Climate Change impact on Food Security and Farmers Coping Mechanisms: in Ginir Woreda,

Bale Zone, Oromia Region, Ethiopia

Gizaw Megersa

A Thesis Submitted to

The Department of Geography and Environmental Studies

Presented in Partial Fulfillment of the Requirements for the

Degree of Masters of Arts

Addis Ababa University

Addis Ababa, Ethiopia
October, 2014

Addis Ababa University

School of Graduate Studies

This is to certify that the thesis prepared by Gizaw Megersa, entitled: Climate Change impact on Food security and Farmers Coping Mechanisms: in Ginir Woreda,Bale zone ,Oromia Region ,Ethiopia and submitted in partial fulfillment of the requirements for the Master Art Geography and Environmental Studies (Climate Change and Adaptation) complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

Signed by the Examining Committee: **Signature** **Date**

Chairman, Department Graduate committee

_____ _____ _____

Examiner, In**ternal**

_____ _____ _____

Examiner, External

_____ _____ _____

Advisor

_____ _____ _____

Abstract

This study examined climate change impact on food security and farmers coping mechanisms in Ginir woreda, Bale zone, Oromia Region. The study aimed at assessing the climate change condition and its impact on framers food security. It assessed perception of local people on climate change, impact of climate change on food security, and farmers coping mechanisms and adaptation strategies. The study utilized semi-structured questioner, key informant interviews, focus group discussions and discussion with government officials in collecting primary data and secondary data collected from published and unpublished sources, and qualitative and quantitative studies were employed in data analysis. The study results showed that temperature and rainfall have shown change trend. As the analyzed 31 years (1982-2012) meteorological data indicated, in the area, rainfall was declining with 3.72 mm while maximum and minimum temperatures were increasing by 0.043°C and0.001°C respectively. Farmers and government officials in the area also agreed with the meteorological data result. All FGDs and 98% of the interviewed farmers recognized as climate change already occurred in the area. About 95% and 100% of the interviewed farmers respectively thought that temperature and rainfall were changing in the area comparing with that of 10-20 years ago. The study showed that climate change affect food security condition of the area through affecting crop production and livestock rearing. 100%, 50% and 20% of the respondents respectively reported that climate change resulted in declined in food production, increased in food item prices and decreased in food item availability in a market. In respond to climate change impacts, different coping mechanisms and adaptation strategies have been utilized. 36%, 11% ,5% and other 5% of the respondents respectively reported that they have been using drought resistant crops, early cropping/planting, livestock migration, casual labor and petty trade as their coping mechanisms and other 42% reported as they have been using combination of two or more mechanisms in respond to climate change impacts. Diversify income source, use improved agricultural input, sale livestock, temporarily migrate to other areas for casual labor or in getting assistance and use irrigation were major adaptation strategies employed by farmers. In study, various analyses indicated that the area is severally impacted by climate change and the climate change is negatively affecting the food security of the community. Thus, the study suggests, improving agricultural production and productivity, enhancing irrigation agriculture and promoting establishment of market networking to minimize climate change impact on food security.

Acknowledgment

First of all I would like to thank the Almighty God for His great help during the entire study period and every aspect.

There are a number of persons I would like to express my gratitude towards for supporting me during the research and writing process. My appreciation and thanks goes to my advisor Dr.Assefa Abegaz for his assistance throughout research work.

I would like to thanks the Ethiopia Evangelical Church Mekane Yesus Development and Social Service Commission (EECMY DASSC) two projects (Rayitu - Sawena Reproductive health and Rayitu Community Development project) managements for their support in arranged vehicle for field works during data collection and the two projects' staff who assist me in data collection.

My special thanks also go to the Bale zone Finance and Economic Development Office (FEDO), Bale zone Agriculture and Rural Development Office (ARDO) and Ginir Woreda ARDO and FEDO officials who provided me with data and other inputs.

Finally, I would like to express my heartfelt gratitude to my beloved wife, Genet Adugna for her continuous encouragement and support throughout this study.

Table of contents

List of Figures

List of Table

List of Acronyms

ARDO- Agriculture and rural development office

CSA- Central Statistic Authority

FAO-Food and Agricultural Organization

FGD-Focus Group Discussion

HHs- Households

IGAs-Income Generating Activities

IPCC-Intergovernmental Panel on Climate Change

ISDR-International Strategy for Disaster Reduction

ITCZ-Inter Tropical Convergence Zone

KI- Key Informant Interview

NGOs-Non Governmental Organizations

NMA - National Meteorology Agency

PRA- Participatory Rural Appraisal

SPSS - Statistical Package for Social Sciences

SSA -Sub-Saharan Africa

UNFCCC-United Nations Framework Convention on Climate Change

USAID -United States Agency for International Development

USD -United State Dollar

WHO- World Health Organization

WSC –Water and Soil Conservation

1. Introduction

1.1 Background of the study

The impacts of climate change, and the vulnerability of communities to climate change, though vary in degree from region to region, is superimposed on existing vulnerabilities. Climate change will severely impose a real threat to food security; further reduce access to drinking water; negatively affect the health of people and disturbing the social lives of communities in many developing countries mainly in Africa, Asia, and Latin America. In some areas where livelihood choices are limited and mostly based on primary economic activities such as agriculture, decreasing in crop yields has been widely exhibited and food insecurity experienced often. The macroeconomic costs of the impacts of climate change are highly uncertain, but very likely have the potential to threaten development in many countries (Christoph et al., 2008).

Many sectors providing basic livelihood services to the poor in developing countries are unable to cope with today's climate change and variability and related stresses. Often, extreme weather events impeded the development process of the poor countries. Through repeated and prolonged droughts, floods and storms, part or entire of the annual harvests in affected areas used to be destroyed. Throughout the world, climate change already increases stresses in overall socioeconomic and ecological environments of many countries in general and food security of poor countries in particular. The climate changes, variability and weather extremes, which have been already experienced, suppose will do so increasingly in the future (Christoph et al., 2008).

The vulnerability of Ethiopia to climate change impact is a function of several biophysical and socioeconomic factors. The livelihoods of the majorities of population in the country depending on agriculture practices, which in turn, tremendously dependent on the timely onset, amount, duration, and distribution of rainfall. 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 (Adgolign, 2006). The use of both irrigation and water harvesting technology has a long way to go to bring the desired development. According to 2008 Farm Management Practices Survey of CSA, the total irrigated crop area was estimated to 180

thousand hectares (about 1.5% of the total crop land) (CSA, 2008). This lag is attributed to the unsuitability of the topography for irrigation, uneven distribution of water resources and lack of technology.

Most South Eastern part of Ethiopia is characterized with low annual rainfall and high temperature. Bale zone, one part of the South East of the country, comprises wide area of such low rainfall and high temperature. Of the total areas of the zone 48,066 km² (69%) is lowland areas (Bale zone socio economic profile, 2007).

The study area (Ginir) is one of the woredas of Bale zone in which most of its areas (75%) falls within low land feature that have been encountered climate change induced challenges like drought and consequently became food insecure area.

The common consequences of climate change with regards to food security are : extreme weather events exhibited damaging crops and livestock; time and length of season altered; favorable conditions /environment established for the emerging and growing of different pesticide and wild plants , and animal disease occur and these all resulted in decrease in food production and end up with food insecurity . Climate change also resulted in shortage of water for human and livestock consumption, causes severe drought which in turn resulted in social turbulences like migration and conflict over resource like water and pasture. Unmanaged or untimely managed effects of climate change can severely destroy both human and livestock lives (USAID, 2011).

Though, in this research area, the problem of climate change/ variability is being recognized and the government institutions at local level initiated working on some activities toward the challenges, it is not quite enough and in sustainable manner. Thus, to address the food security problem in particular and other socioeconomic challenges induced by climate change in general, the integration and involvement of different bodies like communities at grassroots level, local and regional or national government institution, NGOs and other stakeholders is unquestionable. For this, identification and critical analyzing of climate change challenges and its impacts on food security and vulnerability situation of the farmers is needed to be done. Due to this fact,

the researcher being interested to work on or to investigate the climate change impact and farmers food security condition of the study area.

1.2. Statement of the Problem

Today, it is widely agreed by the scientific community, many governing bodies and higher officials as climate change is already a reality. Different extreme weather events occurring at globally, regional and even local are clearly showing the presence of climate change.

The Intergovernmental Panel on Climate Change (IPCC) has concluded that human activities are altering the climate system and will continue to do so. Over the past century, surface temperatures have increased and associated impacts on physical and biological systems are increasingly being observed (IPCC, 2007).

Climate change will complex the existing poverty situation in higher degree and is expected to have serious environmental, economic, and social impacts in the world community as whole and particularly in the developing countries where people mainly depended on agricultural activities as means of livelihoods. Climate change will compound existing poverty in most developing nations. On the other hand, its adverse impacts will be most striking in the developing nations because of their geographical and climatic conditions, their high dependence on natural resources, and their limited capacity to adapt to a changing climate. Within these countries, the poorest, who have the least resources and the least capacity to adapt, are the most vulnerable (IPCC, 2001). The extent to which these impacts are felt varies from community to community depends in large part on the extent of adaptation in response to climate change.

Climate change impacts countries' economies and food security through a variety of channels. Rising temperatures and changes in rainfall patterns affect agricultural yields of both rain fed and irrigated crops producing areas with higher damaging in rainfall restricted areas. A higher frequency of droughts may impair hydropower production, and an increase in floods can significantly raise public investment requirements for physical infrastructure (Stern, 2006; World Bank, 2007; Garnault, 2008)

The climate of Ethiopia is mainly controlled by the seasonal migration of inter tropical Convergence Zone (ITCZ) and associated atmospheric circulations as well as by the complex topography nature of the country. In most of the lowland part of the country, the climate situation is characterized relatively by low rainfall and higher temperature than that of high land part of the country. Lowland parts of Bale zone reflect this feature and most areas have experienced shortage of rainfall and drought prone areas that being exposed to food insecurity.

Vulnerability to climate change in Ethiopia is highly related to poverty and loss of coping or adaptive capacity in most of the regions (Temesgen et al., 2008). Vulnerability can be seen as the context in which adaptation takes place. Adaptive capacity is the ability or potential of a system to respond successfully to climate variability and change, in order to reduce adverse impacts and take advantage of new opportunities (IPCC, 2007). Those societies that can respond to change quickly and successfully have a high adaptive capacity (Smit and Wandel, 2006).The social drivers of adaptive capacity are varied but may include broad structures such as economic and political processes, as well as processes which operate at a very local scale, such as access to decision-making and the structure of social networks and relationships within a community (Smit and Wandel, 2006). Adaptive capacity at a local scale is constrained by larger scale processes. For example a farmer's adaptive capacity will not only depend on access to resources (both physical and social) within the community which allow a crop to be grown successfully, but also the effect of macro-scale economic processes on the price received for the crop (Adger et al., 2005).

Food insecurity is a major problem in developing countries all over the world, and with an increasing global population that are expected to be over 9 billion people in 2050, compared to days population of 7 billion, the problem may become even worse than today (Haile. et al., 2005). Food insecurity is when the people do not have access to enough food to meet the dietary need, and food insufficiency is when not enough domestic food is produced to reach food security.

Sub-Saharan Africa (SSA) and Eastern Africa is especially affected by malnutrition and food insecurity, due to several reasons, e.g. the geography of Africa with no easy access to the interior, poverty and lack of good quality seed and environmental friendly fertilizers. The population in SSA is today 870 million with a rapid growth of 2.36 percent per annum (2011) and in 2050 it is expected to be almost 2 billion people (Haile. et al., 2005). Changes in rainfall and intensified land use would exacerbate the desertification process (particularly in the Western Sahel and Northern and Southern Africa). Grain yields are projected to decrease, diminishing food security, particularly in small food importing countries.

Ethiopia is particularly famine prone due to its agricultural system that relies on precipitation and severe environmental degradation has a negative impact on agricultural production. Ethiopia has the potential to become self sufficient in food, there are crops, e.g. cereals that has increased in production, even though the overall food production has showing decreasing.

In Ethiopia particularly, Increase in droughts, floods, and other extreme events would add to stress on food security, water resources, human health, and infrastructure, constraining development. The challenge of food insecurity is very deep rooted in most Bale lowland areas which has highly striking the study area.

Climate change adaptation (particularly when community-based) offers an opportunity for a multidisciplinary and integrated approach to address climate-related risks which are predicted to impose severe constraints on production in the agriculture sector (i.e. dry land and highland areas) in many parts of Africa (FAO, 2010).

1.3. Objective of the study

1.3.1. General objective

The general objective of this study is to assess the climate change condition and its impact on framers food security in Ginir *Woreda* of Bale zone

1.3.2. Specific Objectives

- To assess the climate change and variability trends of the study area
- To identify climate change impacts that contributed to food security problem in the study area
- To assess constraints that exacerbate farmers' vulnerability to climate change challenges
- To assess farmers coping and adaptation strategies in respond to climate change

1.4 Research questions

- What variation in rainfall and temperature trends looks like in the study area?
- What are major climate change impacts contributed to food security problems in the study area?
- What are constraints that exacerbate farmers' vulnerability to climate change?
- How do the farmers cope up with and minimize climate change problems in the area?

1.5. Significance of the study

In the area where rain fed agriculture is main means of livelihood, the impact of climate change on food security is high. This study assess climate change trend, its impacts on food security and indicates farmers' coping mechanism and adaptation strategies. Thus, the study is significant to give basic information and, enhance community and local government staff understanding about impacts of climate change on food security in order to take appropriate measures to tackle the problem. Also, it can help government, NGOs and other development agents to plan and set strategies towards minimizing the impacts that climate change have on food security in the area. Besides, the study can serve as a source document for other researchers who need reference.

1.6. Scope of the Study

The focus of this study is on climate change and/or variability induced impacts of food insecurity that experienced or manifested in Ginir *Woreda*. The focus is to analyzing the relation between the two factors, and assessing farmers' present copping measures and potential knowhow that being exiting within community but not being utilized so far.

1.7. Organization of the paper

This paper is organized in to five parts. Part one is introductory section of the study includes background of the study, statement of the problem, objective of the study, research question, significant of the study and scope of the study. Part two presents literature reviews of previous studies on climate change and food security. Part three explains research methodology includes description the study area, research design, data collection and analysis. Part four presents, the findings of the study. And part five is summary, conclusion and recommendation part.

2. Literature Review

2.1. Climate Change and its impacts

The world's climate is governed by a great many factors including the amount of incoming solar radiation and atmospheric conditions. Variability, in both time and space is an inherent feature of climate, as atmosphere is always in state of turmoil and instability leading to variation in weather and climatic condition. Climate change thus, is defined as variations and shifts in weather conditionn over space and time of different scale and magnitude resulted in change in climate type (Ahrens, 2009).

In global scale, climate change or variation is the result of "unequal heating and cooling" in the atmosphere. The climate change could be caused by natural and anthropogenic factors. Most of the natural factors induced climate changes events are balanced one another and now a day the climate change challenges with severe adverse influence are those induced by anthropogenic factors like those action which increases the concentration of the greenhouse gases in the atmosphere (Ahrens, 2009).

The United Nations Intergovernmental Panel on Climate Change (IPCC,2007), which brings together hundreds of scientists from all over the world, has confirmed the relationship between human activity and climate change: human emissions of so-called greenhouse gases are reinforcing the Earth's natural greenhouse effect and causing atmospheric temperatures to rise. The main cause of climate change is the burning of fossil fuels, a process necessarily accompanied by release of the greenhouse gas mainly carbon dioxide (CO_2). Other key greenhouse gases include methane (CH_4) and nitrous oxide (N_2O), deriving mainly from farming activities. By the end of the 21st century, according to the IPCC (2007), the planet's temperature expected to have risen by between 1 and 6 degrees Celsius. Some parts of the Earth will face worse droughts than they do today, while elsewhere it is additional rainfall that is likely to be a problem. Sea levels may also rise by as much as half a meter or more. This will all have major consequences for the natural environment, the economy and human welfare in costal areas.

There is extensive evidence of responses of cryosphere components; such as mountain glaciers and ice caps, floating ice shelves and continental ice sheets, seasonal snow cover on land, frozen

ground, sea ice and lake and river ice; in the form of reduction of snow and ice masses in due to enhanced warming. Biological systems have also gone through changes due to shifting climate change. These include shifts in plant and animal ranges pole-ward and higher elevation; reductions and increases within population sizes of some animals and plants; changes in life cycle events, such as blooming, migration and insect emergence; and effects on changes in species at different speeds and different directions causing a decoupling of species interactions, for instance predator-prey relationships (Rosenzweig et al., 2007).

