Group Discussion (FGD)

FGD helps to identify a range of information rather than precise information. In food security assessments the focus was on all topics related directly or indirectly to availability, access and utilization of food in relation to climate change. Thus, to get relevant information on the issues concerned, focus group discussion was done with an average of 10 from different groups of the community with a total of five focus group discussion, one in each of the selected AESs.

Direct observation

Data collected through this technique was used to supplement and triangulate information collected in survey questionnaire, focus group discussion and data from secondary sources.

In addition to primary data, **Secondary data** was also be important which were collected from literatures and official documents from federal and regional line government reports, CSA sampled production data for different years, relevant documents and reports on food security and other published and unpublished documents.

3.6. Data Analysis

For the purpose of measuring household food security situation, Household food balance model (HFBM) and Household food insecurity access scale (HFIAS) was used.

3.6.1 Household Food Balance Model

The net available food for the households was computed using a modified form of a simple equation known as Household Food Balance Model, originally adapted by Degefa (1996) from FAO Regional Food Balance Model and then used by different researchers (Eshetu, 2000; Mesay, 2009; Seyoum, 2012). The quantity of food was calculated and converted into dietary calorie equivalent based on Ethiopian Health and Nutrition Research Institute food composition table. Then the food supply at a household level was calculated by dividing a total number of days per year (365) and adult equivalent value for each sampled households was used to calculate calories available per adult equivalent per day for each household.

According to FDRE FSS (1996), 2100 kilo calories per person per day was used as a measure of minimum calories required per adult equivalent per day (i.e., demand) to enable an adult to live a healthy and moderately active life. Then a comparison between the available (supply) and required (i.e., demand) grain food was made. Finally, the output of the HFBM, comparison between calories available and calories demanded by a household was made to determine the food security status of a household.

A household whose daily per capita caloric available (supply) is less than his/her demand was regarded as food insecure and household who did not experience a calorie deficit during the year under study was regarded as food secure.

$$\mathbf{NGA_i = (GP_i + GB_i + GR_i + GPS_i) - (HL_i + GS_i + MO_i + GG_i + NS_i)}$$

Where, $\mathbf{NGA_i}$= Net grain available/year/household

$\mathbf{GP_i}$= Total grain produced/year/household

$\mathbf{GP_i}$= Total grain bought/year/household

$\mathbf{GR_i}$= Total Grain obtained from remittance /year/household

$\mathbf{GPS_i}$= Total grain obtained through previous stock/year/household

$\mathbf{HL_i}$= Post harvest losses/year household

$\mathbf{GS_i}$=Quantity of grain reserved for seed/year/household

$\mathbf{MO_i}$=Amount of marketed output /year/household

$\mathbf{GG_i}$=Grain given to others as a gift within a year/household

NS_i=grain planned to be left by a household for next season/year/household

In this model, the index i run from 1, 2.....100

Except post harvest losses, all the data needed for HFBM were collected from the primary data from household survey with the period between November 2011 to October 2012. However, the rest post harvest losses data was obtained from secondary data. According to East Gijjam Zone of agricultural office and from previous study made using HFBM an average post-harvest crop loss during the year under investigation was estimated at an average value of 10% of the total production of each crop.

3.6.2 Household Food Insecurity Access Model

The second model that was used to identify household's food accessibility is HFIAS which was adopted by the researcher from food and technical assistance project (FANTA) of USAID. The information generated by the HFIAS can be used to assess the prevalence of household food insecurity (access) (e.g., for geographic targeting) and to identify changes in the household food insecurity (access) situation of a population over time (e.g. for monitoring and evaluation) (Coates et al., 2007).

Each of the nine generic questions was asked with a recall period of four weeks (one month). The first question to the respondent was an occurrence question- that is, whether the condition in the question happened at all in the past four weeks (yes or no). If the respondent answers "yes" to an occurrence question, a frequency-of-occurrence question is asked to determine whether the condition happened rarely (once or twice), sometimes (three to ten times) or often (more than ten

times) in the past four weeks. These questionnaires represent a generally increasing level of severity of food insecurity (access).

Some of the nine occurrence questions inquire about the respondents' perceptions of food vulnerability or stress (e.g., did you worry that your household would not have enough food?) and others ask about the respondents' behavioral responses to insecurity (e.g., did you or any household member have to eat fewer meals in a day because there was not enough food?). The questions address the situation of all household members and do not distinguish adults from children or adolescents. All of the occurrence questions ask whether the respondent or other household members either felt a certain way or performed a particular behavior over the previous four weeks.

Four types of indicators were calculated to help understand the characteristics of and changes in household food insecurity (access) in the surveyed household: Household Food Insecurity Access-related Conditions, Household Food Insecurity Access-related Domains, Household Food Insecurity Access Scale Score and Household Food Insecurity Access Prevalence (Coates et al., 2007).

The researcher has also used descriptive statistics to analyze household's perception of food security and utilization of food in face of climate change. After the necessary information and data were collected and generated, the researcher has employed different statistical methods and tools to analyze and present the data collected side by side with qualitative summarization and discussion. The quantitative data was analyzed by the use of statistical software known as SPSS and Microsoft excel. The information obtained from key informant interview, focus group discussion and direct observation were analyzed through qualitatively by narrative descriptive.

CHAPTER FOUR

4. RESULT AND DISCUSSION

4.1 Demographic Characteristics of Sample Households

4.1.1 Sex and Age of Household

Out of the sampled households 53% of the households are male headed and the remaining 47% are female-headed households. Sex of household is important variable for determining food security status of household. It is hypothesized that female headed households are more food insecure than male headed households. This is due to the fact that female headed households are usually constrained by resources. They are mostly deprived in terms of resources endowment like land, capital and labor. Mostly they share crops their land to men farmers.

Table 2: Sex of sampled household head by kebele and food security status

Kebele	Sex of household				Total	
	M	%	F	%	No	%
Kurar	12	52.2	11	47.8	23	100.0
M/Berhan	11	52.4	10	47.6	21	100.0
Yemezegn	8	47.1	9	52.9	17	100.0
Enerata	11	61.1	7	38.9	18	100.0
D/Kelemo	11	52.4	10	47.6	21	100.0
Total	53	53.0	47	47.0	100	100.0
FS	24	54.5	20	45.5	44	100.0
FIS	29	51.8	27	48.2	56	100.0
Total	53	53.0	47	47.0	100	100.0
X^2		$0.025^{(NS)}$				

Note-, **, *** indicated that the coefficient are statically significant at 10%, 5% and 1% respectively, FIS = Food insecured household, FS = Food Secured Household*

Source: Own field survey, 2012

However, the chi-square test was made to see if there is significant difference in food (in) security between male and female headed household and the result shows that there is no significant difference in food security situation between female headed and male-headed households. This may be due to number of male households are greater than female headed households.

As far as age group is concerned, out of the total sample households, about 80% of the household heads are within the age group of 31-65. The remaining 12% and 8% of respondents are under the age group of >65 and 15-30 respectively.

Age of the household is also regarded as an important variable with an impact on household food security status; i.e older households are usually better than younger households in terms of resources endowments. Thus it was hypothesized that younger households are more food insecure than older households. The chi-square test was run to test this hypothesis and the result shows that there is a statistical difference between age and food security status. That is younger households are more food insecure than older households.

Table 3: Age distribution of households by kebele and food security status

Kebele	Age of household						Total	
	15-30		31-65		>65			
	No	%	No	%	No	%	No	%
Kurar	1	4.3	16	69.6	6	26.1	23	100.0
M/Birhan	3	14.3	17	81.0	1	4.8	21	100.0
Yemezegn	0	0.0	16	94.1	1	5.9	17	100.0
Enerata	4	22.2	11	61.1	3	16.7	18	100.0
D/Kelemo	0	0.0	20	95.2	1	4.8	21	100.0
Total	8	8.0	80	80.0	12	12.0	100	100.0
FS	7	15.9	35	79.5	2	4.5	44	100.0
FIS	1	1.8	45	80.4	10	17.9	56	100.0
X^2		9.78*						

Note-, **, *** indicated that the coefficient are statically significant at 10%, 5% and 1% respectively, FIS = Food insecured household, FS = Food Secured Household*

Source: Own field survey, 2012

4.1.2 Household's Marital and Educational Status

At a kebele level, majority of male headed households are married especially in Enerata where 94.2% married followed by M/birhan (91.3%). On the other hand female headed households are widowed, divorced and single in most cases. Surprisingly, 90.1% of female headed households are widowed. In case of food security status, majority of both food secured and insecured households are married. And there is no statistical systematic difference between food (in) secured and marital status of households.

Table 4: Household's marital status situation

Kebele	Kurar		M/Birhan		Yemezegn		Enerata		D/Kelemo	
	M	F	M	F	M	F	M	F	M	F
Single	0.0	3.7	0.0	0.0	5.9	5.9	0.0	11.1	0.0	6.7
Married	75.0	0.0	91.3	0.0	73.3	0.0	94.2	0.0	83.4	0.0
Divorced	10.0	67.1	0.0	87.9	20.8	4.0	0.0	89.9	5.9	75.0
Widowed	15.0	29.2	8.7	12.1	0.0	90.1	5.8	0.0	10.7	28.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
X^2	$2.07^{(NS)}$									

Note-, **, *** indicated that the coefficient are statically significant at 10%, 5% and 1% respectively, FIS = Food insecured household, FS= Food Secured Household.*

Source: Own field survey, 2012

Concerning education, majority of households included in the study area have not attained basic education. Some of them respond that they have attended the education program provided by the Basic Education Campion (meserete timihirt) in some 25-30 years ago. However most of them do not write and read at present. 55% of the overall sample respondents cannot read and write while only 3% of households attained secondary education.

Literacy level of the household head is also an important variable mostly assumed to have impact on food security status of the household. Thus, it was hypothesized that households which are headed by relatively more educated households are in better position in terms of food security than

whose heads are illiterate. This is due to the fact that more educated households adopt new technology and farm practices faster, which in turn enhance agricultural productivity.

Chi-Square test was run to know if there is a systematic relationship between educational status and household food security status in the sampled household reveals that there is no significant difference in food security situation based on their household head educational status. This is due to the fact extension services do not do their work properly.

Table 5: Respondents level of education and food security status

Kebele	Illiterates		Capable of writing and reading		Primary school		Secondary school		Total	
	No	%	No	%	No	%	No	%	No	%
Kurar	10	43.5	12	52.2	1	4.3	0	0.0	23	100.0
M/Birhan	12	57.1	5	23.8	2	9.5	2	9.5	21	100.0
Yemezegn	12	70.6	5	29.4	0	0.0	0	0.0	17	100.0
Enerata	11	61.1	6	33.3	0	0.0	1	5.6	18	100.0
D/Kelemo	10	47.6	9	42.9	2	9.5	0	0.0	21	100.0
Total	55	55.0	37	37.0	5	5.0	3	3.0	100	100.0
FS	27	61.4	12	27.3	3	6.8	2	4.5	44	100.0
FIS	28	50.0	25	44.6	2	3.6	1	1.8	56	100.0
X^2		3.73$^{(NS)}$								

Note-, **, *** indicated that the coefficient are statically significant at 10%, 5% and 1% respectively, FIS = Food insecured household, FS = Food Secured Household*

Source: Own field survey, 2012

4.1.3 Family Size and Adult Equivalent

The average family size for the overall sample household is 5.25 with standard deviation of 1.892 and with minimum and maximum family size being 1 and 11 respectively. More than half (58%) from the total sample households and 72.2% and 47.1% of households from Enerata and yemezegn kebele have four to six family sizes respectively. Only 15% of sample households have a family size below four and 27% of respondents have number of family size greater than six.

With regard to livestock holding, mean value of livestock holding in terms of tropical livestock units for the total sample households is 5.06TLU and standard deviation of 3.05. The minimum amount of livestock holding in terms of tropical livestock units is zero and the maximum amount is 13.48TLU. The mean value of livestock in terms of TLU for food secure and insecure household is 5.848 and 4.05 respectively. According to Asfaw and Jabar (2008), average TLU in Ethiopia is 4.46. And mean value for sample households are greater than this figure which shows better figure. However, the mean value for food insecured household is lower than the national average.

As it can be evidenced from many studies concerning household food security, livestock possession affects food security as it is the backbone of the farm economy especially in mixed farming systems. The result of chi-square also shows that, there is a statistical systematic relationship between food security and livestock holding in terms of tropical livestock unit.

Table 8: Livestock distribution by sample kebele and food security status in terms of TLU

Kebele	Number of respondents						
	0	0.01-1	1.01-2	2.01-3	3.01-4	>4	Total
Kurar	0	0	4	4	6	9	23
M/Birhan	0	0	1	1	1	18	21
Yemezegn	2	1	0	2	5	7	17
Enerata	0	2	2	0	3	11	18
D/Kelemo	1	1	0	1	7	11	21
Total	3	4	7	8	22	56	100
FS	2	3	1	4	8	18	26
FIS	1	1	6	4	14	25	30
X^2		5.4*					

Note-, **, *** indicated that the coefficient are statically significant at 10%, 5% and 1%*
FIS = Food insecured household, FS = Food Secured Household
Source: own field survey, 2012

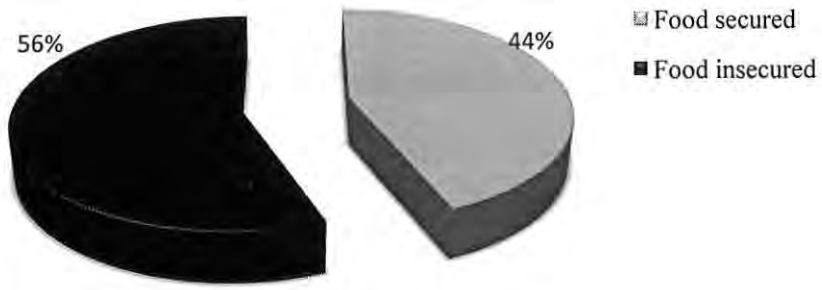
Number of months of the year that sample households of different AES failed with food shortage was also examined in this study. From the total sample households, about 38.3% of respondents live without food 1-2 month/s and 46.8% and 14.9% of household from the total are faced food shortage 2-3 and above 3 moths respectively. Respondents from Kurar (72.7%) and D/Kelemo (60.0%) perceive that, there is food shortage period more than 2-3 months.

Sample households were also asked their perception about their food preferences that they eat. According to their response, 81.0% of respondents do not eat the food that they preferred. Even though they produce food for the year-round for their consumption, majority of households do not eat the food they prefer and only 19.0% of households eat food they preferred.

4.4 Food security and Food Availability

The result of the HFBM reveals that from the total sample households, 44% households are food secured who fulfill the minimum recommended daily calorie (2100 Kcal/adul.equ) demanded for their households. While 56% of them failed to supply this daily minimum requirements.

Fig 5: Pie chart for food secured and in secured households

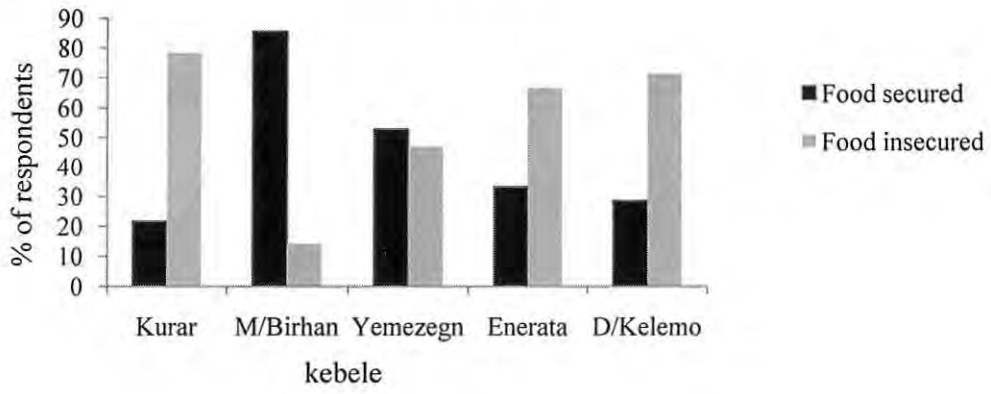


Source: Own field survey, 2012

Majority of food insecured households are from lowland and valley fragmented (Kurar) which constitute 78.3% (N=23) followed by hilly and mountainous highlands (D/Kelemo- 71.4%) from 21 sample households. On the contrary majority of food secured households are from mid land plain with black soil (M/Birhan-85.7%) and from mid land plain with brown soil (Yemezegn-52.9%) and 33.3% of households from Enerata were food secured.

The chi-square test was computed to show if there is any a statistical difference between food secured and food insecured households among five kebeles. And the result shows that there is a significant difference between food secured and food insecured among the sample AESs at 99% confidence level ($X^2=22.86$, $P<0.001$).

Fig 6: Food security status of sample kebele



Source: Own field survey, 2012

4.4.1 HFBM Balance Sheet Result

The balance sheet of HFBM reveals that the mean per adult equivalent kilo calorie of the sampled household is 3244kcal/daily/adul.equ., which is above the minimum daily requirement set by the national standard of 2100 kcal/daily/adul.equ. But the distribution of this average energy available

in each of sampled household is further expose out that it is highly dispersed among the sampled households with a large amount of standard deviation (Std. Dev =2709).

These conditions create groups of household that one could achieve in fulfilling the minimum energy requirement in their household while the second groups failed to do so (food insecured). One could also learn that the extent of food security situation among the sample households in line of food availability stretches along at a range of 241 kcal/daily/adul.equ to 19716.7 kcal/daily/adul.equ. These minimum (241kcal/daily/ad.equ) and maximum (19716.7kcal/d/ad.equ) is found in Enerata and M/Birhan respectively.

Table 10: Household food balance sheet result

HHFBM Items on kcal/d/ad.equ	**Mean**		**All sample**				**t-test**
	FS	FIS	Min	Max	Mean	SD	
Total grain produced	9022.3	2722.2	1037.4	41798.3	5494.3	5637.2	.000***
Total grain purchased	254.3	100.9	.00	3767.1	168.4	508.0	.001***
Food grain as Remittance	8.3	4.5	.00	368.1	6.2	41.2	.133(NS)
Food grain left from Previous season	932.4	56.8	.00	10327.8	442.0	1649.2	.009*
Subtotal of 1+2+3+4	10217.4	2884.6	1169.00	42803.8	6111.0	6527.6	.000***
Grain for Post harvest	1024.8	296.6	103.74	4179.8	617.0	705.0	.000***
Grain for seed	925.9	361.6	.00	5241.9	609.8	763.0	.000***
Grain for market	2391.4	586.9	.00	26189.1	1380.9	3196.7	.000***
Grain as gift for others	387.1	36	.00	5057.9	190.5	774.7	.016**
Grain to be left for next season	155.2	0.3	.00	2513.8	68.5	343.9	.049**
Sub Total of 5+6+7+8+9	4884.5	1281.5	216.7	34746.5	2866.9	4958.8	.000***
Net available/d/ad.eq	5332.9	1603	241.6	19716.7	3244.1	2709.5	.000***
Food grain Market	2137	478.8	-	26189.1	1208.4	3291.3	.000***

Note-, **, *** indicated that the coefficient are statically significant at 10%, 5% and 1% respectively, FIS=Food insecured household, FS= Food secured household*

Source: Own field survey, 2012

The result of the food balance sheet of HFBM in the above table also illustrate that food secured households have greater capacity to produce their own production, a better stock that was left from previous production and have greater capacity to take a food reserve for coming season.

Food Grain Market balance for the household show that food secured household have statically greater average net energy supply for the market in terms of grain energy than the food insecured groups. Even though mean for the samples household show they are net food sellers for the market and both food secured and insecure groups have a net food grain sellers , the data output of the HFBM reveals that there are household that are supplying their household energy as a net food grain buyers. Furthermore, from the result of the key-informant interview and group discussion the current food market price increase trends reward the net food grain sellers, while net food grain buyers are suffered with the price and make their household food security more vulnerable with external price factors for grain market.

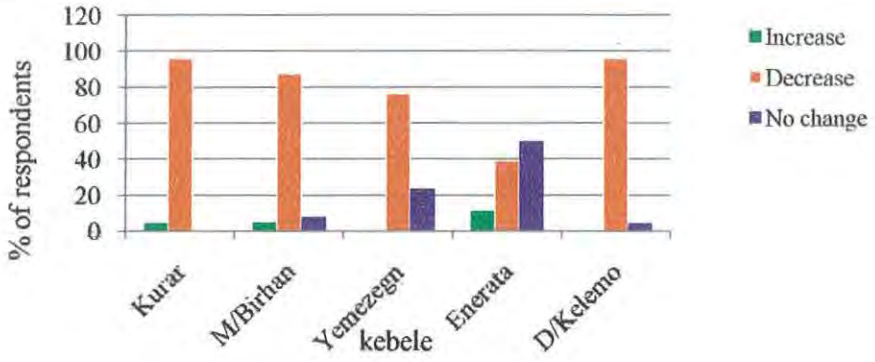
4.4.2 Food Availability and Agricultural Production

Agricultural production and food availability are just one part of the food security. Agriculture in Ethiopia is important for food security in two ways: it produces the food people eat; and (perhaps even more important) it provides the primary source of livelihood for the majority of the working population.

The level of agricultural productivity of a household determines the food security status of a household. This is due to the fact that the greater share of household food energy available is derived from household's own agricultural production. In fact small holder farmers in the study area and all over country at large produce for their own consumption and very insignificant part of the household food economy is exchanged. Agriculture in the choke mountain is predominantly

household's land is decreased in the study area under investigation. Some of the households also reveal about increment and no change of farm size.

Fig 9: A change that has happened to the size of farmers' land holdings starting from they produce in that land.



Source: own field survey, 2012

All respondents were asked about reason for increment, decrement and about no change. The reported reasons for the decline of land holding size includes: land degradation and increase of grazing land (75%) and loss of land to others by redistribution (50%) from the entire sample households.

Land degradation in Choke Mountain is the main constraint to agricultural productivity. Lowland and valley fragmented (Kurar) and hilly and mountainous highlands (D/Kelemo) are the victim kebeles by land degradation that reduce agricultural productivity and in turn affect food security. Belay et al., (2013) also shows that land degradation is the main constraint for production in the same area. According to key informant interviewees and focus group discussants from D/kelemo, land degradation before this time occur during June, July and August; where these months are highly rainy and flood occur and leads to soil erosion. However now a day, it continues up to

October and December which is a harvest time and reduce crop productivity. This is due to climate variability and extreme weather events like flooding.

Population growth has also led to a high level of fragmentation of land in the study area. Hence, acquiring a relatively large tract or tracts of land for farming is a difficult task thereby size of land degraded. When farm land is fragmented to their family, then piece of land will be more vulnerable to other extreme weather events like flooding.

On the other hand, those who got additional land mainly benefited from farming mountainous and hill lands (83.3%) and clearing land for farming or deforestation (33.3%). Recent land reallocation by government and a few households from purchasing land as well as from renting land through share cropping arrangements are also means of increasing land size according to focus group discussants.

15% of total sample households reveal, the size of land holding is constant. This may be partly explained by the fact that the size of the holdings is small and already below the optimal. This fact holds true for Enerata, Yemezegn and D/kelemo respectively even if the percentage is very small.

4.4.4.2 Topography and Fertility Status of Farm Land

The farmers were asked to identify the general topography and fertility status of their farm plots. Because, topography and fertility status of farm plot are determining factor of agricultural productivity and food security status of households. Households from lowland and valley fragmented (Kurar) and hilly and mountainous highland (D/Kelemo) reveal that topography of their cultivated land is hilly and sloppy with mountainous land and not fertile and somewhat fertile with regard to soil fertility status (table 12). This type of topography and low fertility status of soil

is not suitable for agricultural activity and then cause for food in security. Plain level of cultivated land and fertile soil with minimal soil erosion and other degradation problem characterize M/Birhan (AES 2) and Yemezegn (AES 3). Enerata is prone to moderate soil erosion and associated degradation.