As for the future projections of global climate trends and their potential effects, it is expected that under a business as usual scenario, green house gas emissions could rise by 25 – 90 percent by 2030 relative to 2000 and the Earth could warm by 3°C this century. Even with an increase in temperature of 1 – 2.5 °C, IPCC predicts, serious effects such as reduced crop yields in tropical areas resulting in hunger, spread of climate sensitive diseases such as malaria, and heightened risk of extinction of 20 to 30 percent all plant and animal species (UNFCCC, 2007).

Factors like deep rooted poverty, illiteracy and lack of skills, weak institutions, limited infrastructure, lack of technology and information, low levels of primary education and health care, poor access to resources, low management capabilities and armed conflicts have contributed and will have continue in negatively effecting the developing countries' ability to cope with climate change. The overexploitation of land resources including forests, increases in population, desertification and land degradation pose additional threats. Africa is already a continent under pressure from climate change stresses and is highly vulnerable to the impacts of climate change. Many areas in Africa are recognized as having climates that are among the most variable in the world on seasonal and decadal time scales (UNFCCC, 2007). Floods and droughts can occur in the same area within months of each other. These events can lead to famine and widespread disruption of socio-economic well-being.

Agriculture as the main mainstay of the continent relies mainly on rainfall than irrigation and will be severely compromised in many African countries, particularly for subsistence farmers

and in sub-Saharan Africa. Under climate change much agricultural land will be lost, with shorter growing seasons and lower yields.

The other impact of climate change, in developing countries, mainly in Africa is vulnerability to a number of climate sensitive diseases including malaria, tuberculosis and diarrhea. Under climate change, rising temperatures are changing the geographical distribution of disease vectors which are migrating to new areas and higher altitudes, for example, migration of the malaria mosquito to higher altitudes will expose large numbers of previously unexposed people to infection in the densely populated east African highlands (Boko et al., 2007).

In the second half of the last century, mean annual temperatures in Africa rose approximately half a centigrade with some areas (Nile Basin countries increase by 0.2°C and 0.3°C per decade) warming faster than others (Rwanda increase by 0.7°C to 0.9°C over 50 years) This gradual heating meant more warm spells (days) and fewer cold days across the continent (Boko *et al.*, 2007).

The IPCC long term predictions are that warming in Africa may be higher than the global average and persist throughout all seasons (IPCC, 2007). There are discrepancies between models regarding expansion or contraction of vegetation area: some models project significant drying of land, while others a general wetting and expansion of vegetation into the Sahara (IPCC, 2007)

2.2. Climate change and food security

Food security, which became a catch-phrase in the mid-1990s, can be defined as the success of local livelihoods to guarantee access to sufficient food at the household level (Devereaux and Maxwell, 2001). Addressing food security, therefore, requires an integrated approach and challenges many regions' ability to address food security adequately (Vogel and Smith, 2002; Clover, 2003).

Climate variability and change are a major threat to food security in many regions of the developing world, which are largely dependent on rain fed and labor-intensive agricultural production (Döös and Shaw, 1999; IPCC, 2001).

Although there is research on the impact of climate on food production, there is limited understanding of how climate variability or change currently impacts food systems and associated livelihoods (Downing, 2002; Ziervogel and Calder, 2003). This needs to be better understood before assessing the impact of climate change on food security.

Climate change/variability is not the current threat alone but also it is a future severe threat mainly with respect to high population growth and pressure on exiting meager resources. Because of high population growth, world's demand for food is highly increasing. For instance, projections suggest that demand for cereals will increase by 70% by 2050, and will double in many low-income countries (FAO, 2009). For low-income populations, food insecurity negatively affects future livelihoods through the forced sale of assets that are difficult to rebuild, and through reduced expenditure on education (FAO, 2010). This definitely will lead to reduction in consumption of food. On the other hand, reduction in consumption can lead to long-term health issues. In many developing countries, mainly sub-Saharan Africa, poor health reduces agricultural productivity, and some agricultural practices contribute to health problems such as malaria, pesticide poisoning and disease transmission from animals to humans (World Bank, 2008).

A food system is vulnerable when one or more of the four components of food security: food availability, food accessibility, food utilization and food system stability uncertain and insecure.

Thus, the impact of climate change, in one way or another is influencing these four dimensions of food security such as: availability, accessibility, utility and stability.

Food availability is determined by the physical quantities of food that are produced, stored, processed, distributed and exchanged. The consensus of scientific opinion is that countries in the temperate, high, and mid-latitude regions are generally likely to enjoy increased agricultural

production, whereas countries in tropical and subtropical regions are likely to suffer agricultural losses as a result of climate change in coming decades (Arnell et al., 2002; Devereux and Edwards, 2004). It should be noted that the favorable assessment for temperate and high latitude regions is based primarily on analyses of changes in mean temperature and rainfall; relatively little analysis done to date takes account of changes in variability and extremes. Impact of climate variability on crop production should be a priority given that analyses of agricultural vulnerability indicate that the key attributes of climate change are those related to climatic variability, including the frequency of non-normal conditions (Bryant et al., 2000; Smit et al., 2000).

Food accessibility 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 (FAO, 2003). Until the 1970s, food security was linked mainly to national food production and global trade (Devereux and Maxwell, 2001), but since then the concept has expanded to include households' and individuals' access to food.

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, which can cause loss of nutrients in the food and the spread of food-borne diseases if not of a sufficient standard. Climatic conditions are likely to bring both negative and positive changes in dietary patterns and new challenges for food safety, which may affect nutritional status in various ways

Food system stability is determined by the temporal availability of, and access to food. In long-distance food chains, storage, processing, distribution and marketing processes contain in built mechanisms that have protected the global food system from instability in recent times. However, if projected increases in weather variability materialize, they are likely to lead to

increases in the frequency and magnitude of food emergencies for which neither the global food system nor affected local food systems are adequately prepared.

Projected climate change impacts and declining agriculture productivity may compound the risk of food insecurity in the African continent. Agricultural production and food security in many African countries and regions are likely to be severely compromised by climate change and climate variability (IPCC, 2007). Currently, most African countries are net food importers, with over 50% of North Africa's food requirement and between 25% and 50% in sub-Saharan Africa imported food (FAO, 2006). Africa's cereal import bill, for example, estimated at about USD 21.748 billion in 2008 and USD 9.8 billion in Sub-Saharan Africa in 2008, represents a 30% and 35% increase over the 2007 level, respectively

Climate change will also affect affordability by affecting income and also ability of people to choose the food they want to eat or prefer ability to eat (FAO, 2008).

Africa's poor agricultural incentives and infrastructure, inadequate trade and pricing policies, and weak capacity signify low investments in this sector, although more than 60% of its population depends directly on agriculture and natural resources With farming done mainly under rain fed conditions, increasing land degradation and low levels of irrigation, i.e. 6% in Africa compared to 38% in Asia (FAO, 2003), climate change can significantly reverse the progress towards poverty reduction and food security.

Being the above indicated points true, Ethiopia is a large complex country, with complex patterns of rainfall and livelihoods In Ethiopia, higher elevations receive more rainfall than low arid areas and support agricultural livelihoods and higher population densities .Lowlands receive minimal rainfall, and people generally support themselves by raising livestock. In between, agro-pastoralists rely on a mixture of the two livelihood strategies.

2.3. Vulnerability and adaptation concepts

2.3.1. Vulnerability

The Intergovernmental Panel on Climate Change (IPCC) defines vulnerability as the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity and its adaptive capacity. Hence, a highly vulnerable system is one that is highly sensitive to modest changes in climate and one for which the ability to adapt is severely constrained (IPCC 2000).

The UN International Strategy for Disaster Reduction (ISDR) defines vulnerability as the conditions determined by physical, social, economic and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards .

While, vulnerability from the food security point of view, the FAO publication (FAO, 1999), defines vulnerability as "the presence of factors that place people at risk of becoming food insecure or malnourished." Clearly, this definition encompasses causes of food insecurity other than climate change (e.g., armed conflict, landlessness, etc.). Nevertheless, the concept of vulnerability includes hunger vulnerability which refers to the vulnerability of individuals or households rather than that of regions or economic sectors.

Under whichever definition, the level of vulnerability of different social groups to climate change/variability is determined by both socioeconomic and environmental factors. The socioeconomic include the level of technological development, infrastructure, institutions, and political setups; (McCarthy et al., 2001). The environmental attributes mainly include climatic conditions, quality of soil, and availability of water for irrigation (O'Brien et al., 2004). The variations of these socioeconomic and environmental factors across different social groups are responsible for the differences in their levels of vulnerability to climate change.

There are many conceptual and methodological approaches to vulnerability analysis. The major conceptual approaches categorized into the socioeconomic, biophysical, and integrated approaches.

The socioeconomic approach is mainly concerned with the social, economic, and political aspects of society (Adger, 1999). The biophysical, or impact assessment, approach is mainly concerned with the physical impact of climate change on different attributes, such as yield and income. The integrated assessment approach combines both the socioeconomic and the biophysical attributes in vulnerability analysis (Füssel, 2007).

2.3.2. Adaptation

In literature adaptation is defined in several ways. The following are some of the examples:
Adaptation to climate is the process through which people reduce the adverse effects of climate on their health and well-being, and take advantage of the opportunities that their climatic environment provides. Adaptation involves adjustments to enhance the viability of social and economic activities and to reduce their vulnerability to climate, including its current variability and extreme events as well as longer-term climate change; and Adaptation to climate change includes all adjustments in behavior or economic structure that reduce the vulnerability of society to changes in the climate system (Smit et al., 2000). What We have to understand and accept, whatever the definition is that adaptation to the already existing level of climate change is an urgent issue, demanding our attention as much as the prevention of further global warming. Of course, adaptation to climate variability is not a new concern for environment and development specialists. But due to the predicted dimensions of climate change it is becoming a crucial factor in planning and prioritizing almost all fields of mid- and long-term governmental and private sector activity.

Many finance, insurance and real estate companies are therefore starting to incorporate climate change risks and opportunities into their decision-making. Public organizations and also businesses are well advised to follow suit. In practice, two important tools are needed: the best available impact assessments and the best available vulnerability analyses. These analyses and assessments tell us whether and how change occurs, where it will strike and who will be hit hardest. Climate-related effects constitute a threat to the development of poor countries and particularly to impoverished groups within a population. The relevance of climate change to development cooperation is clear: without consideration of these effects and without strategies for adaptation to these effects, the United Nations Millennium Development Goals will be much harder to achieve.

2.4. Conceptual framework

As described in the above section, all components of food security such as: availability, accessibility, utility and stability are subject to impacts of climate change/variability. The degree to which the community vulnerable to or can be affected by such changes depends mainly on the community's exposure, sensitivity and adaptive capacity. This study conceptualized the impact that climate change/variability has on farmers' vulnerability to food insecurity in perspective of these three factors: exposure, sensitivity and adaptive capacity)

According to IPCC (2001), vulnerability to climate change has been defined as:

Vulnerability: the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.

Exposure: Exposure to climate change/variation is primarily a function of geography. For example, communities in semi-arid areas may be most exposed to drought, while coastal communities will have higher exposure to sea level rise and cyclones.

Sensitivity is the degree to which a given community or ecosystem is affected by climatic stresses. For example, a community dependent on rain-fed agriculture is much more sensitive to changing rainfall patterns than one where mining is the dominant livelihood. Likewise, a fragile, arid or semi-arid ecosystem will be more sensitive than a tropical one to a decrease in rainfall, due to the subsequent impact on water flows.

Adaptive Capacity : The ability of a system [human or natural] to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

One of the most important factors shaping the adaptive capacity of individuals, households and communities is their access to and control over resources. The major resources affecting adaptive capacity include: human, social, physical natural and financial resources. Human resource comprises; knowledge of climate risks, conservation of agricultural skill, good health enable

labor; social resources includes women's saving and loan groups, farmer based organization, traditional welfare and social supporting institutions; physical such as: irrigation infrastructure, seed and grain store facilities; natural like reliable water sources, productive land, vegetation and trees; and financial like microfinance, diversified income sources are some of resources affecting adaptive capacity.

A framework developed by Ford and Smit (2004) is used in this study. This framework assist vulnerability and adaptability analysis in relation to climate change in the area. Ford and Smit (2004) indicate that information gained through observations, experiences, and traditional local knowledge is a central component to current vulnerability assessment. Stage one of the process involves an assessment of current vulnerabilities by documenting climatic risks in the community (current exposures) and strategies used to address such risks (current adaptive capacity). Future work could include predicting the degree to which the community can deal with future exposures and vulnerability. This would involve "estimating directional changes in exposure and predicting future adaptive capacity on the basis of past behavior" (Ford & Smit, 2004). However, this part is not covered in this paper.

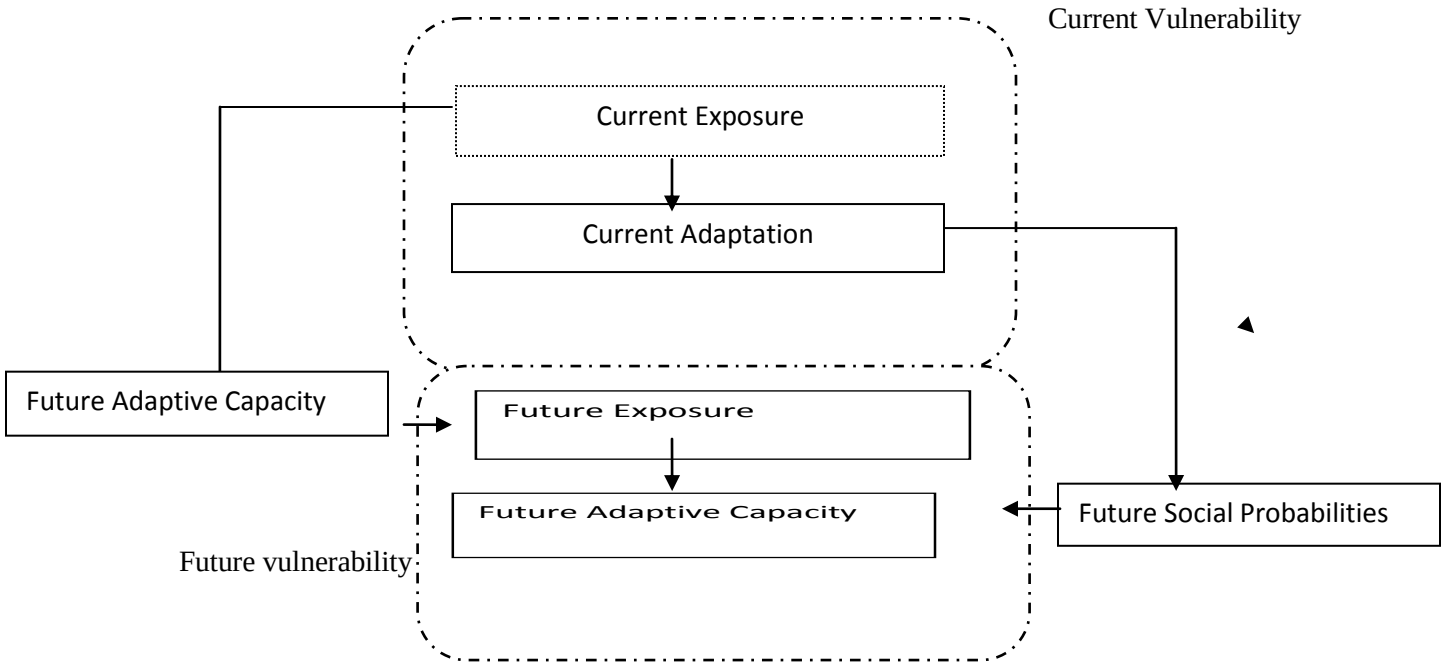


Figure 1: Analytical frame work for vulnerability Assessment from ford and Smith (2004)