Table 12: Topography of cultivated land by a sample household and food security status

Kebele	Plain		Hilly		Highly sloppy		Mountainous	
	No	%	No	%	No	%	No	%
Kurar	0	0.0	18	78.3	5	21.7	0	0.0
M/Birhan	20	95.2	1	4.8	0	0.0	0	0.0
Yemezegn	15	88.2	2	11.8	0	0.0	0	0.0
Enerata	3	16.7	8	44.4	5	27.8	2	11.1
D/Kelemo	1	4.8	18	85.7	2	9.5	0	0.0
Total	39	39.0	47	47.0	12	12.0	2	2.0
FS	28	63.6	13	29.5	3	6.8	0	0.0
FIS	11	19.6	34	60.7	9	16.1	2	3.6
X^2			20.65**					

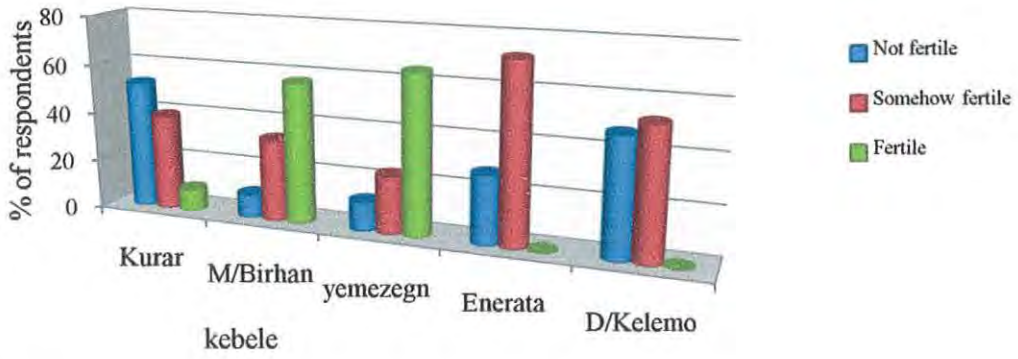
Note-, **, *** indicated that the coefficient are statically significant at 10%, 5% and 1% respectively, FIS=Food insecured household, FS= Food secured household*

Source: Own field survey, 2012

As the result show, there is a statistical systematic difference between food security status and topography of cultivated land. Food secured households have more of plain land with small proportion of hilly, highly sloppy and mountainous where as sloppy hilly mountainous slop of land dominate food insecured kebeles. Eshetu's (2000) work also shows that food has a negative and significant impact on per capita food kilocalorie availability and farmers residing in mid altitude areas are a better position than those residing in high altitude areas regarding per capita food kilocalorie availability.

Food security status of sample household is also determined by fertility status of cultivated land and there is s statistical difference between fertility status of cultivated land and food security status of sample households ($X^2=6.889$, $P<0.05$).

Fig10: Fertility status of farm land by sample kebele

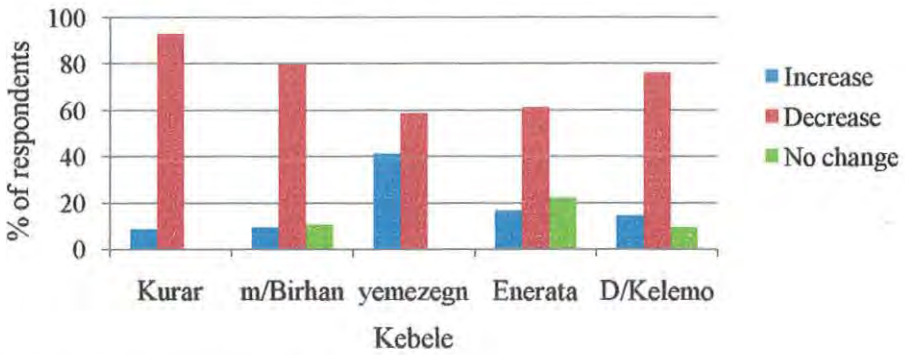


Source: Own field survey, 2012

4.4.4.3 Land Productivity

More than 75% of the total sample households (77%) reveal that, the productivity of land decrease while the remaining 17% and 6% of them give as land productivity increase and remain the same respectively.

Fig 11: A change in land productivity by kebele



Source: Own field survey, 2012

According to the survey result, 61% of total sample respondents especially those from Kurar and D/Kelemo put that, land productivity decrease due to land degradation. Because these two study areas are highly vulnerable to extreme weather events since the topography is sloppy and is more sensitive for flooding. Land degradation, therefore depressing land productivity per unit area and

availability of food from domestic harvest and was a major factor affecting household food security.

The second and third reasons for decrement of land productivity following land degradation are drought and low and variable rain fall patterns. The fourth reason for decrease of land productivity is insect pest and weeds. The farmers felt that insect pest and weeds negatively affected agricultural production and were most important problem that lowered the productive potential of production and affected household food security.

Some respondents (5%) reveal that the reason for increment of land productivity is increasing fertility of soil. Strong extension service and suitable weather condition are also reason for the increment of productivity of land (16% and 2%) according to the survey result respectively.

Table 13: Crop productivity for sampled household by food security type

Crops produced /qun/year	FS		FIS		All sample				t-test
	Mean	SD	Mean	SD	Min	Max	Mean	SD	
Teff	9.04	7.0	3.64	2.62	0.00	40	6.02	5.69	.000***
wheat	7.51	7.94	2.45	2.59	0.00	40	4.68	6.12	.000***
Barley	1.62	3.16	0.13	0.42	0.00	13	0.34	1.47	.000***
Maize	6.44	8.06	2.47	3.61	0.00	35	4.22	6.2	.000***
Sorgum	1.04	3.41	2.06	3.22	0.00	19	1.65	3.33	.000***
Engdo	1.47	3.48	2.09	3.5	0.00	15	1.82	3.49	.000***
Potato	4.73	8.62	3.42	5.25	0.00	35	4.00	6.94	.000***
Nug	0.69	1.71	0.43	1.16	0.00	6	0.55	1.43	.001***
Bean	1.62	3.16	0.13	0.42	0.00	15	0.79	2.23	.023**
Banana	0.04	0.3	0.11	0.43	0.00	2	0.08	0.38	.029**
Cabage	0.35	0.93	0.07	0.32	0.00	5	0.19	0.67	.005**
Onion	0.02	0.15	0.00	0.00	0.00	1	0.01	0.10	.014**

Note-, **, *** indicated that the coefficient are statically significant at 10%, 5% and 1% respectively, FIS=Food insecured household, FS= Food secured household*

Source: Own field survey, 2012

4.4.5 Cause of Seasonal Food Shortage

The designing of the main instrument for the inquiry on why farm households were unable to produce adequate food at home was largely based on household survey and focus group discussion. There are different constraints that hinder agricultural productivity and then induce food insecurity. Not all constraints have equal magnitude of influence on each household and in each AES. Hence, in order to identify the impact of the main perceived cause of food shortage, sample households were asked to respond to each constraint according to their severity to identify and prioritize agricultural problems, which had back the production and the growth of productivity.

The household's rated erratic rainfall, dependency on single harvest, drought and land degradation as most influcial of all study area. From the household survey of total sample households, 98% of respondents reveal that erratic rainfall is both severe and more severe leading reducing productivity and then shortage of food. One key informant interviewee from Enerata stated that, 'rain does not come as it formerly used to, rains these days do not fall at the appropriate time; previously started at the end of February and March at all but now it goes up to June; and the weather is now hotter than in the past'. Woldeamlak (2009) also stated that, virtually all food crop agriculture in Ethiopia depends on rainfall that is frequently erratic and unpredictable.

Dependency on only a single harvest affects production in the study area. 44% and 34% of sample households were responding that dependency on single harvest affect food production severely and more severely respectively.

From the entire households 77% of households' response that land degradation is more severe (30%) and sever (47%) impact on food production through hindering agricultural productivity. At a kebele level, Kurar and D/Kelemo are highly affected by land degradation which leads to soil

erosion and then leaching of soil fertility which is not productive. None of the respondents from these two kebele responded the effect of land degradation as nil rather all of them are included in more severe, severe and moderately. Although land degradation is also a problem for producing food in M/Birhan, Yemezegn and Enerata, the degree of their severity is much differs from Kurar and D/Kelemo (See appendix C).

About 71% of total sample households reflected that, drought is a major cause for food shortage severely and more severely. For more than three decades, Ethiopia has experienced recurrently deadly droughts including those of the 1972/3, 1984% and 2002/03. Drought has a long term effects in reducing the economic base of households, thereby leading to chronic and acute food insecurity. Household's vulnerability to food insecurity increase during protracted drought through progressive depletion of food stocks and capital assets (Markos, 1997).

The farmers felt that insect pests and weeds negatively affected agricultural production and were rated as the most important problem following erratic rain fall, dependency on a single harvest, drought and land degradation. Insect pest and weeds were perceived as a major cause of household food security because they lowered the productive potential of domestic production. 68% of the total sample households explained that pest and weeds infestation as more severely and severely. As compared to the other kebeles', Yemezegn is highly affected by insect pests and weed infestation. As it is shown in appendix C, sample households from this kebele were 17 and all respondents were failed with severe (n=9) and more sever (8%). According to focus group discussants, this insect pest and weed infestation occur due to climate change particularly drought and they reflect that before this time the temperature was normal but now a day temperature increase from time to time and become cause for insect pest and weed infestation which leads to degradation of productivity.

The opportunity to diversify cash income through employment in off farm or non- farm activities appear very limited in Choke Mountain Agroecosystem. Lack of cash impacts not only farmer's livelihoods, but also directly reflects a lack of capacity to modernize agricultural systems which in turn impact negatively on households food security. The lack of cash among farmers results in the inability to purchase farm inputs and a limited scope to innovate outdated and overused farm implements. Consequently, both labor and land productivity was low. Some of sample households attributed poor productivity and food shortage to the inability to purchase and properly apply modern farm inputs and to unproductive traditional practices.

Access to farm credit could compensate for small farmer's cash deficiencies. However, some of the respondents indicated that no such support was provided by the government or government partners. Agricultural extension services were weak due to low resources and poor commitment by the ministry of agriculture towards strengthening the extension services.

Shortage of labor was also indicated as a constraint affecting agricultural production and food security. Post harvest grain loss due to poor storage structures were indicated as one of the constraint to household food security. Considering the already low production, the poor post harvest handling further affected household food security through diminishing the amount of available food from domestic production.

In addition to household survey, different constraints for household food security were explained households during focus group discussion in each kebele. Health problems were as one important cause of food shortage through constraining agricultural production. Malaria was identified as the main diseases affecting production especially in Kurar through loss of labor for farm operation.

The outbreak of an epidemic during critical agricultural operations such as cultivation, weeding and harvesting adversely affected agricultural productivity.

Lack of draught animals greatly affects livelihoods presented by group of households during focus group discussion. Farmers with no draught animals cannot prepare their farmlands in a proper manner. They had either to rent out their land to others farmers with adequate draught power or rent draught animals. This is in both circumstances, farmers' loss some of their produce through shares or income, which diversely affects household food security. Other studies such as Tilaye (2004) in Gera Keya woreda in Amhara region also shows the same result for cause of food shortage.

4.5 Food Accessibility and Result of HFIAS Model

4.5.1 Household Food Insecurity Access-related Condition

This indicator provides specific, disaggregated information about the behaviors and perceptions of the surveyed households. They measure the percent of households experiencing the condition at any level of severity. HIFAS could explore that the problem of food insecurity is severe from one to nine. And the percentage of sample household experienced the food insecurity access related problem decrease from worry that their household would not have enough food (73%) to its severe condition which is spent whole day and night without eating anything (4%) because there was not enough food in the small holder farming households.

The result of HFIAS indicates that mean value for all sampled household is 6.06 with a standard deviation of 5.47. The result also shows that, the mean value for Kurar kebele is greater than other kebele. The maximum score for HFIAS is found in Kurar (23.0) and Enerata with the same value.

4.5.4 Household Food Insecurity Access Prevalence

The Household Food Insecurity Access Prevalence (HFIAP) indicator can be used to report household food insecurity (access) prevalence and make geographic targeting decisions. The HFIAP indicator categorizes households into four levels of household food insecurity (access): food secure and mild, moderately and severely food insecure. Households are categorized as increasingly food insecure as they respond affirmatively to more severe conditions and/or experience those conditions more frequently.

A food secure household experiences none of the food insecurity (access) conditions, or just experiences worry, but rarely. A mildly food insecure (access) household worries about not having enough food sometimes or often, and/or is unable to eat preferred foods, and/or eats a more monotonous diet than desired and/or some foods considered undesirable, but only rarely. But it does not cut back on quantity nor experience any of three most severe conditions (running out of food, going to bed hungry, or going a whole day and night without eating).

A moderately food insecure household sacrifices quality more frequently, by eating a monotonous diet or undesirable foods sometimes or often, and/or has started to cut back on quantity by reducing the size of meals or number of meals, rarely or sometimes. But it does not experience any of the three most severe conditions. A severely food insecure household has graduated to cutting back on meal size or number of meals often, and/or experiences any of the three most severe conditions (running out of food, going to bed hungry, or going a whole day and night without

eating), even as infrequently as rarely. In other words, any household that experiences one of these three conditions even once in the last four weeks (30 days) is considered severely food insecure.

Table 17: Household food insecurity access prevalence

Kebele	Number of respondents				Total
	Food secured	Mildly food insecure	Moderately food insecure	Severely food insecure	
Kurar	4	0	6	13	23
M/Birhan	8	8	3	2	21
Yemezegn	8	5	3	1	17
Enerata	5	4	4	5	18
D/Kelemo	3	2	9	7	21
Total	28	19	25	28	100

Source: Own field survey, 2012

HFIAS prevalence results for sample households show that, 28% of total sample households are food secured. The rest 19%, 25% and 28% of respondents are faced with mildly, moderately and severely food insecured respectively. From the above table, one can conclude that, majority of sample households who constitute severely food insecured are households from Kurar (N=23, from this, 13 households are included under severely food insecure) followed by D/Kelemo (N=7). On the contrary, majority of households from M/Birhan and Yemezegn constitute under food secured and mildly food insecured classification of HFIAS prevalence.

4.6 Food Accessibility and its Factors

Climate change may have a variable impact on its access to food. A decline in agricultural productivity suggests adverse effects on the family income and quality of life through affecting the physical and financial factors as well as social and political factors. For the purpose of this study, only physical and financial factors will be discussed.

4.6.1 Food Accessibility and Physical Capital

Availability of technologies and accessibility to markets are the two indicators of physical capital. Both of these indicators are predictive of the potential for diverse household income sources.

4.6.1.1 Access to Modern Technology

Access to modern technology and the ability of farmers to use these modern technologies determine the level of productivity; in turn affect food accessibility and have an impact on food security status of farmers. Various studies in our country have proved that appropriate application of modern farm inputs such as fertilizers, improved seeds varieties, pesticides and irrigation can increase crop yield and productivity. Because of this fact, Ethiopian farmers have been for long encouraged to adopt utilization of modern farm inputs. The importance of these inputs becomes more significant in highly eroded soils and fragile environments as in Choke Mountain to improve land productivity and to boost overall productivity (Belay et al., 2012). Therefore, usage of modern farm inputs is expected to enhance farm households' food security. The sample farmers were asked whether they have access to use modern farm inputs to enhance yields of their crops.

Among the technological inputs, fertilizer use is one of the most important variables, which could have immense impact on households' food security. In fact, the majority of farm households use chemical fertilizer i.e 77% from total sample households use fertilizer. According to Belay et al., (2012), in the Choke Mountain Watersheds, on the average 75.2% of the sample surveys are applying chemical fertilizers for their crop production which is almost equal to the result of this study. However, the amount of fertilizer used by households per hectare is different from one kebele to another. For example, all of the respondents from M/Birhan and 94.1% from Yemezegn used chemical fertilizer to increase their productivity as they have the ability or financial capacity

to purchase fertilizer. However, only 29.8% of households use chemical fertilizer from D/Kelemo. Focus group discussants from Kurar and D/Kelemo stated that:

"Chemical fertilizer is very important to produce annually adequate food. However, since we are most vulnerable by climate change and our assets are deteriorated from time to time by extreme weather events like flooding and drought, utilizing more chemical fertilizer is difficult for us even if our farm lands need more fertilizers. Because, we might got fertilizer in credit from government. So, if the crops that we produce may fail due to extreme weather events and erratic rain fall, it is impossible to payback that credit. Thus to minimize this fear, we prefer to produce crops that do not need much more fertilizer especially Engdo, Barley and Potato in D/Kelemo (AES 5) and Sorghum in Kurar (AES1). The same households also reported that instead of using chemical fertilizer, they used traditional fertilizer the so called 'Compost' for growing crops".

One key informant interviewee from D/kelemo, who is a religious leader with age 89 whose name is Aba Dessie also stated that:

"When I was a young around 1940_s, 50kg of chemical fertilizer was bought by only 18 birr and at that time farm land was not degraded and we can produce all types of crops only by 50kg of fertilizers with high productivity. But now a day, 18 birr is radically increased in to 700 birr and above this and degradation of our farm land increase due to climate change. Because of this, it needs more and more chemical fertilizer but we don't have a capacity to purchase it".

Regarding the relationship between fertilizer use and food security, the per capita kilocalorie available for households, which do use chemical fertilizer, is higher than that of households which do not use chemical fertilizer. Those respondents from M/Birhan and Yemezegn use chemical fertilizer and produce their own annual production as compared to Kurar and D/Kelemo.

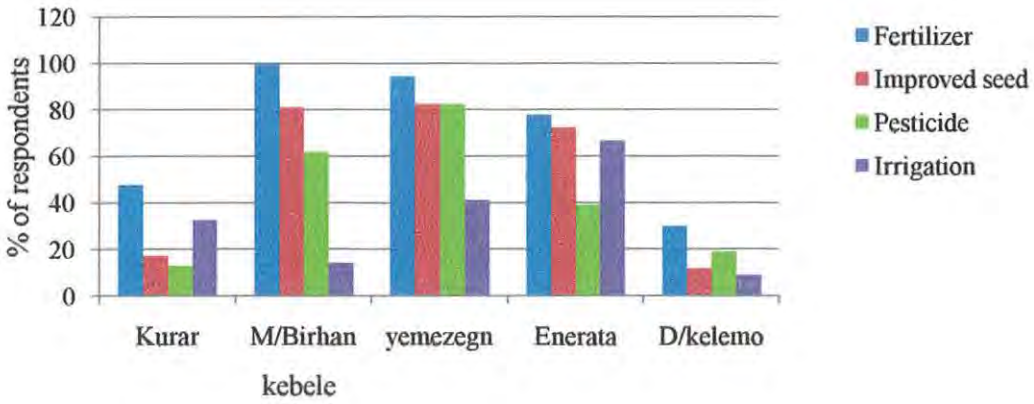
Households from Enerata use chemical fertilizer in a moderate level. The result also shows that there is statistically significant systematic relationship between food security situation and fertilizer use with $X^2 = 0.197, P < 0.05$.

With regard to the use of improved seed, few improved varieties of crops are available in the area. Of all the sample farmers only 54% of them have ever used yielding varieties. 82.4% and 80.9% from mid land plain with brown and black soil respectively use improved seeds as they have financial capacity or ability to purchase seed and become more productive while only 11.7% of households from D/Kelemo use improve seeds.

The chi square test was run to test the relationship between improved seed and food security situation and the result shows that there is no statistically significant systematic relationship between food security and improved seed with the *chi square value of 0.616 and p >0.1.* The reason behind this might be lack of adaptive improved crop varieties for different agro ecological conditions.

Although the problem of pest, disease and weeds have been reported by farmers to be severe and more severe, only few respondents have pointed out that they use pesticides. Only 41% from the total sample households have been used pesticide especially in areas where there is highly vulnerable to pest and weed infestation. 82.4% and only 13% of respondents from Yemezegn and Kurar use pesticide respectively. In line with their relationship between food security and utilization of pesticide, the result shows that there is a statistical systematic relation relationship between food security and use pesticide at 1% significant level ($X^2=27.46$ *and* $p<0.001$).

Fig 12: Distribution of modern agricultural inputs by sample kebele



Source: Own field survey, 2012

Another important variable is irrigation which is important to create accessibility of households to food security. Those who use irrigation were mostly produce marketable products and farmers might have ability to purchase food from market by selling irrigated products. However application of irrigation varies across Agroecosystems. Of all sample households, 41% of them use irrigation. From this, majority of household's i.e 66.7% and 41.2% of households are from Enerata and Yemezegn while only 9% from D/Kelemo also use some form of irrigation.

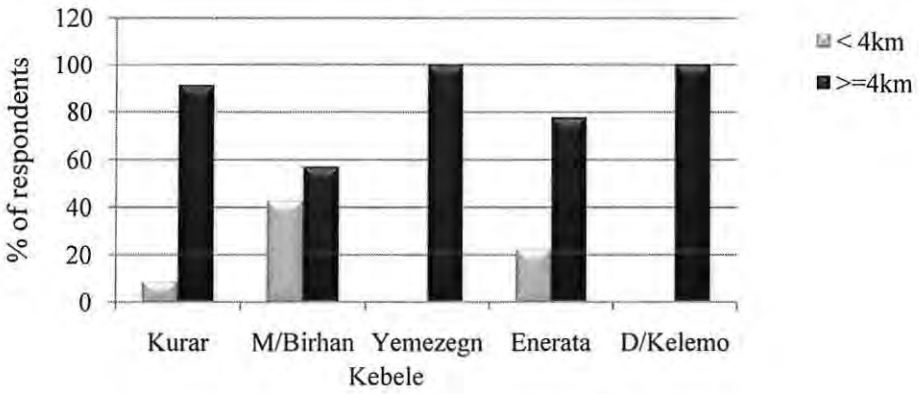
There is a statistical systematic relationship between food security and use of irrigation at 1% significant level *(X^2= 29.2, p <0 .001)*.

4.6.1.2 Access to Market

Access to market is also another important variable with implications to food security. Several household food security studies reveled that access to market, which is measured through indicators like proximity to nearby town, has impact on food security that households which are near to market and towns are in a better position in terms of food security than those which are far from market places and towns.

According to survey result, of all sample households, 85% of respondents reported that there is no access to market as they travel ≥4km to reach a market. All sample households from Yemezegn and D/Kelemo reveal that, the nearby market is found after going to ≥4km from their residence. This is very difficult to sell their own product and to buy necessary food from market easily. Furthermore, as focus group discussants stated that in summer season, going to market is difficult even by using travel; where this season is a period of food shortage, because of extreme weather events especially flood. All bridges are broken down and taken away by flood. Owing to this, movement of people to market to sell and buy some commodity is worrisome for those who do not have a nearby market. They also stated that even if they have a financial capacity the net buying rural farmers are not able to buy food from their village without access to road as extreme weather events like flooding are serious threat for poor rural roads especially for bridges.

Fig 13: Accessibility of market for sample kebeles'



Sources: Own field survey, 2012

Majority (91.3%) from Kurar, 77.8% from Enerata and 57.2% households from M/Birhan also reveal that, an opportunity to get a nearby market is difficult and it far more than 4km from our residence and this affect households ability to buy and sell some commodity; in turn have an impact on food accessibility of households in particular and food security in general. Mekbib et al.,

(2011) also stated that, markets play an important role especially in the so called 'hunger season' from June to August when crop yields are low, large amounts of the needed food have to be bought from markets.

4.5.2 Food Accessibility and Financial Capital

Financial capital consists of stocks of money or other savings in liquid form. In this sense it does not includes financial assets only but should also include easily disposable assets such as livestock. Livestock production plays an important role in Ethiopia's economy. Almost the entire rural population was involved in some way with animal husbandry whose role included the provision of draft power, food, cash, transportation, fuel and for social prestige although varying from one area to another. Of all livestock species, oxen play a very important role in the farm economy of the mixed farming system of rural Ethiopia (Degefa, 2002; Temesgen, 2010).

Hence, oxen holding show the wealth status of a farm household and are mostly positively related to food security. T- test was run to test the hypothesis that food secure households have larger oxen holding than the food insecure households. The result of the test shows that the average oxen possession for food insecure households is 2.214TLU and that of the food secure households is found to be 2.795TLU. This difference in mean oxen holding between food secure and insecure households is found to be statistically significant with $t = 13.00$, $P = 0.043$.

Small ruminants are reared by farmers for the purpose of store of asset and for sales in cases of immediate cash need to purchase food grain at times of crop failure or low yield. They also responded that the sheep and goat are sold to settle debts.

The average small ruminants (sheep, goat and chicken) holding for the entire sample size is 0.061TLU with standard deviation of 0.0052. The minimum small ruminant holding is zero while the maximum is 0.25TLU. The t-test also shows that there is significant difference in the mean number of small ruminant possession between food secure and insecure households at 0.05 significance level ($t = 11.54$, $P<0.05$). The mean number of small ruminants for the food insecure households is 0.0519TLU, which is lower than the corresponding figure of 0.725TLU for the food secure households.