3. Description of the study area and research Methodology

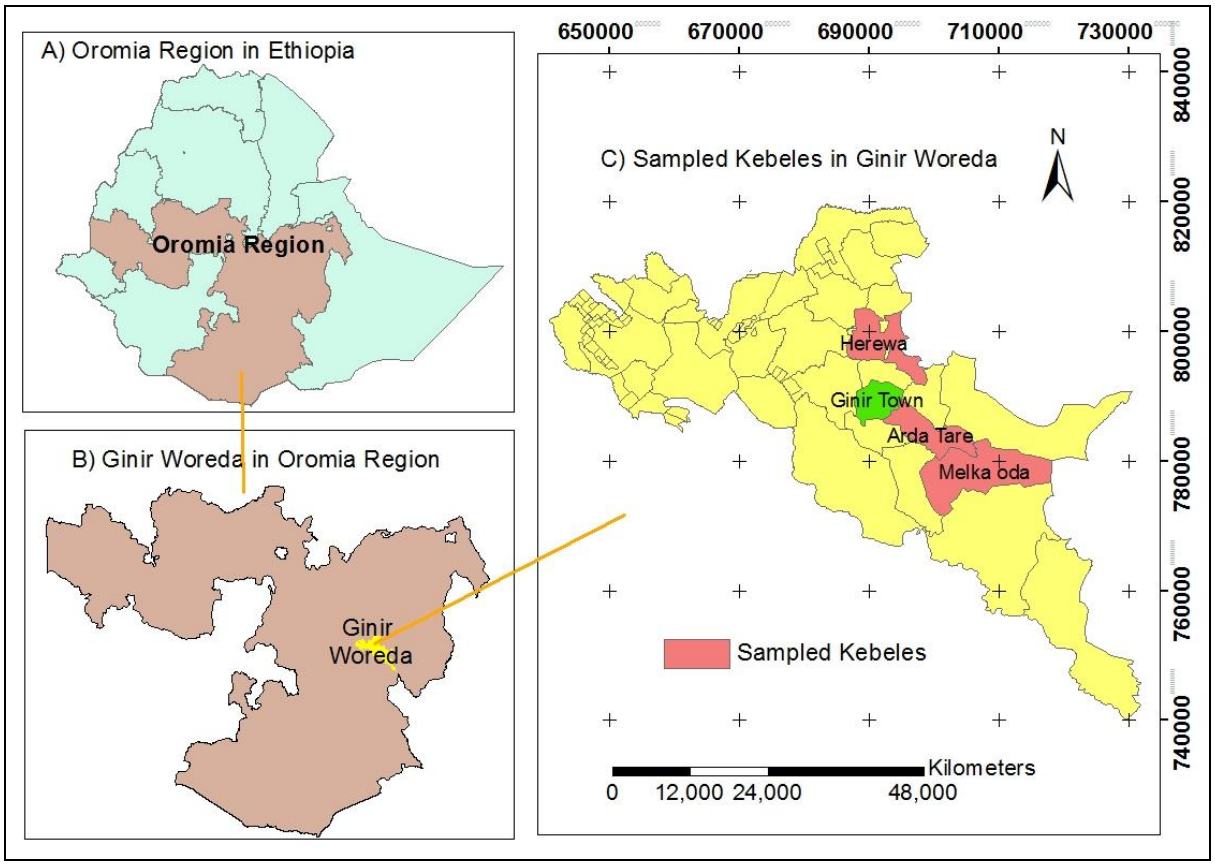
3.1. Description of the study area

3.1.1. Location

The study area, Ginir *Wareda* is found in Bale zone of Oromia regional state. The *Woreda* is located in the South Eastern part of the zone (Figure 2). It is one of the administrative units (among 18 *Woredas*) of Bale zone with an area of about 2,384 square kilometers (account for 3.4% of the area of the zone), which ranked it as 8th largest *Woreda* in the zone. Administratively the *Woreda* is sub divided into 29 rural and 2 urban administration *Kebeles.*

According to 2013 CSA's population projection, total pupation of the woreda by year 2014 is 170,218 (83,500 female and 86,718 male). Among which 141,929(83%) are rural and 28,289(17%) are urban dwellers.

The administrative center of the *Woreda* is Ginir town, which is located at distance of 133 km from zone capital Robe town and 563 km from country center, Addis Ababa. The *Woreda* is bordered by Gololcha and Gasera *Woreda*s in North, Rayitu and Sawena *Woredas* in East, Dawe Kachen in South and Goro and Sinana *Woredas* in West.



Source: Oromia Region Bureau of Finance and Economic Development

Figure 2 Location map of Ginir *Woreda* in relation to Oromia region and Ethiopia

3.1.2. Relief and drainage

Topography of the *Woreda* falls within altitudinal range of 1200-2406m amsl. Relatively, the Northern and North Western part of the *Woreda* is characterized with highland mountainous. Whereas Eastern and South Eastern parts of the *Woreda* is dominated by lowland. And the southern part of the *Woreda* is dominated by undulated value and broken escarpment. The land configuration of the *Woreda* is categorized as plain which account about 85%, mountain 3% and rugged and gorge areas account for about 12 % of the *Woreda's* area.

Drainage system of the woreda as whole is falls within single drainage basin, i.e. Genale drainage basin. Some Perennial and a number of seasonal rivers are found within the woreda. Gololcha, Dinkit and Tebeke are perennial rivers and there many seasonal rivers among these the majors are Burka,Ada ,Fo'a and Alkock rivers.

3.1.3. Climate

Ginir *Woreda* falls within two agro-climatic zone namely 25% temperate (*Woyinadega*) and 75% lowland (*kola*). Rainfall, temperature, wind, humidity and sunshine are some of climatic elements which affect socio-economic activity and life condition of the people in a given spatial units. In the agrarian society, changes in above climatic elements have impact on the agricultural production. Particularly changes in temperature and precipitation directly affect crop production and can even alter the distribution of agro-ecological zones.

Ginir *Woreda* receives mean annual rainfall of about 918 mm. The *Woreda* receive rain in two seasons such as Belg(Autumn) season (March to May) and Tsedey(spring) season (September to November). Bega (winter) season (December- February) is the driest season in the area. Unlike highland part of the country, Kremit (June to August) is dry season with only small rainfall (figure 3).

In the *Woreda* the highest rainfall amounts recorded in months of April, May and October and the lowest amount recorded in months of January and February.

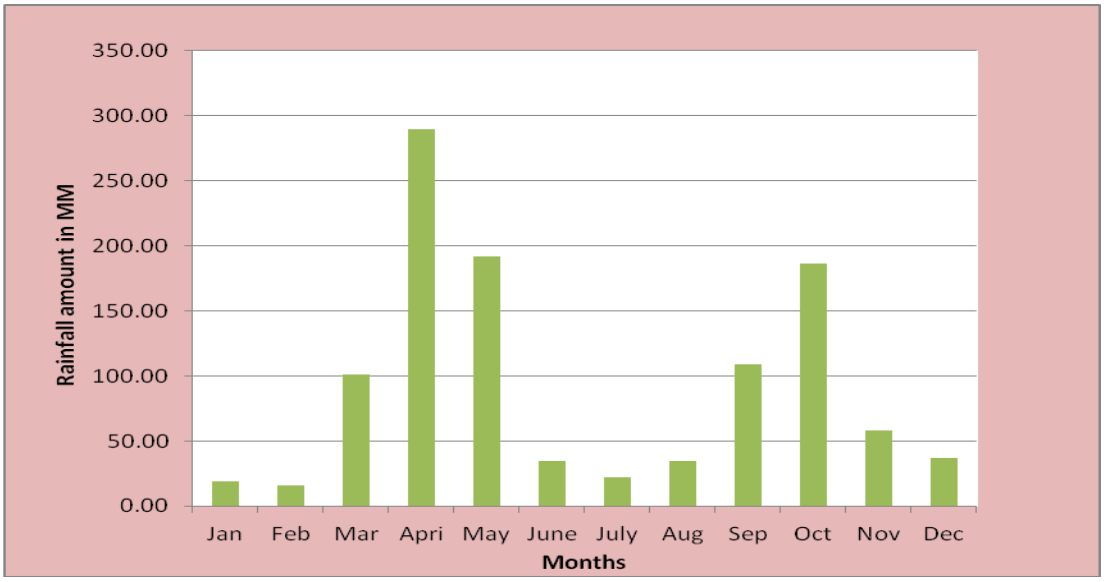


Figure 3: Monthly average rainfall of Ginir Woreda for the period from 1982 to 2012

Source: Computed by Author from NMA data

Temperature is other climatic elements which influence agricultural activity. Similar to rainfall temperature also shows spatial variation. The temperature data from 1982-2023 indicates that the higher monthly mean maximum temperature was recorded in the *Woreda* during month of

December to February where as the lowest monthly mean minimum temperature recorded during months of December and January (figure 4). In these years (1982-2012) the recorded average mean maximum, minimum and average temperature were 24.2^0c, 13.30^0c and 18.7c, respectively.

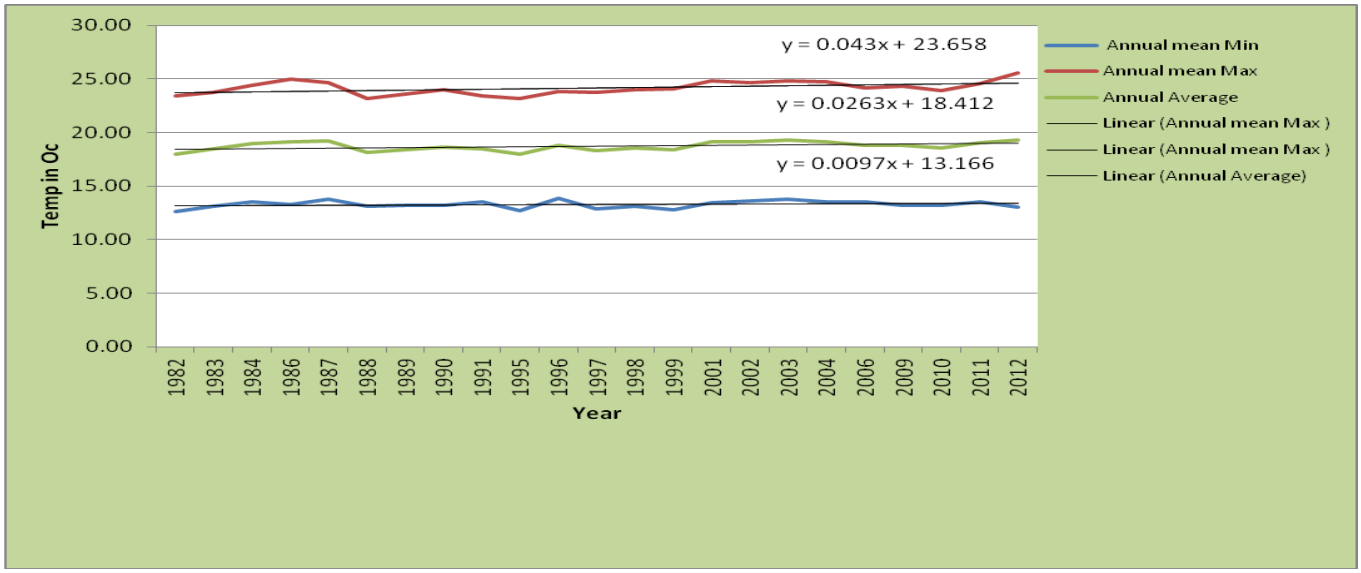


Figure 4 mean maximum, minimum and Average Temperature of Ginir Woreda (1982-2012)

Source: Computed by Author from NMA data

3.2. Research design and Data needs

In the study combination of both quantitative and qualitative studies has been employed. The trends in climatic factors (rainfall and temperature) were quantitatively analyzed, while the vulnerability and coping situations of the farmers were analyzed in qualitatively precept.

In the research, the following procedures have been employed: secondary data collection and analysis; preliminary survey and discussion with officials at various levels Participatory Rural Appraisal (PRA) exercise with different community groups and local government staffs were done in selected three *Kebeles* (Harawa-1, Arda Tare and Melka Oda).

3.2.1. Qualitative study

Qualitative methods take many forms including descriptions of people, places, conversations and behavior. The study used different data collection tools in collecting data for the qualitative analysis. PRA is an approach and methods for learning about rural life and conditions from, with and by rural people. In this research, PRA tools like focus group discussion, key informant interviews and personal observation employed in collecting qualitative data.

3.2.2. Quantitative study

Under quantitative study, data was collected from different institutions and farmers. Climate data for rainfall and temperature records of 31 years was collected from National Meteorology Agency (NMA) and used analyze rainfall and temperature trend overtime. Other data which used for the qualitative study were collected from individual farmers through interview using structured questioners. The interviewees were farmers from purposively selected three *Kebeles*.

3.2.3. Data collecting method and tools

Different methods of data collection instruments/tools like household survey using structured questionnaire; key informant interviews (KII), focus group discussion (FGD), discussions with local level development workers and personal observations were employed to produce primary data. Besides, secondary data were collected from different documents, journals and other published and unpublished documents from library, internet, the *Woreda*, zonal, or regional concerned government offices.

3.2.1.1. Household survey

The study used the semi-structured interview method by administering the household survey to 149 systematically chosen respondents from purposively identified three Kebeles. The three sample *Kebeles* were selected as their agro-climatic can representation the woreda's climate i.e., one *kebele* is located in lowland area, second Kebele is in *Woyinadega* part and the third one is in transition part in between these two agro-climate zones. Besides, the agro-climatic condition, *Kebeles'* accessibility and vicinity to meteorology station were also taken in to consideration during identification of these sample *Kebeles*. After identify sample *Kebeles*, on average, the researcher proposed to collect data from 50 households from each *Kebele*. In indentify the respondents, after having total number households from *kebele* administration and randomly

identify the first interviewee, other respondents have been identified systematically using the ration of *kebele's* total households to the number of proposed respondents (in kebele) as interval. After identification of respondents, the survey was conducted through the face-to-face contact technique in order to reduce nonresponsive rates and encourage more probing on the issues not properly articulated and adequately understood.

The questionnaire as a research instrument contained both closed-ended and open-ended questions (See Appendix 1) in order to maximize the merits of both types of questions.

3.2.1.2. Focus group discussion (FGD)

FGD is semi structured group process used to obtain detailed information about a particular situation. The focus group discussions are rapid assessment, semi-structured data gathering methods in which a purposively selected set of participants gather to discuss issues and concerns based on a list of key themes drawn up by the researcher/facilitator. Composition of FGD is 6 - 9 participants brought together to discuss a clearly defined topic and it is a composed of homogeneous people representing a particular segment of population.

In this research, the FGDs were arranged and conducted to different community groups (women, men, youth, elders, religion leaders and Community Based Organizations) that have long time local knowledge and experience. In each *Kebeles*, 3 FGDs, i.e., 1 women (female headed households) 1 men (male headed households) and 1 youth groups, totally, 9 FGDs were conducted in this research.

3.2.1.3. Key Informant Interviews

Further information was solicited from key informants including community members and government staff. The Key Informants were selected primarily for their knowhow of the subject matter under study. In that regard, the key informants were selected through purposive or snowball methods, that is, they were either handpicked for a specific reason or few key informants identified additional informants. Accordingly, total of 8 people (6 from community and 2 government staffs) were interviewed as key informants.

3.2.1.4. Direct observation

Direct observation is another important method employed in the research. This was done through direct field visit to some farmers' activities and visits some individual home. In the study, the researcher have reached 4-5 farmers from each sample Kebeles (totally 14 farmers) and visited their farm land and practices in field, their backyards, houses and their business in two households who engaged in petty trade.

3.3. Data analysis

Using varieties of analytical approaches that enhance the understanding of change and variability of climate from different prospective is quiet helpful. To do this, sensitive to or vulnerabilities of farmers and in-depth knowledge of local area as well as a good understanding of the local condition is necessary. To ensure this, the research analyzed the collected data using statically approach.

Descriptive statistics based on percentages and ratios were utilized to analyze findings. Data that have been collected from selected farmers, development staff members and other officials using structured questionnaire were organized and entered in to SPSS for descriptive statistics examination of the problem under study.

4. Results and discussions

4.1. Profile of the respondents

The characteristics presented in this study were responses from household members from three *Kebeles* of Ginir *Woreda*. Majority of respondents were male (male headed HHs), constituting 76% of respondents and female (female headed HHs) account for 24% (table 1).

Age wise 46% were between 18 and 30 years, the other age group respondents in the range 31 to 40, 41 to50 and above 50 years old account for 17%, 23% and 14%, respectively. Most of the respondents were married (91 %), while 7% were unmarried and the remaining 2% were divorced. The overall number of children in a family was 4 and the average family size was 5.8 (table 1).

Regarding education level (table 1), the majority of the respondents had attained primary level of education. Among the respondents, 26.85% were illiterate (not writing and reading) , whereas, 29.53% were grade 1-4, 26.85% grade 5-8, 12.75% grade 9-10, 1.34% diploma holders, and 2.68% were educated above diploma level.

As shown on table 1, the means of livelihood out of the total respondents, 53.69% were depend on crop production, 7.38% livestock rearing, 30.20% mixed farming (i.e., crop and livestock production), and 8.72% were based on others means of livelihoods like petty trade and daily labor. As indicated in table 1, the majority of the respondents (84.6%) have no additional income sources. Only 15.4% have additional income sources in which 8.05% got additional income from trade, 6.04% causal labor and 1.34% employee.