Pack animals also sell in time of lack of cash income to purchase food from market followed by small ruminant. The average value of pack animals for the entire sample household is 0.7265TLU with a standard deviation of 0.957. The minimum and maximum value of pack animal is zero and 5.59TLU respectively.

Table 18: Average distribution of livestock in terms of TLU

Kebele	Cattle	Pack animal	Small ruminant
Kurar	3.27	0.34	0.06
M/Birhan	4.56	1.57	0.10
Yemezegn	5.16	0.25	0.03
Enerata	4.95	0.70	0.057
D/Kelemo	3.80	0.69	0.038
All sample	4.28	0.72	0.06

Source: Own field survey, 2012

Households sell different animals during shortage of food. But the price of animals is influenced by the size and condition of the animals, the season of the year and the distance from the main marketing centers. There is seasonal fluctuation in the price of animals coming to the market. In general, animal prices are higher during the rainy season and falls during the dry season. During the dry season animals lose body condition due to shortage of feed and the farmers also

desperately need to sell their animals before further loss of condition and death and to buy grain for family consumption.

Respondents also asked about the trends of animals during the past ten years and 14% and 9% of the total sample households reveal that trend of animals increase and no change respectively. Majority of households (77%) from the entire sample reported that number of animals decrease from time to time.

Table 19: Households response about trend of animals from the last ten years

Kebele	Increase	Decrease	No change
Kurar	26.1	47.8	26.1
M/Birhan	9.5	90.5	0.0
Yemezegn	29.5	70.6	0.0
Enerata	0.0	94.4	5.6
D/Kelemo	4.8	85.7	9.5

Source: Own field survey, 2012

The deterioration of livestock production and the reduction in herd size were asked and households give thier response. 88.2% and 86.0% of total sample households reported that lack of additional fodder and shortage of grazing land are the main costraint of rearing aniamls. Extreme weather events like drought is the main reason for shortage of food. Lack of feed and water during the dry season and drought is the main constraint affecting livestock production in the area.

In turn shortage of feed and water and the harsh climatic condition of the area seriously affect the health and productivity of animals. Animal disesas as being a further serious constraint on livestock production and productivity in the study area. 76.3% of households stated that prevalence of diesease was the major constraints to livestock production especially those from D/Kelemo

(100%), M/Birhan (94.7%) and 94.1% from Yemezegn are highly affected by disease. Tempratue increase from time to time and creat suitable condition for animal and crop disease. Like wise, Adane and Gezahagn (2007) laso stated that, trypanosomosis is a major disease of cattle in the areas bordering the Blue Nile River of East Gojjam zone with an overall infection rate of 8.2%.

Although there is a high prevalnec of disease, there is no access veternary service for aniamls and 71.0% of total sample households reveal about shortage of sufficent vetrnary services. According to focus group discussants, veternary service is available only at woreda level and it is difficult to go to woreda level with animals by foot especially in summer season (June-August) where this season is very rainy season. Conflict on grazing land and water is also another reason for decreament of animals and reported by 61.3% from the total sample household. In general, all the physical household asset and financial asset (livestock holding) culminates in having easier access to food in the sample kebeles'.

Table 20: Households' response for cause decresing ternd of livestock production

Cause		Kurar		M/Birhan		Yemezegn		Enerata		D/Kelemo		Total	
		No	%	No	%	No	%	No	%	No	%	No	%
Shortage of grazing land	Yes	18	90.0	19	100.0	17	100.0	13	76.5	13	65.0	80	100
	No	2	10.0	0	0.0	0	0.0	4	23.5	7	35.0	13	100
Lack of additional fodder	Yes	16	80.0	19	100.0	13	76.5	14	82.4	20	100.	82	100
	No	4	20.0	0	0.0	4	23.5	3	17.6	0	0.0	11	100
Prevalence of diseases	Yes	10	50.0	18	94.7	16	94.1	7	41.2	20	100	71	100
	No	10	50.0	1	5.3	1	5.9	10	58.8	0	0.0	22	100
Lack of sufficient veterinary service	Yes	4	70.0	18	94.7	16	94.1	8	47.1	10	50.0	66	100
	No	6	30.0	1	5.3	1	5.9	9	52.9	10	50.0	27	100
Conflict on grazing Land and water	Yes	17	75.0	16	84.2	8	47.1	7	41.2	11	55.0	59	100
	No	5	25.0	3	15.8	9	52.9	10	58.8	9	45.0	36	100

Source: Own field survey, 2012

4.6.3 Food Security, Climate Change and Adaptive Capacity: Link

In general all AESs have different food security status due to different adaptive capacity and level of vulnerability to climate change. As data from Fenet Belay (2013) indicates, the vulnerability of AESs by climate change vary from lowland and valley fragmented (AES1) to hilly and mountainous land (AES5).

Table 21: Adaptive capacity, Vulnerability and mean value of kcal and HHFIASS

Kebele	Adaptive capacity	Vulnerability	Mean kcal/daily/adul.equ.	Mean value of HHFIASS
Kurar	0.26	0.70	2250.79	8.78
M/Birhan	0.73	-0.66	5531.59	4.95
Yemezegn	0.78	-0.72	3254.26	4.05
Enerata	0.45	0.48	2605.53	6.94
D/Kelemo	0.25	0.76	2583.98	5.05

Note: HHFISS- Household food insecurity access scale score

Source: Own field survey, 2012 and Fenet Belay, 2013

AESs having a good adaptive capacity (AES 2 and AES 3) is less vulnerable to climate change and variability as compared to less adaptive capacity. In addition to this, the mean kcal for M/Birhan (AES2) and Yemezegn (AES3) is high while the mean value for households food insecurity access scale score is low. This means that the lower the score, the more food secured and become less vulnerable to climate change as they have good adaptive capacity and the inverse is true.

Rozbih (2011) also put that, all components of food security, availability, stability, access, and utilization are subject to impacts of climate change .The extent to which communities can be affected by, or be vulnerable to, such changes depends mainly on the community's exposure and its adaptive capacity.

4.7 Food Utilization and its Indicators in Choke Mountain

4.7.1 Access and Availability of Water

Respondents in the study area have to travel long distance for many hours and fetch unsafe and unreliable water from rivers. A number of areas experience considerable water stress as a result of insufficient and unreliable rainfall that changes rainfall patterns or causes flooding.

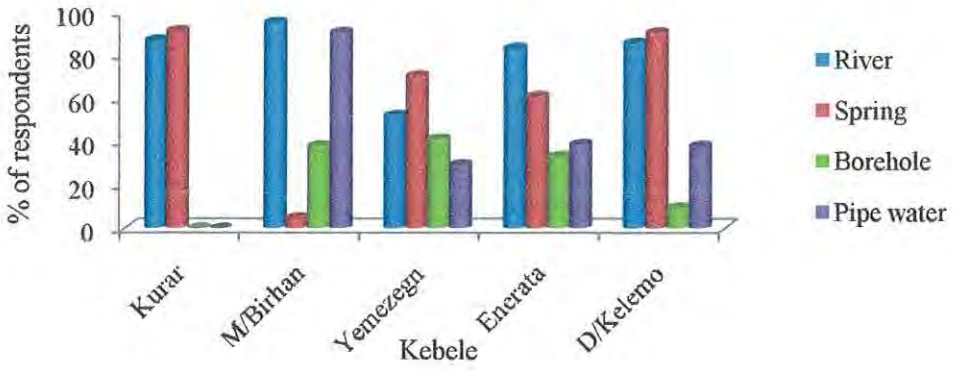
Majority (82.0%) of sample households from the total household replied that, river is the main water sources for both livestock and their livelihood. Except Yemezegn (52.9%), more than 80.0% of respondents from each kebele use river and more than half of the total sample households (54.9%) have to travel more than 0.5 km which is above the maximum standard according to MOWR (2001). According to MOWR (2001), those who fetch water by traveling more than 0.5km are vulnerable by water stress.

Regarding spring as a source of water, 64% from the total sample households fetch water from spring with a minimum distance for different purpose including for drinking and household consumption. However, due to climate change and variability especially recurrent drought affect springs and majority of spring was disappearing according to focus group discussants. Due to this reason, both livestock and human beings are affected by water stress. Different waste of animals entered in to water and become contaminated which affect human health. FAO (2008) stated that, changes in the availability of water will be an essential factor influencing food security effects of climate change. But water is not only relevant for food production and processing; it itself is an important good, needed for survival and almost all human activities.

Borehole water is also prepared by households as there is serious shortage of water as focus group discussants reported. According to them, bore hole water is highly contaminated water. However there is no alternative source for both animal and people. Only 23% of households from the total use borehole. Majority of households are from Yemezegn (41.2%) and M/Birhan (38.1%).

Another important source of water especially for drinking purpose is pipe water where the quality ensured for those who used pipe water as compared to the other sources (MOWR, 2001). 39% from the total sample households use pipe water while none of the respondents from Kurar use pipe water and borehole water. In general access to pipe water is low across the five sample kebeles where the majority of respondents use river and stream as a major source of water for various purposes. This inurn highly exposed them to varies water born diseases thus affecting their health.

Fig 14: Distribution of water type in each kebele



Source: Own field survey, 2012

4.7.2 Prevalence of Disease

As the study shows malaria, abdominal disease, eye disease and cardiac diseases are most prevalent disease in the study area caused by climatic variables. Belay et al., (2012) in the study

area and McMichael et al., (2006) also indicated that extreme rainfall events, droughts, and warming temperatures increase the incidence of disease. From the total sample households 42.0%, all respondents (100%) from Kurar kebele, 76.5% from Yemezegn, 19.0% from M/Birhan and 11.1% from Enerata replied that, malaria is most prevalent disease. Kurar is highly vulnerable by malaria followed by Yemezegn.

Abdominal diseases are the second diseases that occur in the area owing to lack of quality of water and occurrence of water bore disease. 28.6%, 16.7%, 14.3% and 11.8% from D/Kelemo, Enerata, M/Birhan and Yemezegn reported as abdominal disease prevail in their area respectively. Eye infection due to air pollution caused from wind also explained by some of the respondents: 11.0% from the total respondents especially in D/Kelemo (23.8%). Influenza and other related disease are also diseases that affect human health as focus group discussants in M/Birhan said. In general, ability of human to utilize food is affected by these different diseases in the study area.

4.6.3 Access to Health Post

When we see the access to health services in the Choke Mountain Agroecosystem sample kebeles', majority of respondents (81%) from the total sample households have access to health post. However according to focus group discussants, even though there is a health post in each kebele, it does not give the necessary services. Instead, they might got adequate health services after traveling long distances (≥4km) up to at a woreda level and in most case up to zonal level.

dependency on single harvest, lack of farm implements etc are also the cause of reduction of agricultural activities and productivities. However the magnitudes of these factors are not equal across all AESs. Data for temperature and rain fall from NMSA shows there is a change from 1981-2008 in all AES. Due to this reason crops produced are different from one AES to the other. Teff is dominant crop in AES2 and AES3 although produced in all AESs.

The study also illustrates those AESs which are food insecured in terms of availability are also insecured in terms of food accessibility. This means that entitlement to the food or income is significantly related to the daily energy availability of sample households. From HFIAS assessment, HFIAS-prevalence condition shows that most of moderately and severely food insecured households are belong to AES1 and AES5 while major proportion of food secured and mildly food insecured households belong to AES2 and AES3 followed by AES4.

Results from the study indicate that, there is a statistical difference between food secured and insecured households and utilization of modern farm inputs except improved seed. Access to market is also important source of food. Majority of sample households reveals there is no a nearby market center and 85% of sample households got after traveling long distance (≥4km).

Concerning food utilization, climate change affects food utilization of sample households through reducing the availability and quantity of water and prevalence of disease. River (80%) and spring (64%) are the major sources of water for all AESs. Malaria is most prevalence disease almost in all AESs but AES1 is highly vulnerable by malaria.

5.2 Recommendation

The following issues need to be considered to address the food security problem and to counteract the harmful impacts of climate change in the study area:

- Expansion of new varieties of crops and diversification from traditional crops to other types of crops which can with stand drought and higher temperature.
- There should be a great need for the local government through the meteorological department to provide adequate extension information services to ensure that farmers receive up-to date information about rainfall and temperature patterns in the forthcoming season so that they can make well informed decisions about their planting dates.
- Financing the food insecured area (AES 1 and AES 5) by setting up suitable financial systems that will allow small producers to have access to credit.
- Since there is environmental degradation in Choke Mountain especially in AES 1 and AES 5, supporting natural resource conservation measures that include promotion of soil and water conservation practices should be considered.
- Supporting the small-scale livestock production system through pasture rehabilitation and restocking programmes will also be important.
- Creating awareness among farmers that cultivated lands need to be managed properly to reduce surface runoff, thereby reducing peak flows and increasing.

Reference

Abate Feyissa (2009) Climate Change Impact on Livelihood, Vulnerability and Coping Mechanisms: A Case Study of West-Arsi Zone, Ethiopia. MSc. Thesis, Lund University: Sweden.

Adane Mihret and Gezahagn Mamo (2007) Bovine Trypanosomosis in Three Districts of East Gojjam Zone Bordering the Blue Nile River in Ethiopia, Addis Ababa University, *J. Infect Developing Countries,* Vol 3, No 321-325.

Agren, G. et al., (1968) Food Composition Table for Use in Ethiopia. Addis Ababa: Ministry of Agriculture and Sweden International Development Agency.

Asfaw Negassa and Jabar, M. (2008) Livestock Ownership Commercial Of-taking Rates and their Determinant in Ethiopia. Research Report 9. ILRI (International Livestock Research Institute). Nairobi; Kenya.

Belay Simane (2011) Building Resilience to Climate Change and Green Economy in the Mountain Ecosystems of Ethiopia: Integrating Research Capacity Building and Sustainable Development Activities; A case study of the Choke Mountains, Addis Ababa University.

Belay Simane, Zaitchik, B. and Desalegn Mesfin (2012) Climate Resilience in the Blue Nile / Abay Highlands: A framework for Action. *International Journal of Environmental Research and Public Health,* Vol 610-631,No 1660-4601.

Belay Simane, Zaitchik, B.F. and Mutlu, O. (2013) Agroecosystem Analysis of the Choke Mountain Watershades, Ethiopia, *Sustainability*, Vol 592-616, No 2071-1050.

Bipul, C. (2011) Climate Change and Food Security in Asia, Available at, www.wmo.int/pages/puplications/archive/../meteoworld.pdf.[accessed 19th July 2012].

Braun, J. (2008) Impact of Climate Change on Food Security in Times of High Energy Prices, A Background Paper Prepared for the International Centre for Trade and Sustainable Development and the session titled Agriculture, Climate Change and Sustainable Development at. USA International Food Policy Research Institute, Washington D.C.

Burke, M. and Lobell, D. (2008) Climate Effects on Food Security, an Overview: Advance in Global Change Research, 37, DOI 10.1007/978-90.

Coates, J., Swindale, A. and Paula, B. (2007) Household Food Insecurity Access Scale (HFIAS) for Measurement of Household Food Access: Indicator Guide (v. 3). Washington, D.C.: Food and Nutrition Technical Assistance Project, Academy for Educational Development, August 2007.

Collier, P., Conway, G. and Venables, T. (2008) Climate Change and Africa, *Oxford Review of Economic Policy* 24 (2): 337.

Debebe Habtewold (1995) Food Security: A Brief Review of Concepts and Indicators. In Mulat Demeke et al., (Eds.) (1995), Food Security, Nutrition and Poverty Alleviation in Ethiopia: Problem and Prospects. Proceeding Of Inaugural and First Annual Conference of the Agricultural Economics Society of Ethiopia, Addis Ababa.

Degefa Tolosa (1996) Belg Crop Production as a Strategy of Households' Food Security: A Comparative Study of Belg Grower and Non-Belg Farmers in Munessa Wereda, Arsi Zone. MA. Thesis, Addis Ababa University.

Degefa Tolosa (2002) Household seasonal food insecurity in Oromiya Zone, Ethiopia: S.S research Report Series- No.26, OSSREA, A.A.

Degefa Tolossa and Tesfaye Tafesse (2008) Linkages between Water Supply and Sanitation and Food Security: A Case Study in Four Villages of East Hararghe Zone, Oromiya Region. Ripple (Research-Inspired Policy and Practice Learning in Ethiopia and the Nile Region).

Dercon, S. and Krishnan, P. (1998) Change in Poverty in Rural Ethiopia 1988-1995; Measurement, Robustness, Test and Decomposition. WSP/98-7, Center for the Study of African Economies, Institute of Economics and Statistics, University of Oxford.

Devereux, S. and Maxwell, S. (2001) Food Security in Sub-Saharan Africa. London UK: Intermediate Technology Development Group Publishing.

Devereux, S. (2010) Food Security in Ethiopia, Discussion Paper for Department for International Development (DFID), Sussex University.

Elbehri, A., Genest, A. and Burfisher, M. (2011) Global Action on Climate Change in Agriculture Linkages to Food Security, Markets and Trade Policies in Developing Countries Trade and Markets Division Food and Agriculture Organization of the United Nations.

Eshetu Bekele (2000) The Underlying Causes of Household Food Insecurity and Coping Strategies. The Case of Ligambo Wereda, South Wollo Zone, Amhara Region, Northern Ethiopia. MA Thesis, Addis Ababa University.

FAO (2002) World Agriculture: Summary Report (Food and Agriculture Organization, Rome).

FAO (2003) Agricultural Extension, Rural Development and the Food Security Challenge: Extension, Education and Communication Service Research Extension and Training Division. Sustainable Development Department, Rome.

FAO (2001, 2008) Climate Change and Food Security: A Framework Document. Food and Agriculture Organization of the United Nations, Rome, Italy.

FDRE FSS (1996) Federal Democratic Republic of Ethiopia: Food Security Strategy Document. Addis Ababa.

Gero, C., Mauro, M., Benjamin, D. and Kathleen, B. (2005) Measuring Food Security Using Respondent's Perception of Food Consumption Adequacy, ESA working paper No.05-10, FAO, Italy.

Hamza, I. and Iyela, A. (2012) Land Use Pattern, Climate Change, and its Implication for Food Security in Ethiopia, *A Review*. *Ethiopian Journal of Environmental Studies and Management,* Vol. 5, No.1 2012.

IFPRI (2004) International Food Policy Research Institute, Assuring Food and Nutrition Security in Africa by 2020; Proceedings of an all Africa Conference, Uganda (Washington, DC: IFPRI, 2004).

IPCC (2001) Climate Change: Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change, edited by J. J. McCarthy, O. F. Canziani, N. A. Leary, D. J. Dokken and K. S. White (eds). Cambridge University Press.

IPCC (2007) Climate Change: Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Third Assessment Report of the Inter governmental Panel on Climate Change (Cambridge University of Press, Cambridge, UK).

Mahamed Yesuf, Falco, S., Ringler, C. and Kohlin,G. (2008) Impact of Climate Change and Adaptation to Climate Change on Food Production in Low Income Countries: Household Survey Data Evidence From the Nile Basin of Ethiopia. IFPRI Discussion Paper No. 828. International Food Policy Research Institute, Washington, DC.

Marius, K. (2009) Climate Risks and Development Projects Assessment Report for a Community-Level Project in Guduru, Oromiya, Ethiopia.

Markos Ezera (1997) Demographic Responses to Ecological Degradation and Food insecurity: Drought Prone areas in Northern Ethiopia. Amsterdam. Thesis Publishers Ph.D. Dissertation.

Maxwell, D. and Smith, M. (1992) Household Food Security: a Conceptual Review. In: Maxwell S, Frankenberger, T. Household Food Security: Concepts, Indicators, Measurements. IFAD and UNICEF, Rome and New York.

Maxwell, D. (2001) The Impact of Urban Agriculture in Kampala on Household Food Security and Nutrition Status. In Africa Crop Science Society Annual Proceedings.

Mekbib Haile, Benedict, O. and Christine, W. (2011) Implication of Climate Change on Crop Yield and Food Accessibility in Sub Saharan Africa. Interdisciplinary Term Paper, Docteral Studies Programme, University of Bonn.

Mesay Mulugeta (2009) Food Security Attainment Role of Urban Agriculture: a Case Study from Adama Town, Central Ethiopia Journal of Sustainable Development in Africa.

Mesay Mulugeta (2001) A study on Rural Households's Food Security Status: The case of Ruyuu Woreda Oromiya State. MA. Thesis in Addis Ababa University.

McMichael, A. and Woodruff, R.E. (2006) Climate Change and Human Health: Present and Future Risks. Lancet 367(9513):859–869.

MOWR (2001) Federal Democratic Republic of Ethiopia: Ministry of Water Resources, National Metrological agency, Addis Ababa, Ethiopia.

NAPA (2007) Climate Change National Adaptation Programme of Action (NAPA) of Ethiopia. Report of the Federal Democratic Republic of Ethiopia, Ministry of Water Resources, National Meteoro-logical Services Agency.

NMSA (2001) Initial National Communication of Ethiopia to the United Nations Framework Convention on Climate Change (UNFCCC), Addis Ababa, Ethiopia.

Parry, M., Ronseweing, C., Iglesisa, A., Livermore, M. and Fischer, G. (2007) Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change Cambridge University Press, Cambridge, United Kingdom and New York, USA.

Rosenzweig, C. and Hillel, D. (2006) Potential Impacts of Climate Change on Agriculture and Food Supply, Available at, http://www.gcrio.org/consequences/summer 95/ agriculture. [accessed 17th June 2012].

Rozbih, M. (2011) Rural Community Vulnerability to Food Security Impacts of Climate Change in Afghanistan Evidence from Balkh, Herat and Nangarhar Provinces; MA. Thesis, University of Waterloo: Canada.

Seyoum Mengist (2012) The contribution of Maize Technology Towards Household Food Security: The case of Asosa Woreda, Benshangulgumz, Ethiopia. Msc.Thesis, Addis Ababa University.

Schmidhuber, B. and Tubiello, F. (2005) Impact of Climate Change, Variability and Weather Fluctuations on Crops and their Produce Markets, (Impact Reports, Cambridge UK).

Stork, H., Bezabh Emamnahanu , Berhanu Adnew, Borowiecki, A. and Shimels Woldehaweriat (1991) Farming Systems and Farm Management Practices of Small Holders in Hararghe Highlands, Farming Systems and Resources Economics in Tropics, Germany, Vol 11.