Table 1: Characteristic of the household survey respondents

Characteristic		Frequency of the respondents by with Kebele Melka Oda	Harawa 1	Arda Tare	Total (frequency)	%
sex	Male	41	40	32	113	75.84
	Female	8	12	16	36	24.16
	Total	49	52	46	149	100
age of respondents	18-30	23	18	27	68	45.64
	31-40	9	8	8	25	16.78
	41-50	10	17	8	35	23.49
	Above	7	9	5	21	14.09
	Total	49	52	48	149	100
Marital Status	Married	45	47	43	135	90.60
	Unmarried	4	2	5	11	7.38
	Divorced	0	3	0	3	2.01
	Total	49	52	48	149	100
Education Status	Illiterate	12	19	9	40	26.85
	1st cycle(grade 1-4)	10	20	14	44	29.53
	2nd cycle(Grade 5-8)	19	10	11	40	26.85
	Secondary School(grade 9-10)	6	2	11	19	12.75
	preparatory(Grade 11-12)	2	0	0	2	1.34
	Diploma and above	0	1	3	4	2.68
	Total	49	52	48	149	100

Characteristic		Frequency of the respondents by with Kebele				
		Melka Oda	Harawa 1	Arda Tare	Total (frequency)	%
number of children	Not have children	6	5	8	19	12.75
	1-3	22	24	21	67	44.97
	4-6	11	13	17	41	27.52
	7-9	8	8	1	17	11.41
	10-12	2	2	1	5	3.36
	total	49	52	48	149	100
number of family	1	1	3	1	5	3.36
	2	2	1	3	6	4.03
	3	8	2	4	14	9.40
	4	8	10	8	26	17.45
	5	7	12	9	28	18.79
	6	3	6	5	14	9.40
	More than 7	20	18	18	56	37.58
	Total	49	52	48	149	100
means of livelihood of respondent	Crop production	24	28	28	80	53.69
	Livestock rearing	6	2	3	11	7.38
	Mixed farming	10	21	14	45	30.20
	Others	9	1	3	13	8.72
	Total	49	52	48	149	100
Additional source of income	No additional income source	36	45	45	126	84.56
	Trade including petty trade	9	1	2	12	8.05
	Casual laborer	4	5	0	9	6.04
	Employee	0	1	1	2	1.34
	Total	49	52	48	149	100

4.2. Trend analysis of climate variability

4.2.1. Temperature trend analysis of Ginir *Woreda*

In the study period (1982-2012), the mean minimum temperature was 13.28°C and mean maximum was 24.17°C. Both mean minimum and mean maximum temperatures have shown increasing trends. The minimum temperature has increasing with trend of 0.01°C and having R^2 value of 0.1106. Similarly, maximum temperature has shown an increasing with annual trend of 0.043°C and having R^2 value of 0.2183 (figure 5).

From these average values, it is clearly seen as the maximum temperature was highly increased whereas the minimum temperature was increased very slightly.

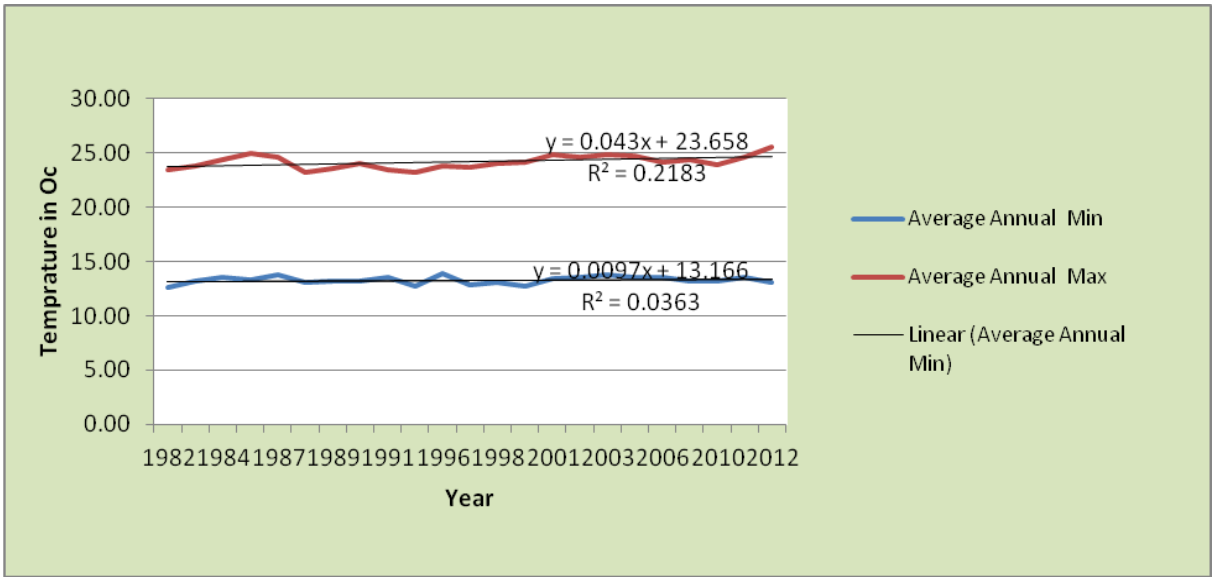


Figure 5: Annual Maximum and Minimum Temperature trend of Ginir *Woreda*

Source: - Computed by Author from NMA data

Kiremit and *Bega* temperature of the area was also analyzed for the period of 1982-2012. As figure 6 shows, during *Kermit* season, maximum temperature has been increasing with annual trend of 0.0558 °C having R^2 value of 0.1621, whereas, the average minimum temperature is slightly decreasing with annual trend of 0.005 °C having R^2 value of 0.0075.

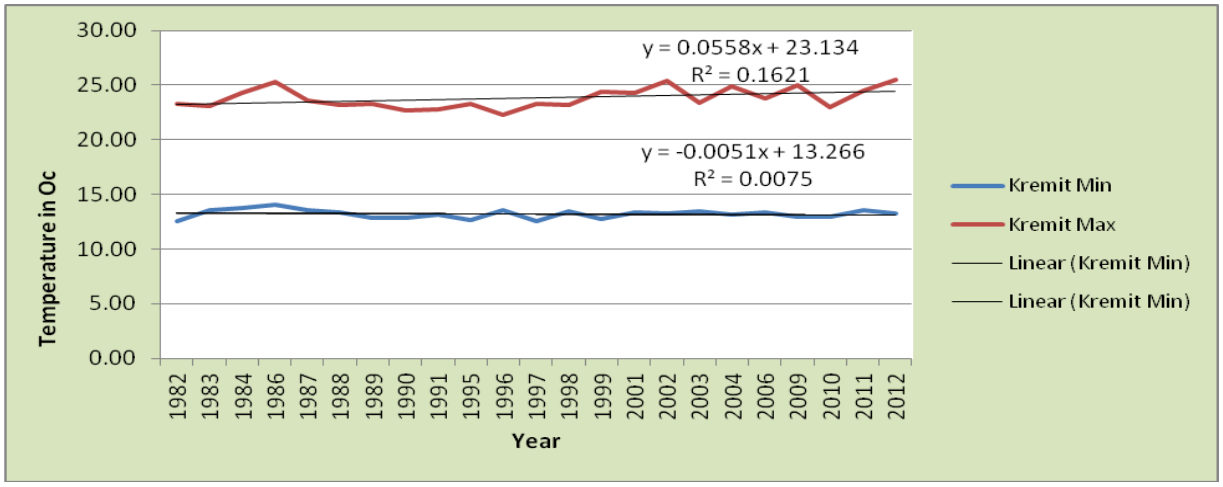


Figure 6 : *Kremit* Maximum and Minimum Temperature trend of Ginir *Woreda*:

Source: - Computed by Author from NMA data

As figure 7 indicates, *Bega* maximum temperature has been increasing with annual trend of 0.0535, having R^2 value of 0.229, whereas, minimum temperature has been decreasing with annual trend of 0.003°C and having R^2 value of 0.0012.

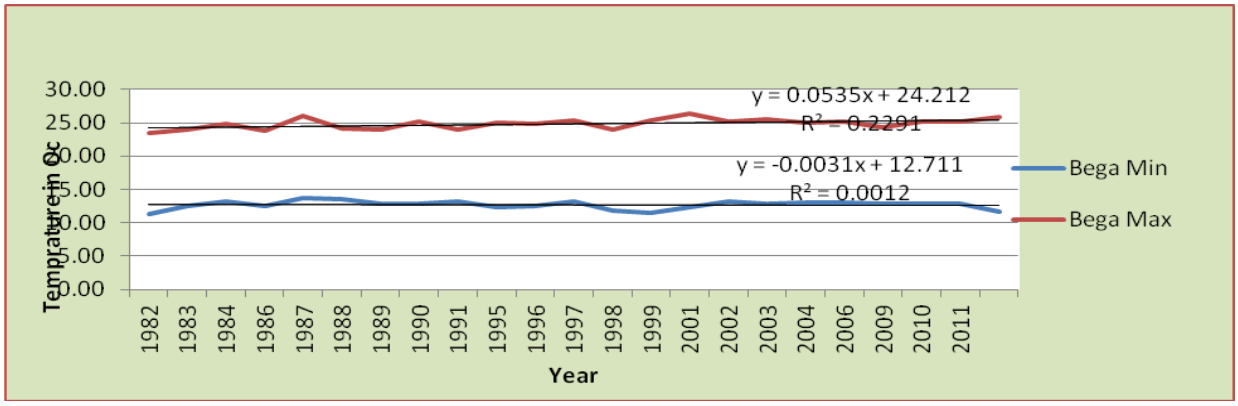


Figure 7: *Bega* Maximum and Minimum Temperature trend of Ginir *Woreda*

Source: - Computed by Author from NMA data

In addition to the annual trend, in the study, the decade temperature trend of area was analyzed for the period of 1982 - 2012.

In the first decade of the study period, (i.e., from 1982 – 1989), the average maximum annual temperature was 23.83°C and it increased to 23.95°C for the period between 1990 and 1999 and then decreased to 23.77°C in the period between 2000 and 2012. However, as table 2 shows, in all the three decades, the average annual temperature shown an increasing trend with amount of 0.03°C, 0.113°C and 0.18°C, respectively.

When we see the seasonal trend, the maximum temperature has been increasing during both Bega and Kremit seasons in three decades but with higher increasing trend during Bega season.

As shown in table 2, the minimum temperature has slightly increasing from decade to decade. From 1982 to1989, the average minimum annual temperature was 13.13°C and it was 13.15°C in the period from 1990 to 1999 and was 13.41°C in the period between 2000 and 2012. In the first and third decades, average minimum temperature was showing an increasing trend with average of 0.03°C and 0.05°C, respectively, but in the second decade the annual trend was decreasing with amount of 0.07°C.

The average minimum Bega temperature for 1982 -1989 was 12.65°C, 12.50°C for 1990 - 1999 and 12.72°C for the period between 2000 and 2012. The trend was slightly increasing with 0.01°C in the first decade, decreasing by 0.19°C in second decade and increased by 0.11°C in third decade.

During Kremit season, the average minimum temperature was higher than Bega temperature and the average value was 13.32°C for 1982 - 1989, 12.99°C for 1990 - 1999 and 13.24°C for 2000 - 2012. And the trend was slightly decreased in first and second decades by 0.04°C and 0.01°C, respectively, whereas the third decade shows slight increased by 0.04°C. Table 2 below the summary of the maximum and minimum temperature trend by decades given.

Table 2: Maximum and Minimum Seasonal Temperature trend by Decades, 1982-2012

Temperature	Period	Annual temperature			Bega Temperature			Kiremit Temperature		
		Average Annual (oc)	Annual trend (oc)	Annual trend (%)	Bega Average	Bega trend (oc)	Bega trend (%)	Kremit Average	Kremit trend (oc)	Kremit trend (%)
Maximum	1982-1989	23.83	0.03	0.17	24.06	0.14	0.70	23.61	0.05	0.27
	1990-1999	23.77	0.13	0.57	24.83	0.19	0.83	23.18	0.17	0.79
	2000-2012	23.95	0.18	0.77	22.74	0.33	1.41	21.98	0.15	0.68
	1982-2012	24.11	0.11	0.49	24.74	0.12	0.58	23.79	0.12	0.59
Minimum	1980-1989	13.13	0.03	0.27	12.65	0.01	0.27	13.32	-0.04	-0.25
	1990-1999	13.15	-0.07	-0.38	12.50	-0.19	-1.40	12.99	-0.01	0.08
	2000-2012	13.41	0.05	0.40	12.72	0.11	1.03	13.24	0.04	0.38
	1982-2012	13.24	0.003	0.09	12.63	-0.05	-0.24	13.20	0.00	0.10

4.2.2. Trend of Rainfall in the study area

The recorded data at Ginir station has shown that the rainfall has high annual and seasonal variation trend in the study period (1982-2012). The average annual rainfall of the area for the study period was 918 mm and this has been varying from lowest amount of 659.9 mm (in 2001) to highest amount 1453.4 mm (in 1983).

Average annual rainfall has shown declining trend with annual amount of 3.4 mm and having R^2 of 0.0088 (figure 8).

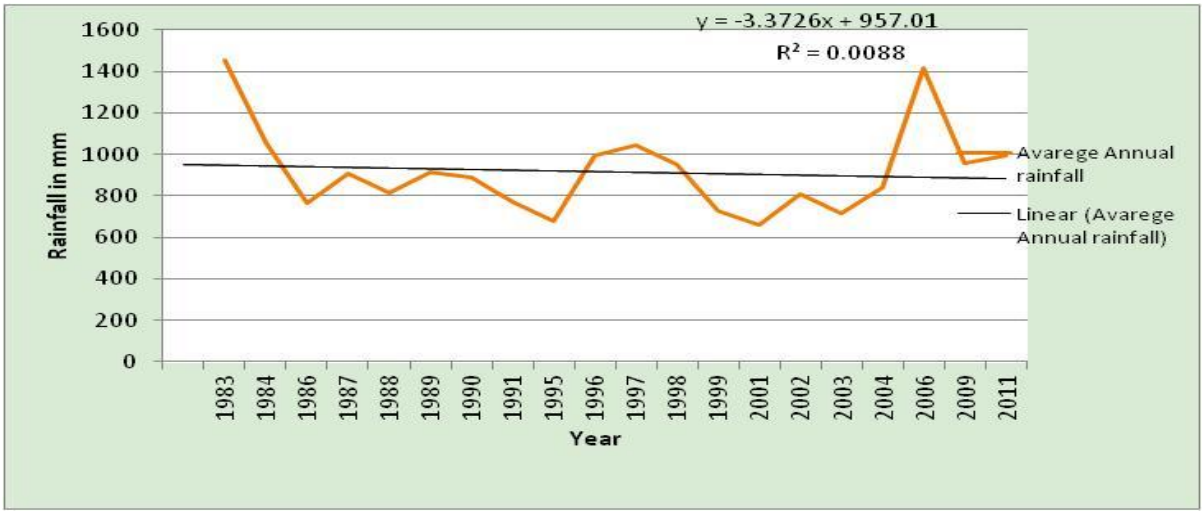


Figure 8: Average Annual rainfall of Ginir *Woreda* for the period between 1983 and 2012

The rainfall has also shown high variation from season to season. The analyzed data shows that the area has two distinguished rainy seasons and two dry seasons. The two rainy seasons are *Belg* (Autumn i.e.,March to May and *Tsedey* (Spring) September-November.

Bega (winter) season i.e., December- February, is the driest season in the area. *Kermit* (summer) June to August, is the other season with low rainfall.

Rainfall in *Kremit* season, unlike in highland areas is with low amount in the study area. In the area the average Kremit rainfall for the period from 1982 to 2012 is 90.35 mm. It has shown slight decreasing trend with 0.46 mm average annual increasing and R2 value of 0.0034(table 9). Though, the amount of rain in this season is small, it is very important to *Meher* (main) cropping season.

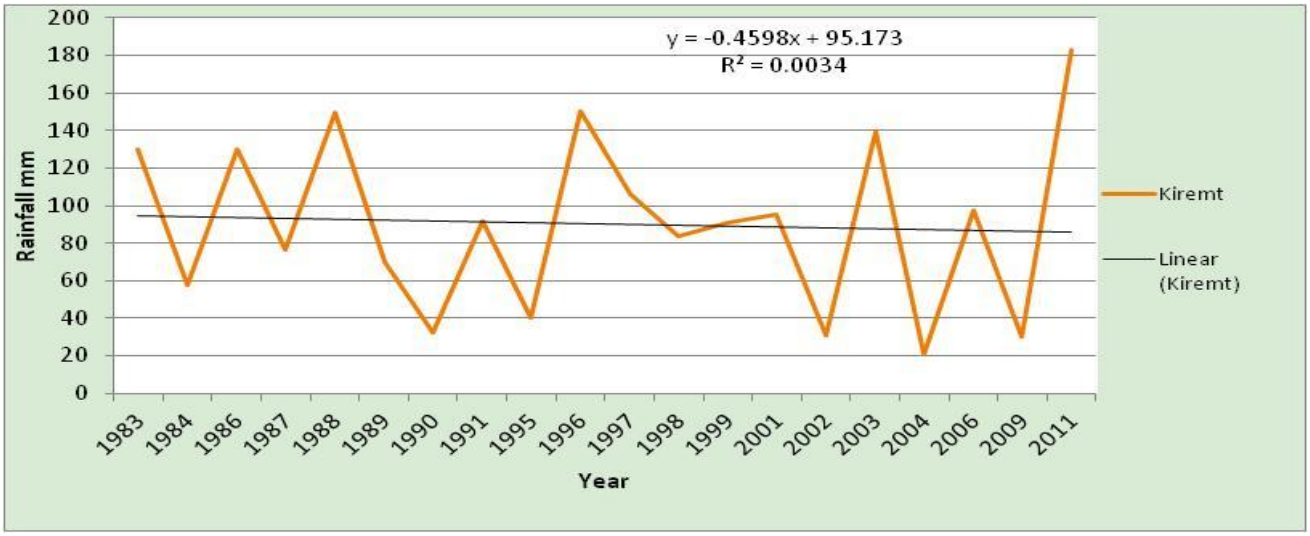


Figure 9; Average *Kremit* rainfall of Ginir *Woreda* for the period between 1983 and 2012

In the study area, *Belg* is relatively with high amount of rainfall. The average annual amount of *Belg* rainfall in the period was 416 mm, which accounted for about 45% of annual rainfall. In the area *Belg* rainfall has shown declining with annual trend of 12.9 mm in the study period and having 0.2375 R^2 value (table 10).