35	2608.09	3767.12	368.15	0	**6743.36**	260.81	0	0	0	0	**260.81**	**6482.55**	-3767.12
36	3781.12	0	0	0	**3781.12**	439.54	957.78	361.83	0	0	**1759.15**	**2021.97**	361.83
37	4361.26	0	0	0	**4361.26**	521.9	512.16	1070.66	206.68	0	**2311.4**	**2049.86**	1070.66
38	2907.02	0	0	0	**2907.02**	290.7	432.46	155.67	0	0	**878.83**	**2028.19**	155.67
39	2383.93	0	0	0	**2383.93**	238.39	129.54	305.74	9.65	0	**683.32**	**1700.61**	305.74
40	1463.18	0	0	184.29	**1647.47**	146.32	30.56	39.85	0	0	**216.73**	**1430.74**	39.85
41	2021.79	0	0	0	**2021.79**	202.18	36.41	288.83	0	0	**527.42**	**1494.37**	288.83
42	2761.3	0	0	568.98	**3330.28**	276.13	47.49	0	18.61	0	**342.22**	**2988.06**	0
43	2080.69	0	0	0	**2080.69**	208.07	28.82	0	0	0	**236.89**	**1843.8**	0
44	1742.13	0	0	0	**1742.13**	174.21	96.16	0	0	0	**270.37**	**1471.76**	0
45	2508.59	0	0	0	**2508.59**	337.9	84.47	0	0	0	**422.37**	**2086.22**	0
46	8383.99	0	0	0	**8383.99**	838.4	298.59	0	0	0	**1136.99**	**7247**	0
47	1597.3	0	0	0	**1597.3**	159.73	38.97	21.07	0	0	**219.77**	**1377.53**	21.07
48	2277.1	0	0	213.29	**2490.39**	227.71	234.02	52.27	0	0	**514**	**1976.39**	52.27
49	1853.4	0	0	0	**1853.4**	185.34	216.72	29.65	0	0	**431.71**	**1421.69**	29.65
50	3871.79	0	0	0	**3871.79**	387.18	152.18	214.16	0	0	**753.52**	**3118.27**	214.16
51	2704.07	0	0	0	**2704.07**	270.41	42.83	551.23	0	0	**864.47**	**1839.6**	551.23
52	4112.79	0	0	1116.44	**5229.22**	411.28	71.8	65.75	0	0	**548.84**	**4680.38**	65.75
53	1778.36	0	0	145.6	**1923.96**	177.84	15.81	320.73	0	0	**514.38**	**1409.58**	320.73
54	2624.22	0	0	0	**2624.22**	325.82	194.18	99.32	0	0	**619.32**	**2004.9**	99.32
55	2088.84	0	0	432.7	**2521.53**	208.88	109.2	273.64	0	0	**591.73**	**1929.8**	273.64
56	3293.3	0	0	0	**3293.3**	329.33	261.78	818.63	0	0	**1409.74**	**1883.56**	818.63
57	3573.58	0	0	0	**3573.58**	357.36	165.73	1019.23	0	18.22	**1560.54**	**2013.04**	1019.23
58	1267.12	0	0	0	**1267.12**	126.71	29.83	149.17	0	0	**305.72**	**961.4**	149.17
59	2223.39	0	0	0	**2223.39**	222.34	129.87	0	0	0	**352.21**	**1871.18**	0
60	2169.29	0	0	0	**2169.29**	216.93	122.34	0	0	0	**339.27**	**1830.02**	0
61	3805.86	0	0	0	**3805.86**	380.59	196.5	40.42	0	0	**617.51**	**3188.35**	40.42
62	3202.63	0	0	0	**3202.63**	320.26	400.16	400.62	0	0	**1121.04**	**2081.59**	400.62
63	6568.9	0	0	834	**7402.9**	652.38	766.92	1421.43	0	556	**3396.74**	**4006.16**	1421.43
64	4188.23	0	0	1166.92	**5355.15**	414.09	881.53	897.18	291.73	0	**2484.53**	**2870.62**	897.18
65	4847.37	0	0	0	**4847.37**	484.74	653.65	276.94	0	0	**1415.33**	**3432.04**	276.94
66	19875.59	0	0	10327.89	**30203.48**	3906.15	5241.91	10218.6	5033.52	2513.84	**26914.02**	**3289.46**	10218.6
67	10156.06	0	0	0	**10156.06**	1015.61	1197.76	2978.15	0	0	**5191.52**	**4964.54**	2978.15
68	10999.3	0	0	1036.41	**12035.71**	1399.9	877.19	2048.79	0	0	**4325.88**	**7709.83**	2048.79
69	18314.9	0	0	9665.79	**27980.69**	1826.87	1853.85	4583.26	0	0	**8263.99**	**19716.7**	4583.26
70	5647.33	810.75	0	0	**6458.09**	564.73	548.69	1063.13	0	0	**2176.56**	**4281.53**	252.38
71	13281.36	0	0	0	**13281.36**	2752.08	614.67	1229.35	0	0	**4596.1**	**8685.26**	1229.35
72	8767.68	0	0	1521.76	**10289.44**	876.77	1230.94	1138.42	0	0	**3246.13**	**7043.31**	1138.42

73	2143.84	0	0	0	**2143.84**	212.47	235.96	235.96	0	0	**684.38**	**1459.46**	235.96
74	2500.4	0	0	0	**2500.4**	250.04	277.6	277.6	0	0	**805.24**	**1695.16**	277.6
75	5315.83	0	0	0	**5315.83**	531.58	331.24	1449.39	0	0	**2312.21**	**3003.62**	1449.39
76	8261.89	0	0	888.2	**9150.1**	826.19	320.56	1327.15	0	0	**2473.89**	**6676.21**	1327.15
77	4990.87	0	0	0	**4990.87**	496.96	314.07	1216.89	0	0	**2027.92**	**2962.95**	1216.89
78	17051.58	0	0	8586.55	**25638.13**	2288.97	3501.71	2951.43	5057.91	2148.19	**15948.21**	**9689.92**	2951.43
79	4072.13	0	0	0	**4072.13**	405.71	184.61	0	0	0	**590.33**	**3481.8**	0
80	14446.27	0	0	0	**14446.27**	1444.63	1014.86	4393.21	0	0	**6852.69**	**7593.58**	4393.21
81	7472.91	0	0	0	**7472.91**	747.29	537.72	0	0	0	**1285.01**	**6187.9**	0
82	14215.23	0	0	0	**14215.23**	2494.08	1890.57	2353.67	2145.08	0	**8883.41**	**5331.82**	2353.67
83	3103.27	478.13	0	0	**3581.4**	308.48	2542.59	488.67	0	0	**3339.75**	**241.65**	10.54
84	1259.33	342.47	171.23	0	**1773.03**	1773.03	421.88	673.02	0	0	**1511.91**	**261.12**	330.55
85	11792.1	38.68	0	0	**11830.78**	1179.21	897.06	3656.33	0	0	**5732.59**	**6098.19**	3617.65
86	5742.15	881.74	0	0	**6623.89**	574.22	1113.66	20.81	0	0	**1708.69**	**4915.2**	-860.93
87	2570.14	0	0	0	**2570.14**	257.01	233.98	159.04	0	0	**650.03**	**1920.11**	159.04
88	1519.94	1201.25	0	0	**2721.18**	151.99	511.52	0	0	0	**663.51**	**2057.67**	-1201.25
89	3595.89	1510.88	0	0	**5106.77**	359.59	525.95	100.73	0	0	**986.27**	**4120.5**	-1410.15
90	1037.41	1061.64	0	0	**2099.06**	103.74	454.24	0	0	0	**557.99**	**1541.07**	-1061.64
91	2105.49	635.31	0	0	**2740.8**	210.55	730.77	412.04	0	0	**1353.36**	**1387.44**	-223.27
92	7541.05	0	0	0	**7541.05**	754.11	1131.24	0	0	0	**1885.35**	**5655.7**	0
93	5029.79	0	0	0	**5029.79**	646.32	775.56	1799.47	0	0	**3221.36**	**1808.43**	1799.47
94	2183.51	1810.24	0	0	**3993.75**	218.35	546.22	0	0	0	**764.57**	**3229.18**	-1810.24
95	2171.52	445	0	0	**2616.52**	217.15	551.49	0	0	0	**768.64**	**1847.88**	-445
96	4397.25	119.69	0	581.3	**5098.24**	509.29	908.59	848.75	973.03	0	**3239.66**	**1858.58**	729.06
97	1590.35	48.92	0	0	**1639.27**	159.03	260.5	66.34	0	0	**485.88**	**1153.39**	17.42
98	2481.73	0	0	604.73	**3086.46**	354	490.87	649.22	403.35	0	**1897.44**	**1189.02**	649.22
99	2732.83	89.44	84.75	0	**2907.02**	273.28	204	577.51	0	0	**1054.79**	**1852.23**	488.07
100	10972.4	0	0	1538.61	**12511.01**	1208.95	1838.15	2675.2	1026.4	0	**6748.71**	**5762.3**	2675.2

35	3	2	2	1	1	1	0	0	0	**3**
36	2	2	2	2	2	2	0	0	0	**3**
37	0	0	0	0	0	0	0	0	0	**1**
38	2	0	0	0	0	0	0	0	0	**2**
39	3	2	2	2	2	1	1	1	0	**4**
40	3	3	2	2	2	1	1	0	0	**4**
41	2	2	1	1	1	1	1	0	0	**4**
42	0	0	0	0	0	0	0	0	0	**1**
43	2	2	2	1	1	1	1	1	0	**4**
44	2	2	2	2	2	1	1	0	0	**4**
45	3	2	2	2	1	1	0	0	0	**3**
46	0	0	0	0	0	0	0	0	0	**1**
47	2	1	1	1	1	1	0	0	0	**3**
48	3	2	2	2	1	1	1	1	1	**4**
49	3	2	1	1	1	1	1	0	0	**4**
50	1	0	0	0	0	0	0	0	0	**1**
51	2	2	2	2	1	1	1	1	0	**4**
52	2	1	1	1	1	1	1	0	0	**4**
53	3	3	2	2	1	1	1	0	0	**4**
54	3	2	2	0	0	0	0	0	0	**3**
55	3	2	2	1	1	1	0	0	0	**3**
56	3	2	2	2	2	1	1	0	0	**4**
57	0	0	0	0	0	0	0	0	0	**1**
58	3	1	1	1	1	1	1	1	0	**4**
59	3	2	2	2	1	1	1	0	0	**4**
60	2	2	1	1	1	1	0	0	0	**3**
61	2	1	1	1	1	0	0	0	0	**3**
62	2	2	2	0	0	0	0	0	0	**3**
63	0	0	0	0	0	0	0	0	0	**1**
64	3	2	2	0	0	0	0	0	0	**3**
65	2	2	2	0	0	0	0	0	0	**3**
66	0	0	0	0	0	0	0	0	0	**1**
67	2	2	2	0	0	0	0	0	0	**3**
68	0	0	0	0	0	0	0	0	0	**1**
69	0	0	0	0	0	0	0	0	0	**1**
70	2	0	0	0	0	0	0	0	0	**2**
71	2	0	0	0	0	0	0	0	0	**2**
72	0	0	0	0	0	0	0	0	0	**1**
73	3	2	2	2	1	1	1	1	1	**4**
74	2	2	2	1	1	1	0	0	0	**3**
75	2	2	2	2	2	2	2	2	0	**4**
76	1	0	0	0	0	0	0	0	0	**1**
77	2	1	1	0	0	0	0	0	0	**2**

78										
79	1	1	1	1	1	1	1	1	0	**4**
80	3	2	2	2	2	2	1	1	1	**4**
81	0	0	0	0	0	0	0	0	0	**1**
82	2	2	2	1	0	0	0	0	0	**3**
83	0	0	0	0	0	0	0	0	0	**1**
84	3	2	2	2	2	2	0	0	0	**3**
85	2	2	1	1	1	1	0	0	0	**3**
86	0	0	0	0	0	0	0	0	0	**1**
87	2	2	0	0	0	0	0	0	0	**2**
88	2	2	2	2	2	1	1	1	0	**4**
89	3	3	3	3	3	3	2	2	1	**4**
90	2	2	2	2	2	2	0	0	0	**3**
91	3	2	2	1	1	1	1	0	0	**4**
92	3	2	2	2	2	1	1	0	0	**4**
93	2	0	0	0	0	0	0	0	0	**2**
94	0	0	0	0	0	0	0	0	0	**1**
95	2	2	1	0	0	0	0	0	0	**2**
96	3	2	1	1	1	1	0	0	0	**3**
97	0	0	0	0	0	0	0	0	0	**1**
98	2	2	1	1	1	1	1	0	0	**4**
99	1	0	0	0	0	0	0	0	0	**1**
100	2	2	0	0	0	0	0	0	0	**2**
	0	0	0	0	0	0	0	0	0	**1**

Appendix C: Frequency distribution for factors causing seasonal food shortage

Cause	Number of respondents																			
	Kurar				M/Birhan				Yemezegn				Enerata				D/Kelemo			
	Nil	Moderate	Severe	More severe	Nil	Moderate	Severe	More severe	Nil	Moderate	Severe	More severe	Nil	Moderate	Severe	More severe	Nil	Moderate	Severe	More severe
Drought	0	1	5	17	1	7	5	8	2	1	9	5	2	4	10	2	4	7	6	4
Erratic rain fall	0	0	2	21	0	1	6	13	0	1	1	15	0	0	8	10	0	0	9	12
Shortage of labor	4	13	6	0	12	2	6	0	6	2	9	0	10	8	0	0	3	8	9	1
Lack of farming implement	0	3	11	9	18	2	1	0	17	0	0	0	0	8	5	5	0	6	6	9
Lack of agricultural credit service	0	7	5	11	13	6	1	1	13	2	2	0	7	6	3	1	0	5	7	9
Land degradation	0	2	7	14	2	6	9	4	5	3	8	1	1	1	12	4	0	3	11	7
Dependence on single harvest	0	0	7	16	0	2	8	13	1	3	7	6	0	7	5	6	0	5	7	9
Weed infestation	2	3	11	7	3	6	10	2	0	0	9	8	0	7	10	1	3	8	7	3
Lack of cash income	0	2	15	6	10	4	4	3	7	4	2	4	2	7	4	5	0	9	7	5
Post harvest loss	4	12	6	1	7	5	6	3	14	0	1	2	13	5	0	0	16	5	0	0

Source: Own field survey, 2012

College of Development Studies
Addis Ababa University

Introduction

My name is Demeku Mesfin, a graduate student of Addis Ababa University and conducting research for the partial fulfillment of the requirements for the degree of Master of Arts in development studies with the title, status of food security in the face of changing climate in the Choke Mountain Agroecosystem, Eastern Gojjam.