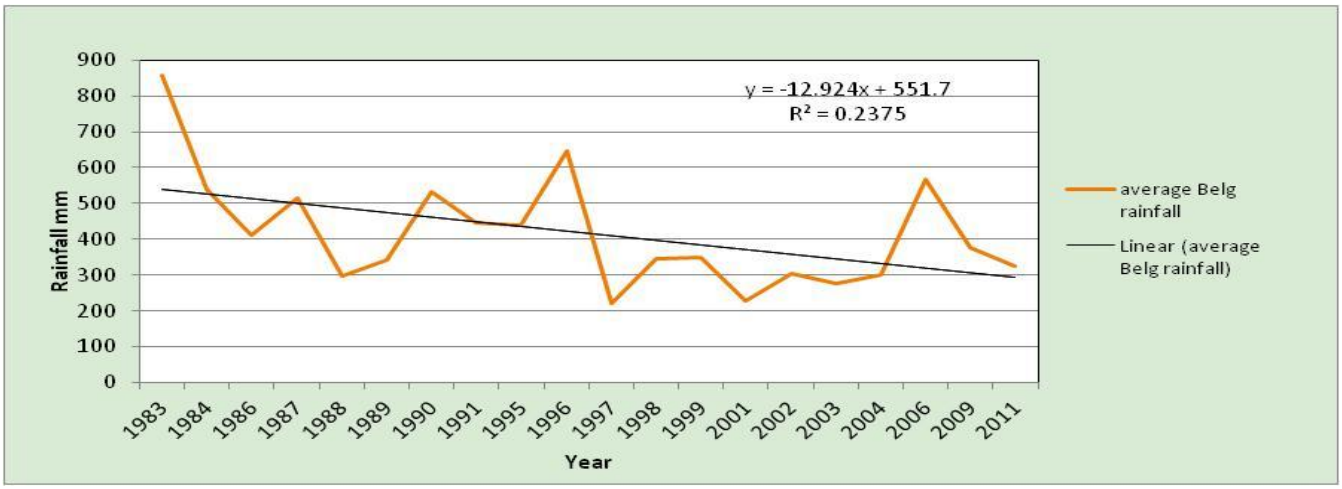


Figure 10: Average *Belg* rainfall of Ginir *Woreda* for the period between 1983 and 2012

Tsedey season is the other season when the area has been receiving good amount of rainfall. In the study period, the average Tsedey rain amount was 337 mm (37% of the annual rainfall). In the study period Tsedey rainfall has shown increasing trend, with average annual trend of 6.6 mm, having 0.0788 R^2 value (figure 11). This rainfall has an immense contribution to *Meher* cropping season.

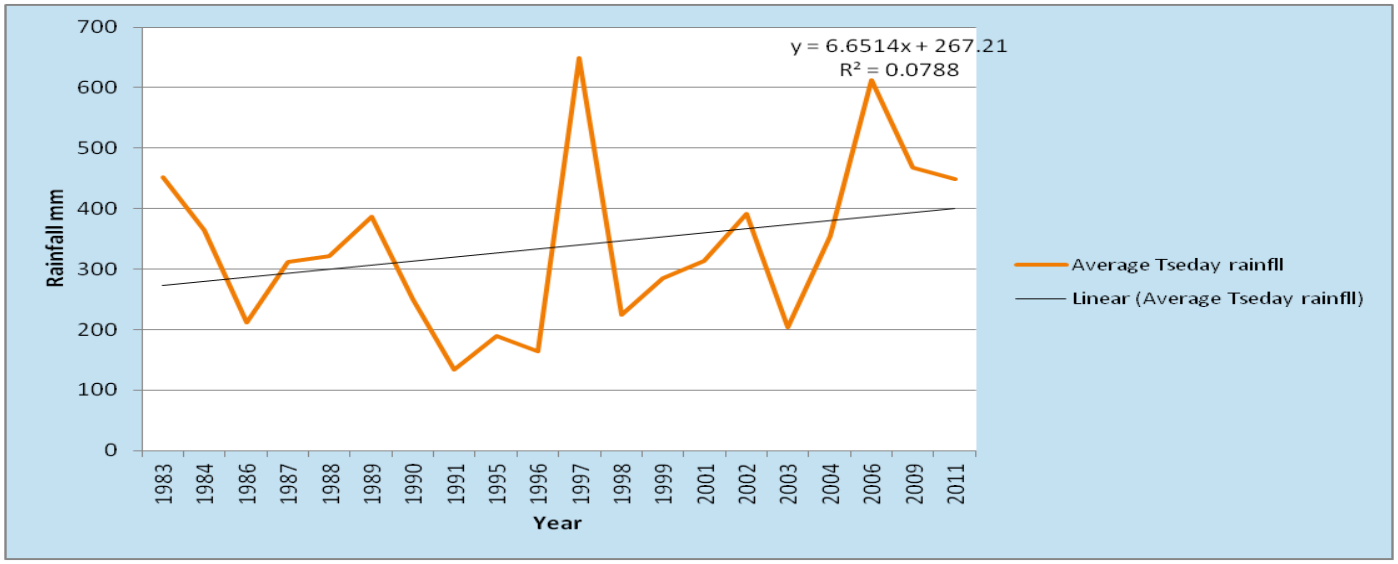


Figure 11: Average *Tsedey* rainfall of Ginir *Woreda* for the period between 1982 and 2012

Bega is the driest season in the area. the average rainfall amount of the season in the study period was 74.8 mm. The rainfall amont shows incearesing trend by annual amount 3.4 mm and

having 0.0807 R^2 valaue (figure 12). This season is critical period when the farmers have been encounting water shortage and pasture limitation to their livestock.

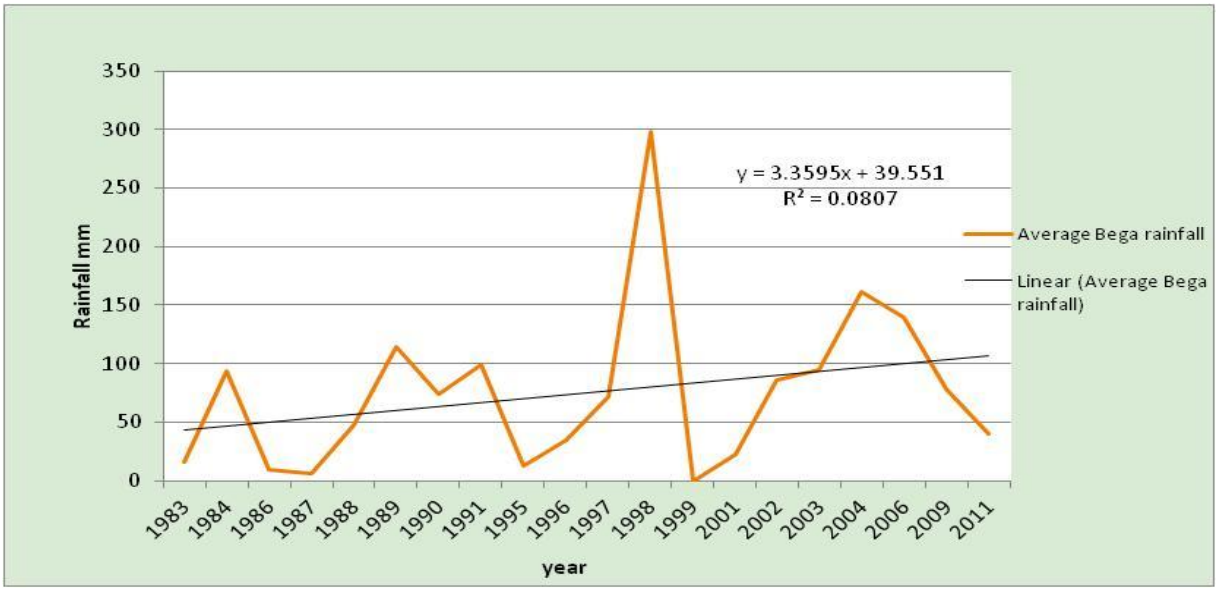


Figure 12: Average *Bega* rainfall of Ginir *Woreda* for the period between 1982 and 2012

The rainfall analysis was also done to see the trend in decade to decade. Table 3 shows annual and seasonal pattern of rainfall in decades. As indicated in the table 3, the average rainfall for the period of 1982 - 1989 was 984.83 mm. The amount was decreased to 865.91 in 1990 - 1999. But the amount in the period between 2000 and 2012 has slightly increased and the average was 913.43 mm.

As shown in the table 3, the rainfall variation for the period of 1982-1989 was decreasing with trend of 93.9 mm. Whereas, in the period 1990 to 1999 and 2000 to 2012, the rainfall has shown an increasing trend with amount of 8.34 and71.41 mm respectively.

The seasonal rainfall amounts were also show variation from one decade to other. During *Belg* rainfall in the study area has shown a significant decline trend. In the period 1982-1989 the average Belg rainfall was 493.5 mm and has shown decreasing trend with amount of 93.4mm. In the period 1990-1999, it has also shown decreasing trend with amount of 34.69mm where the

average amount was 425.64mm. However, for the period 2000 - 2012 Belg rainfall has shown increasing trend with amount of 25.41 mm and the average amount was 339.94 mm.

Tsedey season is the other season relatively with high amount of rain in the area. The average rainfall amounts were 341.48 mm, 270.84 mm and 399.44 mm in the period of 1982 - 1989, 1990 - 1999 and 2000 -2012, respectively. For the analyzed data, it is clearly observed that the rainfall was highly decreased in the second decade and considerably increased in the third decade.

Kremit rainfall, which was 102.23 mm during 1982 - 1989, was decline to 85.21 mm during 1990 - 1999 and was almost the same the period between 2000 and 2012 having average amount of 85.29 mm.

During Bega season, the amount of rainfall has progressively increased in decade. The amounts of rainfall were 47.62 mm, 84.21 mm and 88.76 mm in 1982 - 1989, 1990 - 1999 and 2000 – 2012, respectively.

Table 3: Annual and seasonal rainfall pattern of Ginir Area

seasons		Decadal period			
		1982-2012	1982-1989	1990-1999	2000-2012
Annual	Minimum	659.90	764.80	679.60	659.90
	Maximum	1453.40	1453.40	1046.30	1417.30
	Average	918.22	984.83	865.91	913.43
	Trend	-3.72	-93.90	8.34	71.41
Kermit	Minimum	20.80	57.60	32.60	20.80
	Maximum	182.90	149.40	150.30	182.90
	Average	90.35	102.23	85.21	85.29
	Trend	-0.45	-2.26	8.03	7.95
Tsedey	Minimum	134.10	212.60	134.10	204.20
	Maximum	648.60	451.40	648.60	613.30
	Average	337.05	341.48	270.84	399.44
	Trend	6.65	-10.15	26.65	34.65
Bega	Minimum	0.00	6.20	0.00	22.50
	Maximum	298.30	113.90	298.30	161.80
	Average	74.83	47.62	84.21	88.76
	Trend	3.36	-9.91	8.35	2.95
Belg	Minimum	220.00	297.00	220.00	228.30
	Maximum	856.00	856.00	646.40	567.50
	Average	416.01	493.50	425.64	339.94
	Trend	-12.92	-93.40	-34.69	25.41

4.3. Perception of local people on climate change or variability

Besides statistical analysis of meteorological data, knowing perception of local people on climate situation of the area is a paramount. For this interview with government officials, community members and focus group discussion has been conducted.

All the interviewed government experts, key informants, FGD participants and 98% of the interviewed farmers know and recognized as climate change /variability is already occurred in the area. All respondents indicated that climate change/variability is reflected on rainfall and temperature situation of the area. As shown in table 4, comparing temperature and rainfall

condition of the area with that of 10 to 30 years ago, 95.3% and 100% of the respondents, respectively thought that there is temperature and rainfall change in the area.

Most of the respondents perceived that temperature has been increasing in the area from time to time. Among the interviewed farmers, 48.6% of the respondents said temperature has been moderately increasing and 51.4% said temperature highly increasing in the area in the last three decades. They also indicated as the rainfall has declined and shown high fluctuation. Most respondents (79.9%) indicated as rainfall has declined and 57.7% noticed as rainfall shown fluctuation from time to time both annual and seasonal aspects.

Table 4: Farmers' perception about climate change/variability in the study area by Kebeles

		Melka Oda		Harawa 1		Arda Tare		Total	
Questions	Responds	Freq.	%	Freq	%	Freq	%	Freq.	%
Do you think that climate change/variability occurred in the area?	Yes	48	97.96	50	96.15	48	100	146	97.99
	No	1	2.04	1	1.92	0	0	2	1.34
	I don't know	0	0.00	1	1.92	0	0	1	0.67
	Total	49	100	52	100	48	100	149	100
How you perceive the weather condition of the area in terms of temperature?	very hot	12	24.49	4	7.69	15	31.25	31	20.81
	Hot	32	65.31	27	51.92	27	56.25	86	57.72
	Moderate	5	10.20	21	40.38	6	12.50	32	21.48
	Total	49	100	52	100.00	48	100	149	100.00
Is there any change in temperature trend in area in last 10 to 30 years?	Yes	49	100	45	86.54	48	100	142	95.30
	No	0	0.00	1	1.92	0	0	1	0.67
	I don't know	0	0.00	6	11.54	0	0	6	4.03
To what extent temperature varies in the area?	Increased very much	27	55.10	21	40.38	25	52.08	73	48.99
	Moderately increase	22	44.90	24	46.15	23	47.92	69	46.31
	Total	49	100	45	86.54	48	100	142	95.30
How you perceive the weather condition of the area in terms of rainfall?	Medium	0	0.00	3	5.77	2	4.17	5	3.36
	Low	44	89.80	45	86.54	39	81.25	128	85.91
	Very low	5	10.20	4	7.69	7	14.58	16	10.74
	Total	49	100	52	100	48	100	149	100.00
Is there any change in rainfall trend in the area in last 10 to 30 years?	Yes	49	100	52	100	48	100	149	100.00
	Total	49	100	52	100	48	100	149	100
How rainfall change in the area?	Decrease	45	91.84	35	67.31	39	81.25	119	79.87
	Fluctuation	22	44.90	39	75.00	25	52.08	86	57.72
	Total	49	100	52	100	48	100	149	100.00

In assessment of community perception on climate change /variation, indicators, cause and effect/impact of climate change/variation were also assessed.

The majorities of the respondents (86.2%) recognized as human intervention/activities causes and aggravate climate change /variability and 13.4% of the respondents perceived as human activities have no adverse impact on climate change. In the farmers interview, of the total respondents 84.5%, 75%, 40% and 7% have suggested farm land expansion to forest ,deforestation for fire wood, tree cutting for charcoal and poor farming management respectively as major anthropogenic activities that caused and exacerbated the climate change /variability in the area.

In FGD, participants explaining that expansion of farm land into forest area were due to increase in population and corresponding enhanced need for farm land to young people who have not farmland.

Farmers also indentified some main indicators for the existence of climate change/variability. Most of the respondents (82.2%) reported as repeated occurrence of drought in the area indicated the existence of climate change and/or variability in the area. in addition, increase incident of animal disease and death; increased occurrence of crop diseases; frequent crop failure, and dry out of water resource were reported as indicators of climate change in the area by 73.3%, 8.9%, 73.3% and 8.2% of respondents respectively.

Frequent occurrences of drought, crop failure, lose of animals, human disease and people displacements are the main shocks identified by famers as climate changed induced challenges affecting people in the area. About 80.71% of the respondents reported as drought and crop failure are their main concerns, and 35.71%, 64.43% and 9.29% indicated as human diseases, lose of livestock and displacement respectively are their concerns.