With Respect to this, the objective of this questionnaire is to collect primary data on socio-economics, ecological, about food security and climate change related information that are required to assess the situation of food security with changing climate in the Choke Mountain Agro ecosystem. Therefore, you are kindly requested to give your response freely and accurately to the success of this study.

Dear respondents: You should be confident that the data/information which you give us works only for this study.

Lastly, I thank you for your cooperation

Name of data collector _____ Date _____ Code_____

AES: _____ Kebele:_____

Appendix D: Household survey to be completed by household heads

General information:

Socioeconomic Characteristics:

1. House Code_____
2. Sex 1= Male 2= Female
3. Age 1= 15-30 2= 31-65 3=>65
4. Marital Status 1=Married 2= Not married 3= Divorce 4=Widowed
5. Religion 1. Orthodox 2. Muslim 3. Protestant 4. Other, specify_____
6. Educational Status 1= Illiterate 2= Capable of reading and writing
   3= primary school 4= Secondary school
   5= Higher education
7. Livelihood source 1= Crop production 2= Livestock production
   3= Mixed agriculture 4=Government civil servant
   5= other, please specify_____.
8. Responsibility in the community 1= member of the community 2= religious leader
   3= coordinator of community development work
   4= other, please specify_____.
9. Size of family

No	Age		No	Age	
	Male	Female		Male	Female
1			8		
2			9		
3			10		
4			11		
5			12		
6			13		
7					
Total			Total		

A. Household's Perception of food security

1. How do you evaluate your household food security status?
   1. Food secure 3. Chronic food insecure
   2. Transitory food insecure 4. None
2. In your opinion, do you think that your families eat food that they prefer?
   1.Yes 2. No
3. If you say no, what is the reason? _____
4. Was your production enough for your household to satisfy various needs throughout the year?
   1. Yes 2. No
5. If "No" for Q11, for how many months food shortage was critical in the last years?
   1. 1-2 month(s) 2. 3-5 months 3. More than 5 Months

A. Household's food Availability

Land:

6. Do you have your own farm land 1. Yes 2. No
7. If your answer for question 1 is yes, what is its size in hectare or (Timad)?
   1. Cultivated land _____
   2. Grass and woodland_____
   3. Homestead_____
   4. Irrigated Land_____
8. Has your farm land size decreased or increased since you start farming?
   1. Increased 2. Decreased
   3. No change: please give your suggestion_____
9. If you say increased, do you think that deforestation if the reason for increment?
   1.Yes 2. No
10. Do you think farming of mountainous and hill lands are a cause for increment?
    1. Yes 2. No
11. If your answer for Q 9 is decrease, do you think degradation of land and increase of rangeland is the reason?
    1.Yes 2. No
12. Do you think that distribution of cultivated land in the family is the reasons for the decrement of your cultivated land? 1.Yes 2. Yes
14. Is your farm land productivity decreasing or increasing since you have started farming in this cultivated land? 1. Increasing 2. Decreasing
    3. No change
15. If you say increase, do you think that increased soil fertility is the reasons for the increment of your cultivated land productivity? 1. Yes 2. No
16. Do you think that strong extension service is the reasons for the increment of your cultivated land productivity? 1. Yes 2. No
17. Do you think that suitable weather conditions the reasons for the increment of your cultivated land productivity? 1. Yes 2. No
18. If your answer is decrease, land degradation is the cause for decrement.
    1. Yes 2. No
19. Do you think that rainfall variability the reasons for decrement of your cultivated land productivity?
    1. Yes 2. No
20. Do you think that drought is the reasons for decrement of your cultivated land productivity?
    1. Yes 2. No
21. Do you think that pests and crop diseases is the reasons for decrement of your cultivated land productivity? 1. Yes 2. No
22. How is the status of your cultivated land fertility?
    1. Not fertile 2. Somehow fertile 3. Fertile 4. Highly fertile
23. How is the slop of your cultivated land?
    1. Plain 2. Hilly 3. Highly sloppy
    4. Mountainous 5. Other, please specify_____.

Crops:

24. Is there any market access in your locality? 1. Yes 2. No

25. How far from your residence_____?

26. For what purpose you mostly used these crops?
    1. Consumption 2. Market 3. Both

27. For how long your annual production can feed your family?
    1. Below six month 3. one year-two years
    2. Six month -one year 4. above two years

28. If your production is not enough to feed your household year round, please specify the main reason by severity levels as nil, moderate, severe and more severe. Write the severity level as: 1-nil, 2-moderate, 3-severe and 4-more severe.

Items	Nil-1	Moderate-2	Severe-3	More severe-4
Drought				
Shortage of labor				
Shortage of farming implement				
Lack of agricultural credit				
Pest damage				
Weed infestation				
Land degradation				
Dependency on single harvest				
Lack of cash income				
Post harvest losses				
Health problem				
Other, specify				

29. What are the critical months in which you often encounter serious food shortage? _____.

30. Pleas estimate the different sources of household food consumption during November 2011 to October 2012.

Name of crops	Total grain produced	Total grain purchased	Total grain obtained from remittance	Total grain obtained from previous stock	Post harvest losses	Total grain utilized for seed	Total marketed output	Grain planned to next season	Total grain given to others	Net grain available
Teff										
Wheat										
Barely										
Maize										
Sorgum										
Engdo										
Potato										
Nug										
Faba beans										

Vegetable										
Banana										
Cabbage										
Onion										
Avocado										
Tomato										
Carrot										
others										

Livestock:

31. Do you have your own livestock? 1. Yes 2. No

32. How many livestock do you own?

Types of livestock	No
Cattle	
1. ox	
2. Cows	
3. Calves	
4. Heifers	
5. Bulls	
Pack Animals	
6. donkeys	
7. horses	
8. Mule	
Small Ruminant	
9. Chicken	
10. Sheep	
11. Goat	
Specify others	

33. How do you see the trend of livestock ownership in your household for last 3 years?
1. Increasing 2. Decreasing 3. No change

34. For what purpose you use mainly livestock and their products?
1. For cash income 2. For food 3. Both for food and cash equally

35. Which of the following are the constraints to rearing livestock in your community?

Constraints	Yes	No
Shortage of grazing land		
Lack of additional fodder		
Disease prevalence		
lack of sufficient veterinary services		
Shortage of water		
Conflict on grazing land and water		
Other, specify		

B. Household Food Insecurity Access Scale (HFIAS)

36. Occurrence and frequency occurrence question for households

No	Question	Response option
1.	In the past four weeks, did you worry that your household would not have enough food?	0 = No (skip to Q2) 1=Yes
1a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)
2	In the past four weeks, were you or any household member not able to eat the kinds of foods you Preferred?	0 = No (skip to Q3) 1=Yes
2a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (3 to 10 times in the past four weeks) 3 = Often (more than ten times in the past four weeks)
3	In the past four weeks, did you or any household member have to eat a limited variety of foods?	0 = No (skip to Q4) 1 = Yes
3a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (3 to 10 times in the past four weeks) 3 = Often (more than ten times in the past four weeks)
4	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat?	0 = No (skip to Q5) 1 = Yes
4a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (3 to 10 times in the past four weeks) 3 = Often (more than ten times in the past four weeks)
5	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed?	0 = No (skip to Q5) 1 = Yes
5a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)
6	In the past four weeks, did you or any other household member have to eat fewer meals in a day?	0 = No (skip to Q5) 1 = Yes
6a	How often did this happen?	1 = Rarely (once or twice in the past fou weeks) 2 = Sometimes (3 to 10 times in the past four weeks) 3 = Often (more than ten times in the past four weeks)
7	In the past four weeks, was there ever no food to eat of any kind in your household?	0 = No (skip to Q5) 1 = Yes
7a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (3 to 10times in the past four weeks) 3 = Often (more than ten times in the past four weeks)
8	In the past four weeks, did you or any household member go to sleep at night hungry?	0 = No (skip to Q5) 1 = Yes

8a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (3 to 10 times in the past four weeks) 3 = Often (more than ten times in the past four weeks)
9	In the past four weeks, did you or any household member go a whole day and night without eating anything?	0 = No (skip to Q5) 1 = Yes
9a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (3 to 10 times in the past four weeks) 3 = Often (more than ten times in the past four weeks)

Modern agricultural activities

37. Do you use modern fertilizer applications on your farm land? 1. Yes 2. No
38. Do you use improved seeds? 1. Yes 2. No
39. Do you use irrigation technologies? 1. Yes 2. No
40. Do you use pesticide? 1. Yes 2. No

C. Food Utilization situation of Households

Water:

41. Is there any water source in your locality/surrounding? 1. Yes 2. No

42. If your answer is yes please fill the following table.

Type of water source	Distance from home/farm land	Adequate and pure water			
		For irrigation	For drinking	For animal	For house consumption
River					
Spring					
Borehole					
Pipeline					
other					

Health:

43. Is there any health post in your locality? 1. Yes 2. No
44. How much distance and time it takes to reach the nearby health centre? _____.
45. What is the most prevalent disease in your family?
    1. Malaria 3. Eye 4. Abdominal
    2. Cardiac problem 5. Other, specify 6. There is no disease
46. What do you think about the cause for the prevalence of these diseases_____ _____?
47. Do you go to health center if you are sick? 1. Yes 2. No
48. If your answer is no, what is the reason_____?

Appendix E: Check list for key informant interview

AES_____ Kebele _____Name_____

Age _____Sex_____ Position/occupation_____

1. What is the current condition of food security in the woreda?
2. What are the major agricultural activities?
3. What is the availability and productivity of land?
4. What are the major constraints that reduce the productivity of land?
5. Which types of crops are grown?
6. What are the types of livestock?
7. What is the accessibility of basic livelihood resources in the woreda?
8. What are the major sources of income for households?
9. What is the quality and availability of water, sanitation and infrastructure?

Appendix F: Check list for focus group discussion

1. How is the general trend of food security situation of the area?
2. What are the main food crops and food types used normally in the area?
3. Did you get the type of food that you preferred to eat?
4. If not, what is the reason?
5. What looks like the productivity of these crops?
6. If it is decrease, what is the reason?
7. How long your own harvest could cover food need in good and bad season?
8. What do you think about frequency that drought attack the area (Every two, three, five, ten).
9. How many meals does your family normally eat per day?
10. What is the general health condition of the area?

Appendix G: List of conversion factors used for the research

1. Conversion factor used to estimate tropical livestock unit

Animal category	TTLU	Animal category	TTLU
Cow and Ox	1.00	Horse	1.10
Calf	0.25	Chicken	0.013
Heifers	0.75	Sheep and Goat (Young)	0.13
Donkey	0.7	Goat and Sheep(Adult)	0.06

Source: Stork et al.,1991

2. Conversion factor used to estimate adult equivalent unit

Age group in year	Male	Female
0 -2	0.4	0.4
3-4	0.48	0.48
5-6	0.56	0.56
7-8	0.64	0.64
9-10	0.76	0.76
11-12	0.8	0.88
13-14	1	1
15-18	1.2	1
19-59	1	0.88
60+	0.88	0.72

Source: Dercos and Krishnan, 1998

3. Conversion factors for grain produced

1kg of	Kcal equivalent
Teff	3450
Wheat	3440
Maize	3630
Sorghum	3550
Engdo	3390
Barley	3390
Nug	5130
Bean	3390
Potato	750
Banana	1160
Cabage	280
Onion	480

Source: Agren et al., 1968

List of photos

FGD in Enerata

FGD in M/Birhan

FGD in Yemezegn

KII in Kurar

KII in D/kelemo

For memory

Declaration

I, the undersigned, declare that this thesis is my original work and has not been presented for a degree in any University, and that all the source of materials used for the thesis has been duly acknowledged.

Declared by:

Name: _____

Signature: _____

Date: _____

The examiners' comments have been dully incorporated.

Confirmed by

Name: Belay Simane

Signature: _____

Date: _____