Table 5: Farmers perception about major causes and indicators of climate change/ variably and climate change induced shocks affecting farmers in the area

		Kebele Name							
		Melka Oda		Harawa 1		Arda Tare		Total	
		Ferq.	%	Ferq.	%	Ferq.	%	Ferq.	%
Major human activities adversely contributed to climate change or variability?	Farm land expansion to forest	25	69.44	39	92.86	40	88.89	104	84.55
	deforestation for fire wood	32	88.89	26	61.90	34	75.56	92	74.80
	Tree cutting for charcoal	22	61.11	10	23.81	18	40.00	50	40.65
	poor agricultural land management	1	2.78	4	9.52	4	8.89	9	7.32
	Total	49	100	52	100	48	100	149	100
What are indicators for the climate change or variability?	repeated drought occurrence	46	95.80	41	82.00	33	68.8	120	82.2
	increase incident of animal disease and death	37	77.10	39	78.00	31	64.6	107	73.3
	increased occurrence of crop diseases,	2	4.20	4	8.00	7	14.6	13	8.9
	frequent crop failure	36	75.00	38	76.0%	33	68.8	107	73.3
	dry out of water resource	7	14.60	3	6.0%	2	4.2	12	8.2
	Total	49	100	52	100	48	100	149	100
What types of climate change and/or variability induced shocks affect you ?	Drought	39	83	37	82	37	77	113	80.71
	Crop failure	35	74	40	89	38	79	113	80.71
	Human diseases	22	47	14	31	14	29	50	35.71
	Loss of livestock	29	62	32	71	32	67	93	66.43
	Displacement	7	15	1	2	5	10	13	9.29
	Total	49	100	52	100	48	100	149	100

4.4. Climate change contribution in farmers' vulnerability to food insecurity

4.4.1. Farmers perceptions about effect of climate change on food crops

In the study area, shortage and fluctuation of rainfall that occurred due to climate change and/or variation has been highly affecting crop production. In the farmer interview, 90.5% of the respondents confirmed that climate change and/or variability have adverse effect on crop production where 41% of these respondents indicated as the effect was very high, 37% and 20.5% reported as the effect was high and medium respectively. On the other hand, during the FGDs, the participants explained that some other factors like crop disease, pests and crop weeds

which have been mainly emerged due to climate change have contributed for crop failure in the study area.

Because of these, challenges, crops yield in the area decline from time to time. Comparing recent seasons' harvest with that of what farmers used to produce using similar inputs, all FGDs, key informants and most respondents indicated as current yield became lower in the area. In this regards, 27.5% of the respondents reported as yield became very low, 69% reported as it low and only 3.4% said as they produce same yield. Besides, climate change/variability induced challenges, high cost of inputs and difficulty in accessing inputs were the other factors contributed for decline crop yield in the area.

Livestock rearing is the other agriculture segment affected by climate change/variability. Woreda agricultural experts, FGDs and key informants have explained the existence of adverse influence of climate change/ variation on livestock production and productivity in their respective discussion. By 96% of the respondents reported as climate change/variability adversely affect their livestock rearing. Shortage of water and pasture, and occurrence of various diseases were the major problem affected livestock population in the area. It was also indicated as many farmers encounter shortage feed for their livestock mainly during drought seasons and as a result a number of livestock became physically week, farming animals unable to plow, their production like milk and meat decline, and livestock price became very low.

4.4.2. Trend in yield of major crops in Ginir *Woreda*

Wheat, barley, teff, maize, sorghum and oats are Major crops produced in Ginir *Woreda*. Success or fail in the harvest of these crops significantly affect the food security situation of the area. Thus, to have good picture about climate change /variability's impact on food security situation of the study area, besides analyzing farmers' perception, the researcher has made crop yield trend analysis. To see yield trend and impact of climate change/variably on these crops, statistical analysis such as simple regression and correlation have been utilized in the research.

For this analysis, crop production for the period of 1999-2012 was collected form *Woreda* agriculture and rural development office. The trend analysis indicated that wheat, barley and teff have shown decline trend with different degree.

Wheat is major crop produced in the area. It covers 59% of the total cultivated area and 68% of the production of the *Woreda* on average. In last 14 years, wheat yield has shown decline with a trend of 44.9 kg/ha/year and having 0.5006 R2 value (figure 13). Some of the reasons for the decline of this yield as explained by agriculture office experts during interview are crop diseases, weeds, pests and impact of decline in rainfall.

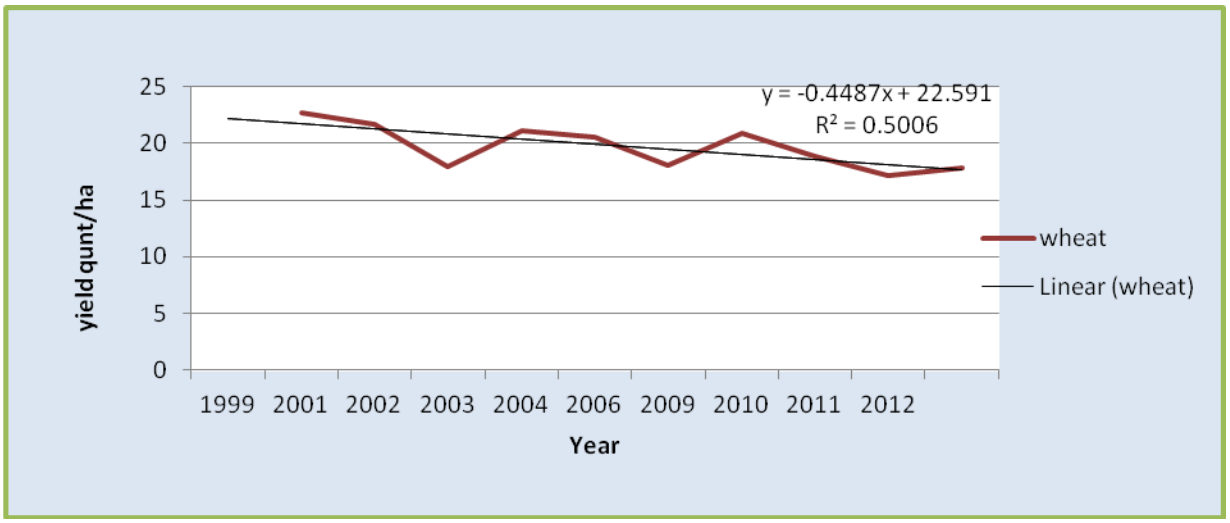


Figure 13: Trend of wheat yield in Ginir *Woreda*, 1999-2012

Figure 14 shows that barely has declining slightly over last 14 year from 1999 - 2012, with annual declining trend of 30 kg /ha and R² value of 0.0779.

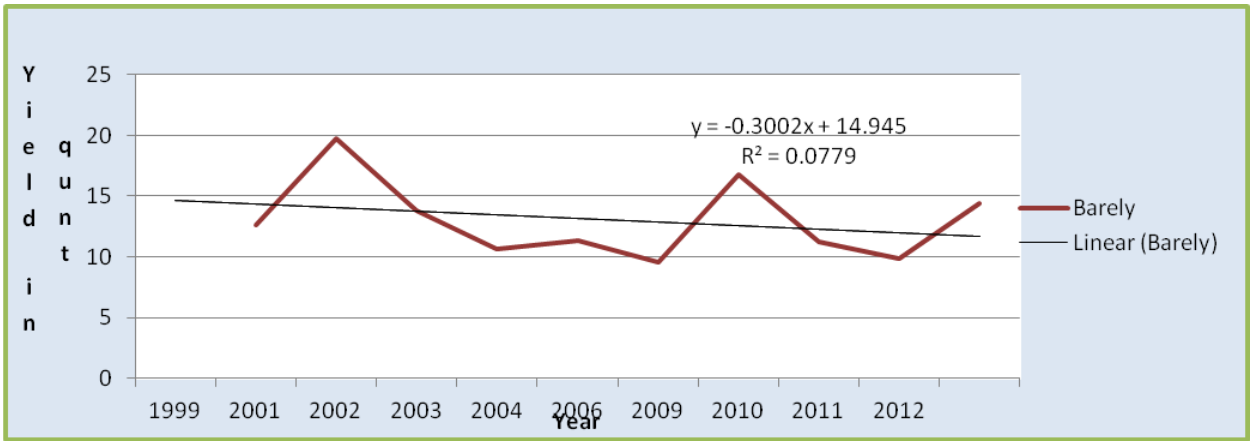


Figure 14 Trend of barely yield in Ginir Woreda, 1999-2012

Teff is also other crop produced in Ginir Woreda. Figure 15 shows that teff yield in Ginir Woreda is declining slightly with annual trend of 4 kg/ha and with R^2 value of 0.0029

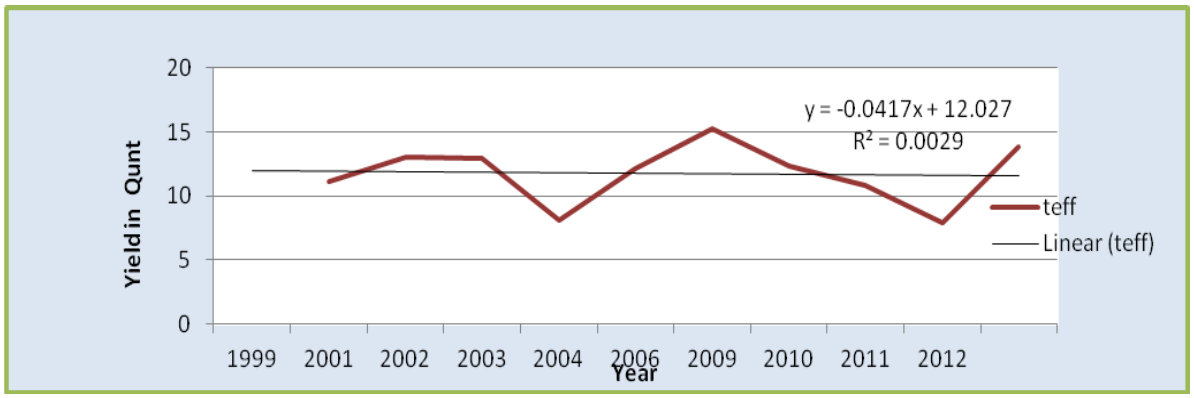


Figure 15: Trend of teff yield in Ginir Woreda, 1999-2012

On the other hand yields of maize, sorghum and oats have shown increasing trend in the period 1999 to 2012 in the study area. As figure 16, shown maize yield has shown an increasing trend with 98.2 kg/ha and having R^2 value of 0.8161.

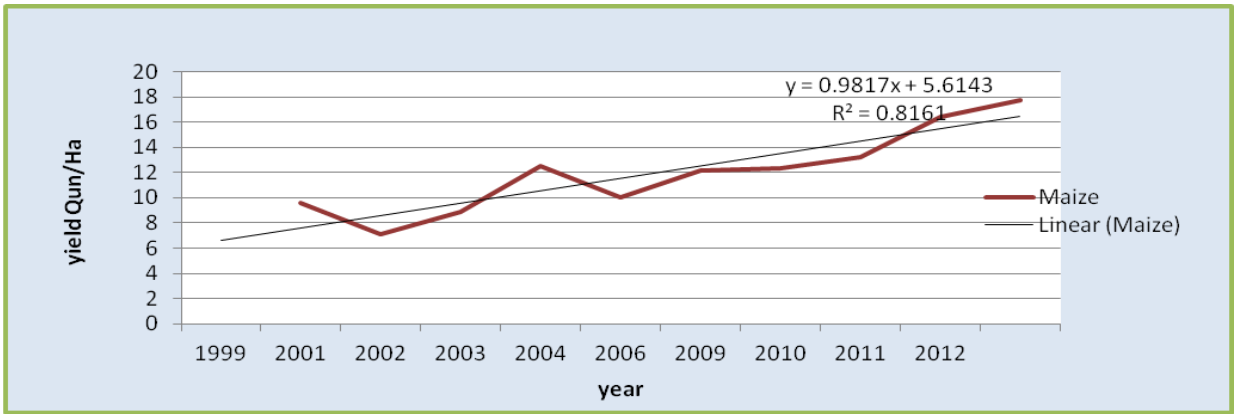


Figure 16: Trend of maize yield in Ginir *Woreda*, 1999-2012

Figure 17 shows that sorghum has increase slightly in the last 14 year from 1999 to 2012, with amount of 22kg/ha and having R^2 value of 0.1353.

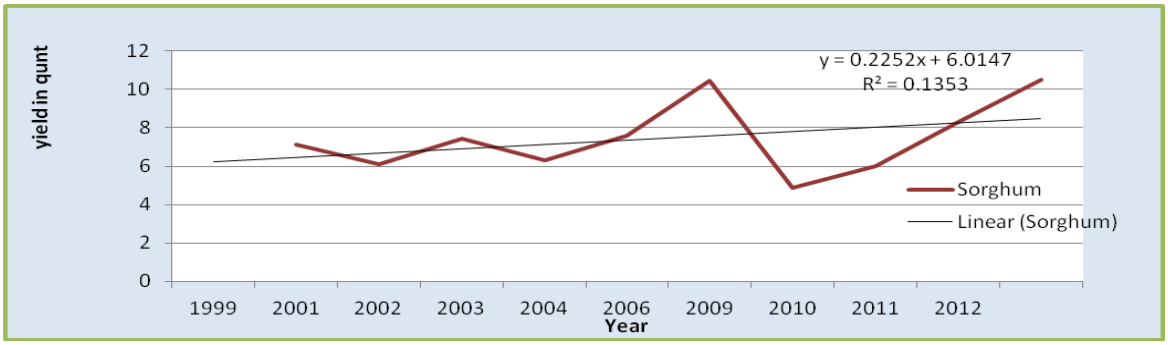


Figure 17: Trend of Sorghum yield in Ginir Woreda, 1999-2012

Oats is the other cereal crop produced in Ginir Woreda. It mainly produced in the area with relatively high elevation and cold condition. In the area, oats yield show significant increasing with amount of 77kg/ha and having R^2 value of 0.2702 (figure 18).

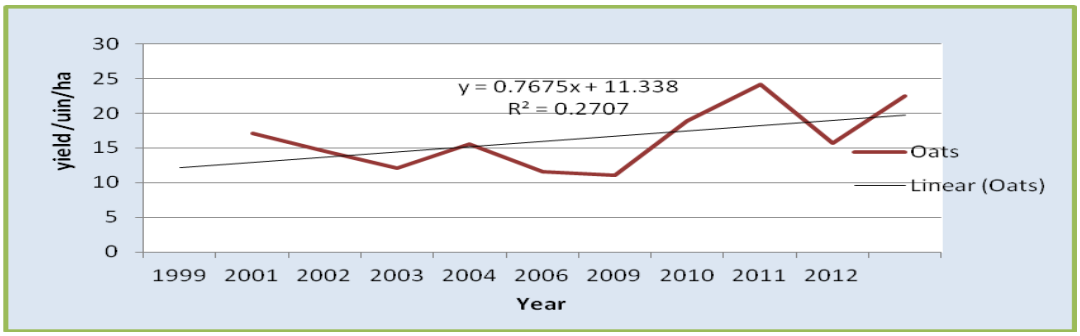


Figure 18: Trend of Oats yield in Ginir Woreda, 1999-2012

From the crops yield analysis, it was seen that the climate change and/or variability have adverse impact on some crops like for wheat, barley and teff and on the other hand positive impact on some crops like maize, Sorghum and oats. However, when we assess the overall impact, the former crops (wheat ,barley and teff) are account for large area coverage and production, i.e., these crops account for 83% of and 87% woreda annual cultivated land and woreda annual production respectively. Therefore, decline in yield of these crops significantly affect the overall woreda annual production and in turn highly affect the woreda's food security situation.

Besides, conducting trend analysis of major crops, the relationship between climate change/variability and major crops was analyzed in the research. Major crops' yield for the period of 1999-2012 has been utilized in the analysis process (table 6).

Table 6: Correlation between major crops yields and rainfall and Temperature

Rainfall and Temperature	Major crop yield per hector in Quintal					
	Wheat	Barley	Teff	maize	Sorghum	Oats
Average annual rainfall in mm	-.631*	-.485	.419	.491	.730*	.360
Average *Kiremt* rainfall in mm	-.222	-.388	-.644*	.592	.262	.203
Average *Belg* rainfall in mm	-.343	-.435	.326	.116	.378	-.647*
Average Annual Maximum temperature	.221	-.028	-.084	-.487	.047	-.148
Average Annual Minimum temperature	-.573	.247	-.127	.237	.220	-.531

*. Correlation is significant at the 0.05 level (1-tailed).

As table 6 indicated wheat yield shows negative correlation with annul, *Kieremit* and *Belg* rainfalls and average annual minimum temperature and shows positive correlation with maximum temperature. Barley shows positive correlation only with average annual minimum temperature and correlated negatively with others. Teff shows negative correlation with K*iremit* rainfall, average annual maximum and minimum temperatures and shows positive correlation with average annual and *Belg* rainfalls. Maize yield shows positive correlation with all climatic variables under analysis except average annual maximum temperature. Sorghum shows positive correlation with all climate variables under analysis. And oats has positive correlation with average annual and *Kremit* rainfalls and negative correlation with others.

4.5. Impacts of climate change on food security

The existence of climate change in the study area is clearly seen from the analyses done in the above section. This climate change/variation has a range of impacts on physical and socio-economic condition including on food security situation of the area. The degree or severity of climate change impacts depends on the extent and frequency of drought occurred.

In this regard, all household survey respondents indicated that vivid drought was occurred and resulted in low agricultural production and productivity. The interviewed farmers who reported

drought in the area within 3-4 years, 5-6 years and 1-2 years account for 70%, 20% and 10%, respectively. The respondents also reported that besides the low agricultural production the drought has been adversity influencing on-farm and off-farm activities, social services like education and health, and some other social affairs. Key informants also explained that as the area has experienced multi climate change induced challenges such as: poor education service and high students' dropouts due to food and water shortage, poor health services deliveries due to lack of water in health institutions, high turnover of teachers and health personnel because of shortage of basic services like potable water in the area. During FGDs, participants stressing on and raised as unemployment is the other socio-economic problem of the area. They mentioned as it is common to see groups of people mainly youth sit idle and chewing "chat".

Climate change affected food security in differ ways. It affected food production, availability and prices of food items. Almost all HH survey respondents reported, as it affected/reduced food production. Of the HH survey, respondents those who reported increase in food items' price and decline of food items availability in the market due to the climate change were 50% and 20%, respectively.

One of FGDs members stated "*our land is fertile, during good season farmers produce different crops like maize, teff ,wheat ,sorghum and others crops. In such seasons, in the area market became full of various food crops, traders from Ginir town and other place used to come and purchased our products to resell in other markets. But what always surprises me is that during drought seasons/years when intense crop failure occurred, no enough crops available in local market and no trends of brining food crops from other market to our market. Because of this, we have been forced travel to Ginir or other far markets to buy food crops which exposed us for high costs.*´´

In turn food insecurity condition has a number of problems. FGD participants and interviewed farmers have identified some major problems occurred in the area due to food insecurity such as: malnutrition, physical weakness, various human diseases, students' dropout, migration and human death.

Food insecurity problem has affected all community groups. But the degree of the effect is varies from group to group. As FGDs participants explained and interview respondents reported, children, elders and women are the highly affected groups in order of importance.

4.6. Community Response to climate change induced food security problem

4.6.1. Coping strategies

In response to the food security problem, the local community use different coping mechanisms. FGDs and interviewed framers indicated the major coping mechanisms which include: planting drought resistance and early maturing crop varieties, early cropping, livestock migration (*Godantu*), engaging on casual works and petty trade.

Table 7: Farmers' Coping Mechanism to climate change and/or variability caused food security problem

Copping mechanism	Kebele			Total	
	Melka Oda	Harawa 1	Arda Tare	No	%
Drought resistant crops(maize, sorghum)	19	13	22	54	36
Early cropping	4	12	1	17	11
Livestock migration	3	4	1	8	5
Casual labor and petty trade	5	0	3	8	5
Combination of two or more mechanism	18	23	21	62	42
Total	49	52	48	149	100

As table 7 shows, 36%,11%,5% and other 5% of the respondents reported as they have been utilizing drought resistant crops varieties, early cropping, livestock migration (to their relatives in unaffected area), and causal labor and petty trade, respectively in responding to the negative impacts of climate change and variability. And 42 % responded reported that they use combination of two or more above coping mechanisms.

4.6.2. External support

Besides, local community's efforts, the government and international organization like World Bank provided support to community in respond to the climate change related challenges.

The government provided awareness raising education to local community on impacts of climate change, water and soil conservation (WSC) and other natural resource management intervention, and on income diversification and promoting saving and credit. The government also promoting and participating the community in tree planting and other WSC works to mitigate the climate change impact.

In addition, the government and international organization (e.g., World Bank) provide food aid (for those who have chronic food shortage) and financial input as revolving fund for community members who can engaged in Income Generating Activities (IGAs). For instance according to the Woreda Agriculture and Rural Development, in the last four years (2010 - 2013), out of identified 28,374 people, who were exposed to chronic food insecurity (account for 16% of the Woreda population), 11,268 people (40% of chronic food insecure population) provided with food support (table 8). Likewise, 9791people (6805 male and 2986 female) provided with financial support for income generation activities (IGAs). The IGA support totaled to 10,436,394 birr in the period 2010 to 2013 which was provided by World Bank (85.6%) and federal food security program (14.4%). Table 8 shows the detail food support and financial provision.

Table 8: Food item support and financial supplies (revolving fund) in Ginir Woreda, 2010 -2013

S. No	Support item	Unit	Quantity	Beneficiaries
A	Food support			
1	Wheat	Quintal	24,027.30	11,268
2	Haricot bean	"	1,675.50	"
3	Maize	"	7,729.00	"
4	Pea	"	2,751.00	"
5	Oil	"	2,360.75	"
6	Supplementary food(for children)	Carton	2,433.25	"
B	Financial supplies (revolving fund)			
1	World bank fund	Birr	8,935,886	9,114
2	Federal food security program fund	"	1,500,508	677

Source: Ginir woreda ARDO (2013)

4.7. Local Adaptive strategies

Local existed knowledge is one and the most important adaptive strategies in overcoming the challenges of climate change and variability. In the study, the researcher has assessed both the previous and currently existing the local community's adaptation strategies/mechanisms.

In assessing the previous adaption, for the question "Do you have any stories about climate change induced challenges like drought previous recounted and passed onto you "raised by researcher, all the respondents reported as they have stories that recounted and passed on to them from elders. Also the respondents mentioned local ways of adaptation last generation have been used as adaptation strategies in overcoming the challenges. They identified ways such as social networking, livestock selling, migration, off- farm activity humanitarian aid and combination of some of these ways. Of the total surveyed HH, about 10%, 3% and 1% of the respondents reported as social networks, sales of livestock and off-farm employment were strategies community used to employ as adaptation strategies against climate change related challenges. However, most of the interviewed farmers responded as the combination of two or more strategies have been utilized in adapting the challenges by the last recent generation. Where, 75% of the respondents reported as combination of strategies such as: use of the social network(borrow money, in kind support for affected family and covering destroyed livestock/crops during damages), migration and sale of livestock have been utilized and the other 15% responded as social network, migration and humanitarian aid, have been used as adaptation strategies.

The current generation also uses some of the above mentioned and some more adaptation strategies. Diversify income sources, use irrigation practices, use improved agricultural inputs (, improved seeds and), early mature crops, sale livestock, temporary migrate, support from relative and food aid.

Tabel 9:- Local adaptation strategies by *kebele*

Current adaptation strategies	Kebele Name			Total	
	Melka Oda	Harawa 1	Arda Tare	No	%
Use multi-strategies	30	31	29	90	61
Diversify income source ,use improved agricultural input and sale livestock, temporary migrate	23	26	9	58	39
Diversify income source, uses irrigation and use improved agricultural input	1	5	19	25	17
Temporary migrate External support from relative and relief (food aid)	6	0	1	7	5
use single strategy as adaptation	19	21	19	59	39
Diversify income source	16	19	10	45	30
Use irrigation	0	0	8	8	5
Use improved agricultural inputs	1	0	1	2	1
Use early matured crops	1	0	0	1	1
Sale livestock	1	1	0	2	1
External support from relative	0	1	0	1	1
Total	49	52	48	149	100

As indicated in the table 9, 61% of the interviewed farmers responded as they use multi adaptation strategies. Specifically, 39% responded as they utilize combination of diversifying income source, use improved agricultural input and sale their livestock and temporary migration; and the other 17% of responded as they employ strategies such diversify income source, uses irrigation and use improved agricultural input in their adaptation effort. The other, 31% of respondents reported that they use single adaptation strategy. 30% of the total respondents indicated as they diversified their income sources and 5% as they use irrigation. Whereas, others 4% responded as they use improved agricultural inputs (1%), use early matured crops (1%), livestock sale (1%) and external support from relative (1%) as their single adaptation strategy.

Though various community coping strategies, government and international organization support and different community's adaptation strategies are under implementation, there is lack of coordination and systematic arrangement in implementation of these strategies. During discussion with government's DAs and experts, they indicated as there are some resistance among some community groups in accepting and implementing government initiated and

previously existing coping and adaptation strategies, and show dependence syndrome to external food support. On the other hand, in FGDs and KIIs, farmers raised as there are some gaps from the government side in proper implementation of coping and adaptation strategies. For instance farmers raised as some of the government initiated activities like forcing people to plant one type of tree, provided forest area to investors though it promote farmers for forest conservation and protection, shortage in providing some improved agricultural inputs like livestock varieties and limitation intervention in development activities and solving critical area problem like water shortage.

5. Summary, Conclusion and Recommendation

Summary and Conclusion

In the study, climate change and/or variability and farmers vulnerability to food insecurity in Ginir *Woreda*, Bale zone, Oromia region, Ethiopia was analyzed. For this study, three sample *kebeles (Harawa-1, Arda Tare and Malka-Oda),* were identified and data collected from 149 farmers. In the study, socioeconomic, bio-physical, meteorology and other data were collected from Woreda, zone and regional offices, NMA, CSA and supportive data were collected from different published and unpublished documents. Different data collection tools like household survey using structured questionnaire, KII, FGD and discussions with local government officials were utilized.

First trend analysis was carried out to see the overall picture how the two major climatic variables (rainfall and temperature) are changing in the study area. The study result shows that mean annual temperatures (both minimum and maximum) have show increasing trends. In which the minimum temperature has increased with trend of 0.001°C and maximum temperature has increase with tend of 0.043°C. On the other hand, the result of analyzed rainfall data shows that annual rainfall has declining trend with annual amount of 3.72 mm. Changes in these climate variables indicated the existence of climate change and variation the area.

The study result also shows, as farmers and local government officials responds coincided with the meteorological data result. All FGDs and 98% of the interviewed know and recognized as climate change and variability is already occurred in the area. About 95% and 100% of the interviewed farmers respectively thought as temperature and rainfall changing in the area as compared with that of 10 -20 years ago. As the result of these changes, farmers vulnerability to food insecurity and other climate change related socio-economic problems increased.

The study result shows that all FGDs, KII, and interviewed farmers responded as climate change affect food security through affecting crop and livestock production. Crop yield analysis result also agreed with the community's response. In crop yield analysis, major crops yields such as wheat, barley and teff have show decline trend. On the other hand, maize, sorghum and oats yields have show declining trend. As wheat, barley and teff are major crops covering relatively

large area, decline in yields of these crops considerably affect the food security of the study area people.

The study also analyzed the impact of climate change and variability on food security and food security related problems. The analysis shows that climate change affected the community food security, where all respondents reported that climate change affect food production. Of the survey respondents, 50% and 20 % reported increase in food item price and decrease in of food items availability in the market. The study shows as climate change affected other socio-economic activities and services. Poor education due to shortage of food for children, lack of water in school compounds, poor health service due to lack of water in health institutions, and high unemployment. The study also identified major food insecurity related problems. FGDs, and HH survey respondents indentified as malnutrition, physical weakness, various human diseases, student dropout and migration and human death as major problems occurred due to food insecurity.

The study also analyzed local coping mechanisms, external support and adaptive strategies. The analysis result show that, 36%, 11%, 5% and other 5% of the respondents reported as they have been utilizing drought resistant crops varieties, early cropping/planting, livestock migration , and causal labor and petty trade, respectively in response to the impacts of climate change and variability. And 42% of the respondents responded as they use combination of two or more coping mechanisms as a reaction for the climate change challenge. The government and international organization have also provided various supports to community in cope up with the challenges. The government provided awareness raising education on impacts of climate change, water and soil conservation (WSC), and on income diversification. The government also promoted and participate community in tree planting and other WSC works to minimize the climate change impact. Besides, food aid and financial support were provided by the government and international organization, where 11,268 people were provided with various food items and 9791 people got 10,436,394 birr as financial support as revolving fund.

The study result also indentified community adaptation strategies. 61% of the interviewed farmers responded as they use multi adaptation strategies. where, 39% responded as they utilize combination of diversify income source, use improved agricultural input and sale their livestock

and temporarily migrate to other areas for casual labor or in getting assistance; and the other 17% of responded as they employ strategies such diversify income source, uses irrigation and use improved agricultural input in their adaptation effort. On the other, 31% of the respondents reported that they use single adaptation strategy. About 30% of the total respondents indicated as they diversified their income sources and 5 % as they use irrigation.

The various analysis indicated that the study area is severally impacted by climate change and the climate change is negatively affecting the livelihood of the community. The population impacted by climate change is concededly large.

Recommendation

One of the key finding of this study was that the decline in crop and livestock yields has resulted in food insecurity in the area. This indicated as crop and livestock yields should be improved to minimize food insecurity problem. Improving agricultural production and productivity through continuous extension services, accessing improved agricultural inputs (improved seed varieties, fertilizers and appropriate techniques) and sustainable farm management should be planned and implemented.

The other finding was that climate change provided better conditions for some crops, for instance for maize and sorghum. The government and NGOs should make detail assessment and develop strategies on how to use this opportunity in minimizing farmers' food insecurity.

Enhance irrigation work through expanding the scheme to potential rivers and using different rain water harvesting like pond development in the lowland parts of the *Woreda.*

Market related problem like access of food items in the market during drought season was one of the challenges in the area. Organizing community groups like consumer cooperative and promoting establishment of market networking.

The initiated community awareness raising education and practices on SWC and other NRM are important long-term oriented adaptation strategies. However, it should not be only in campaign form, rather is should be in continuous and sustainable ways that take area's context in to consideration.

References

Adger, W. N., 2000. Social and Ecological Resilience: are they related? Progress in Human Geography, 24(3)**,** pp.347-364

Adger, W.N. and P.M. Kelly., 1999. Social vulnerability to climate change and the architecture of entitlements. Mitigation and Adaptation Strategies for Global Change, 4(3–4), 253–266.

Adgolign, T.B., 2006. Theoretical and Practical Considerations for the Selection of Water Harvesting Techniques: Case Study of Sasiga District of Oromiya, Ethiopia. UDESCO-IHE Institute for Water Education .

Ahrens, C. Donald., 2009. Meteorology Today: An introduction to Weather, Climate and Environment. 9th ed. Belmont, CA.

Arnell, N. W., M. G. R.Cannell, M. Hulme, R. S. Kovats, J. F. B. Michell, R. J. Nicholls, M. Parry, M. J. Livermore, and A. White., 2002. The consequences of CO2 stabilization for the impacts of climate change. Climatic Change, 53:413-446.

Bryant, C.R., B. Smit, M. Brklacich, T. Johnston, J. Smithers, Q. Chiotti, and B. Singh., 2000. Adaptation in Canadian agriculture to climatic variability and change.

Chambers, Robert/Conway, Gordon R., 2007. Sustainable rural livelihoods: Practical Concepts Climate Change. Cambridge University Press. Cambridge, UK.

Christoph , B. Sven,H . & Michael, W. 2008. Climate Change, Food Security and the Right to Adequate food: Stuttgart. Bread for the World and Dlakone Katastrophenhllfe

D. Scott, B. Jones, J. Audrey, R. Gibson, P. Key, L. Mortsch and K. Warriner., 2006. Eds. Kitchener-Waterloo, Canada: Environment Canada, pp. F3.18–F3.25

Devereux, S., and J. Edwards., 2004. Climate Change and Food Security, In: Climate change and development, Yamin, F. and Kenbar, M., Eds., IDS Bull., 35:22–30.

Devereux, S., and Maxwell, S., 2001. Food security in sub-Saharan Africa. London, UK: Intermediate Technology Development Group Publishing.

Döös, B. R. and Shaw, R., 1999. Can we predict the future food production? A sensitivity analysis, Global Environ.l Change 9:261–283.

Downing, T. E. 2002. Linking sustainable livelihoods and global climate change in vulnerable food systems. Die Erde. 133:363–378.

FAO. 2003a. Conceptual framework for national, agricultural, rural development, and food security strategies and policies, by K. Stamoulis and A. Zezza. Rome.

FAO. 2008. Expert Meeting on Global Perspectives on Fuel and Food Security: Technical Report. 18_20 February 2008. Rome.
FAO (2003): Trade reforms and food security. Conceptualizing the linkages, Rome, <http://www.fao.org/docrep/005/y4671e/y4671e00.htm> (acc. Feb. 2014).

FAO (2009a). Harvesting Agriculture's Multiple Benefits: Mitigation, Adaptation, Development and Food Security. FAO Policy Brief. (ftp://ftp. fao.org/docrep/fao/012/ak914e/ak914e00.pdf)

FAO and WFP (2009b). FAO/WFP Joint Guidelines for Crop and Food Security Assessment Missions (CFSAMs). Rome, Food and Agriculture Organization of the United Nations, 319p

FAO. 2010. The State of the Food Insecurity in the World: Addressing Food Insecurity in For the 21st century, Institute for Development Studies (IDS), discussion paper 296.

FAO: 2010.Climate, Energy and Tenure Division Natural Resources Management and Environment Department www.fao.org/docrep/014/i2155e/i2155e00.pdf . Strengthening Capacity for Climate Change Adaptation in the Agriculture Sector in Ethiopia

Ford, J. D., & Smit, B. (2004). A Framework for Assessing the Vulnerability of Communities in the Canadian Arctic to Risks Associated with Climate Change. *Arctic*, *57*(4), 389-400)

Haile H.K., 2005. Causes of Household Food Insecurity in Koredegaga Peasant Association, Oromiya Zone, Ethiopia, Working Paper, University of The Free State south Africa

IPCC. 2000. Special Report on Emissions Scenarios: Summery for Policymakers Intergovernmental Panel on Climate Change. Available on: http://www.ipcc.ch/pdf/special-reports/spm/sres-en.pdf Accessed Jan 12, 2014

IPCC, 2001. Climate Change 2001: Impacts, Adaptation, and Vulnerability: Contribution of Working .Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press

IPCC (2007). Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Geneva, IPCC

IPCC (Intergovernmental Panel on Climate Change). 2007b. Climate Change 2007: Impacts, Adaptation and Vulnerability. Summary for policy makers. Cambridge University Press, Cambridge.

McCarthy, J.J., 2001. Climate change 2001: impacts, adaptation, and vulnerability: contribution of Working Group II to the third assessment report of the Intergovernmental Panel on Climate Change, Cambridge University Press.

O'Brien, K. et al., 2004. Mapping vulnerability to multiple stressors: climate change and globalization in India. Global Environmental Change, 14(4), 303-313.

Oxfam .2008. 'Survival of the Fittest: Pastoralism and climate change in East Africa,' http://www.oxfam.org/sites/www.oxfam.org/files/bp116-pastoralism-climate-change-eafrica-0808.pdf

Parry M.L., C. Rosenzweig, A. Iglesias, M. Livermore, and G. Fischer., 2004. Effects of climate change on global food production under SRES emissions and socioeconomic scenarios'. Global Environ. Change 14:53–67.

Rens Kortmann, Edgar Peijnenborgh ,Judith Harrewijn and Lindske van Hulst. , 2007. **Climate change: causes, consequences, and solutions** scientific background to the on-line platform Climate Quest, CE Delft, RPS, SME Advies , 2007

Rosenzweig, C., G. Casassa, D.J. Karoly, A. Imeson, C. Liu, A. Menzel, S. Rawlins, T.L. 84 Root, B. Seguin, P. Tryjanowski., 2007: Assessment of observed changes and responses in natural and managed systems. Climate Change 2007. Cambridge

University Press. Cambridge, UK. 79-131.

Smit, B., Burton, B., Klein, R.J.T., and Wandel, J., 2000. "An Anatomy of Adaptation to Climate Change and Variability." Climatic Change, 45: 223 – 251.

Smit, B., E. Harvey, and C. Smithers., 2000. How is climate change relevant to farmers? In Climate change communication: Proceedings of an international conference.

Smit, B. and Wandel, J., 2006. Adaptation, adaptive capacity and vulnerability. Global Environmental Change 16: 282-292.

Stern NH., 2007. The economics of climate change: the Stern review. Cabinet Office, Great Britain, Treasury, UK, Cambridge University Press, Cambridge, U.K.

Temesgen D. , R.M. Hassan, C.Ringler .,2008. Measuring Ethiopian Farmers' Vulnerability to Climate Change Across Regional States. IFPRI Discussion Paper

UNFCCC. 2007. Climate Change: Impacts, Vulnerabilities and Adaptation in Developing Countries. United Nations Framework Convention on Climate Change.

USAID. 2011. Climate change and Conflict in pastoral Regions of Ethiopia: Mounting Challenges, Emerging responses, Discussion paper.

World Bank, World Development Report 2008: Agriculture and Development Washington D.C.: World Bank Publications.

Ziervogel, G. and R. Calder. 2003. Climate variability and rural livelihoods: Assessing the impact of seasonal climate forecasts. Area, 35:403–417.

Questionnaires for household and Government officers

A. Questionnaires for households

Introduction

My name is Gizaw Megersa. I am student in Addis Ababa University, College of Social Science. I am studying Geography and Environmental studies specialization in climate change and adaptation

Now I am doing my master's thesis on title "Climate Change/Variability and Farmers Vulnerability to Food Insecurity in Ginir Woreda, Bale Zone,".

The objective of this questioner is to collect essential data that will help the researcher in realizing the intended research work. Therefore, your contribution is very high and helpful in completion of this study.

Finally I would like to thanks and appreciate you for your cooperation and due attention in responding my questions. .

Interview question: local households

Questioner Number..... Kebele Name .....

Section 1: General Information

Please tick (√) where appropriate

1. Sex {1}. Male □ {2}. Female □
2. Age {1}. 18-30 □ {2} 31-40 □ {3}. 41-50 □ {4} > 50 □
3. Marital status {1} Married □ {2} unmarried □{3} Divorced □{4} Widow□
4. Educational level? {1} Illiterate□ {2} read and write □{3} 1st cycle (Grade 1-4) □ {4} 2nd cycle(grade 5- 8)□ {5} secondary school(grade 9-10 □ {6} preparatory (grade 11-12) □{7} diploma and above □
5. Do you have children? {1) Yes□ {2} No □ if yes how many? ……
6. What is the number of your family size including you {1} 1 □ {2} 2 □ {3} 3 □{4} 4 □ {5} 5□ {6} 6 □{7} >6□
7. What is/are your means of livelihood or major source/s of income? {1} Crop production □{2}cattle rearing□{3} mixed farming □□{4} other (specify)……

8. What is/are your additional source of income other than farming? {1}no additional source □{2} trade including petty trade□ {3}causal laborer □□{4} Other (specify)……..

……

Section 2: Assess the climate change trends of the study area

9. Do you think that climate change has been occurred in your area? { 1} yes□ {2}No□ {3} I don't know □
10. If your answer in Q. No 9 is yes, what is/are indictors of the climate change? (You can choose more than one responses)

[1] Repeated drought occurrence □ {2} Increase incidence of animal disease and death□

{3} Increase occurrence of crop disease□ {4} increase crop weeds and insects □

{5} Frequent crop frailer□ {6} Decrease and /or dry out of water sources□

{7} others (specify) ……

11. How do you characterize the weather of this area in terms of its temperature?

{1} very hot□ {2} hot □ {3} moderate □ {4} cold □ {5} very cold □

12. Do you think that there is any change in temperature trend in your area in last 10 to 30 years? {1} yes □ {2} no □ {3} I don't know □
13. If yes, how? {1} increase very much □ {2} moderately increase {3} decreases □ {4} decrease very much □
14. How do you characterize the weather of this area in terms of its precipitation?

{1} very high □ {2} high □ {3} medium□ {4} low□ {5} very low □

15 Do you think that there is any change in precipitation trend in your area in last 10 to 30 years? {1} yes□ {2} no□ {3} I don't know □

16. If yes, how? {1} rainfall increase □ {2} rainfall decrease □ {3} fluctuation in rainfall □
17) Do you think that there exist human activities/interventions that adversely contributed to climate change?

{1} Yes□ {2} No□ {3} I don't know □

18) If your answer to Q. No 17 is yes, what are these activities? (You can choose more than one responses)

[1] Farm land expansion to forest area □ {2} Bush clearing□ {3} Deforestation for fire wood□,

{4} Tree cutting for charcoal □ {5} Poor agricultural land management□

{6} others (specify) ……

19. Have you ever faced any climate related challenges /impact in your life time? {1} Yes □ {2} No □

20. If yes, what type of climate change induced shock? (You can choose more than one responses)

{1} Drought□ {2} lose of livestock□ {3} crop failure □ {4} human diseases □ {5} displacement □

{6} others (specify) .....

21. Which type of climatic shock is your main concern? (Identify serious one)

{1} Drought□ {2} lose of livestock□ {3} crop failure □ {4} human diseases □ {5} displacement □

{6} others (specify) .....

Section 3: Vulnerability to food insecurity

22. Did the climate change affect your crop production? {1} Yes□ {2} No□

23. If yes how much? {1} very high □ {2} high□ {3} medium□ {4} low □ {5} very low□

24. Did the climate change affect your livestock production? {1} Yes□ {2} No□

25. If yes how much? {1} very high □ {2} high□ {3} medium□ {4} low □ {5} very low□

26. How do you rate recent seasons' yield comparing with what you are capable of producing**?**

{1} very high yield □ {2} high yield □ {3} same yield □ {4} low yield □ {5} very low yield □

27. What were the reasons for the yield to be at the level it was last seasons?

{1} Low rainfall □ {2}High rainfall □ {3}High cost of inputs □ {4}Late cropping □

{5}Low cost of inputs □ {6} Easy accessibility to inputs □ {7} Early cropping □

{8} Difficulties with accessing inputs □

{9} other (please specify) .....

.....

28. Which of the following agricultural seasons were affected by climate change

Induced problem in recent years? (You can choose more than one responses)

{1}2000/01 □ {2}2001/02 □{3}2002/03 □ {4}2003/04 □ {5}2004/05 □

{6}2005/06 □ {7}2006/07 □ {8}2007/08 □{9}2008/09 □ {10}2009/2010 □

{11}2010/11 □ {12}2011/12 □ {13}2012/13 □

29. Do you think that drought occurred and resulted in poor agricultural production in your area because of climate change? {1} yes □ {2} No□ {3} i don't know

30. If your answer tor Q. No 29 is yes, how often do you encounter such kind of droughts (drought cycles)?

{1} 1-2 years □ {2} 3–4 years □ {3}5–6 years □ {4} 7–8 years □ {5} 9–10 years □

{6} other (please specify .....

31. To what extent has the experienced drought cycles influenced your on-farm and off- Farm activities?

{1} very high □ {2} high □ {3} Medium □ {4}low □ {5} very low

32. Do you think that the climate change challenge has impact particularly on food security in the area? {1} Yes □ {2}No □ {3} I don't know□

33. If your answer to Q.No. 32 is yes, to what extent climate change affect food security situation of the area?

{1} very high □ {2} high□ {3} medium □ {4} low □ {5} very low□

34. How the climate changes affect food security in your area? (You can choose more than one responses)

{1}. food production decrease in the area□ {2} Availability of food item decrease in market□

{3} food items' price increased □

{4} others specify .....

35. To what extent that climate change induced food insecurity has affected your family life in particular?

{1} very high □ {2} high □ {3} medium□ {4} low□ {5} very low □

36. What were the effects of the climate change induced food security problem you Have experienced**?** (You can choose more than one responses)

{1} Loss of human life □ {2} Malnutrition □ {3} Diseases □ {4} physical weakness

{5} School students' dropout □ {5}Migration □

{6}Other (please specify): .....

37. Who do you think is most harmed by the event? (Give rank with 1st for most harmed)

{1}Elders □ {2} adult men □ {3} Adult women □{4} youth □ {5} Children □

Section 3: Response to climate change induced problems

38. How did you prepare for previous climate changed induced food insecurity problem? (You can choose more than One responses)

{1} Early cropping □ {2}Drought resistant crops □

{3}Livestock migration (loaning to relatives in areas unaffected by droughts) □

4. Other (please specify):.....

.....

39. How easy or difficult is it to cope up with such situation?

{1}Very easy □ {2}□Easy □ {3}Difficult □ {4}Very difficult □

40. Did different bodies responding /support to reduce the impact of climate change in your area? {1}Yes □ {2} No □

41. If yes which bodies participated and how they responded (You can choose more than one responses)

{1} Community members □ {2} NGOs□ {3} Government□

{4} others specify.....

Community members.....

.....

NGOs:.....

.....

Government:.....

.....

42. If no, what responds/supports do you think they should give you in the area to reduce climate change impact?

Community members:.....

.....

NGOs: .....

.....

Government:.....

.....

Section 4: local indigenous Adaptation Strategies

42. Do you have any stories about climate change induced challenges like drought previous recounted and passed onto you by your elders? {1} Yes □ {2}No □

43. If yes how did they cope with such droughts**?** (You can choose more than one responses)

{1}Humanitarian aid □ {2}Social networks □ {3}Migration □ {4}Remittances □ {5}Hunting □ {6}Sale of assets□

{7}Sale of livestock □ {8}Grain trade □ {9}Informal trade □ {10}Off-farm employment □ {11} Casual labor □

8. Other (please specify): .....

44. Did you find this information useful in deciding ways of coping with these climate changes problems that you have Faced? {1} Strongly Agree □ {2} Agree □ {3} Disagree □ {4} Strongly disagree □

45. How was this information transmitted to you?

{1}Oral tradition □ {2}Written/ documented evidence □

46. If oral tradition, do you think these experiences should be documented for future Generations? .

{1}Strongly Agree □ {2}Agree □ {3}Disagree □ {4} Strongly disagree □

Section 5: Adaptive capacity and external support

47. Do you have capacity to cope with climate change induced food security challenges {1} Yes□ {2} No □

48. What did you do to cope up with such situation? (You can choose more than one responses)

{1}Diversify income source □ {2} use irrigation □ {3} use improved agriculture inputs □ {4} use early mature crops □

{5} sale livestock □ {6} temporary migrate □ {7} External support from relative □ {8} Relief (food aid) □

{9} others (specify).....

49. What are the major constraints you have that hinders your coping mechanisms? (You can choose more than one responses)

{1} Shortage of farm land □ {2} financial shortage □ {3} lack of inputs (improved seeds, livestock, and other inputs Like fertilizer) □ {4} infrastructure limitation (road) □{5} lack of access to market □ {6} lack of credit service□

{7} others (specify).....

50. Did the Government provide any support to cope with climate change induced food insecurity problem? Yes □ No □

51. If answer for Q 50 yes, was the government support provided on time in your area?

{1}Strongly Agree □ {2} Agree □ {3}Disagree □ {4}Strongly disagree □

52. Did you receive any support from NGOs/humanitarian organizations to cope with the challenge? Yes □ No □

53. If answer for Q 52 is yes, was the NGOs/humanitarian organizations' support provided on time?

{1}Strongly Agree □ {2}Agree □ {3}Disagree □ {4}Strongly disagree □

54. Do you think the government and NGO/humanitarian organizations' should provide you with any form of support to enhance your capacity?

{1}Strongly Agree □ {2}Agree □ {3}Disagree □ {4}Strongly disagree □

55. If answer is in the affirmative, what support should they provide you with? (You can choose more than one responses)

{1}Humanitarian aid □ {2} Seed finance for income-generating activities □

{3}Livestock investments □ {4} Education and agricultural training □

{5}Information provision □ {6} Infrastructure development □ {7} Promoting safety nets □

8. Other (please specify):.....

.....

Thank you!

Interview questions: Woreda/ Zone Disaster Prevention and Preparedness Commission (DPPO)

1. Name _____Position _____ Education /profession_____

2. What are the impacts of climate change on food security in Ghinir Woreda?

_____
_____

_____
_____

_____
_____

3. Do you think that the farmers are being vulnerable to food insecurity because of climate change? How?

_____
_____

_____
_____

4. Who is more vulnerable to the impact? Why?

_____
_____

_____
_____

5. What is your role in prevention of socio-economic problem in general and food insecurity problem in particular that caused by climate change and variability before and after the problem? How?

Roles

_____
_____

_____
_____

_____
_____

6. What are your major challenges in alleviation of the problem and what should be done?

_____
_____

_____
_____

_____
_____

Thank you!

Woreda Agriculture Development Office staff (Development Agents and other experts)

1. Name _____Position_____ Education /profession _____

2. What is the agro-climate of your Peasant Association / Woreda / Zone?

_____
_____

_____
_____
_____
_____

3. Do you think that climate change is occurring in your Woreda? Yes No

If your answer is yes please mentioned the indicators of the change

_____
_____
_____
_____
_____

4. Is there any form of climate change in your Woreda that impacting on crop production/ livestock rearing? Yes No

If your answer is yes please explain when, how often, in what degree it affect and other explanations?

_____
_____
_____
_____
_____
_____

5. If the answer to Q2 is yes, please explain to what extent it affect food security situation of the area?

_____
_____
_____
_____
_____
_____

6. Who is more vulnerable to the impacts? Why?

_____
_____
_____
_____

7. What are the local coping mechanisms used to reduce the climate change related impacts?

_____
_____
_____
_____

8. What is the institutions effort to reduce future impacts?

_____
_____
_____
_____

9. What are the main challenges and how do you think they can be improved?

_____
_____
_____
_____

Thank you!