ASSESSMENT OF ADAPTATION MECHANISMS OF AGRO-PASTORALISTS TO CLIMATE CHANGE IN OROMIA REGION. ETHIOPIA: THE CASE OF KOFELE AND KORE DISTRICTS

A THESIS

Submitted to Indira Gandhi National Open University in partial fulfillment of the requirement for Master of Arts Degree in Rural Development.

by

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Enrolment No. 089132892

May 2013

Addis Ababa, Ethiopia

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DECLARATION

I hereby declare that the Dissertation entitled "ASSESSMENT OF ADAPTATION MECHANISMS OF AGRO-PASTORALISTS TO CLIMATE CHANGE IN OROMIA, THE CASE OF KOFELE AND KORE DISTRICTS" submitted by me for the partial fulfillment of the M.A. in Rural Development to Indira Gandhi National Open University, (IGNOU) New Delhi is my own original work and has not been submitted earlier either to IGNOU or to any other institution for the fulfillment of the requirement for any course of study. I also declare that no chapter of this manuscript in whole or in part is lifted and incorporated in this report from any earlier work done by me or others.

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This is to certify that Mr. Abebe Lemma Gebrewold student of M.A. (RD) from Indira Gandhi National Open University; New Delhi was working under my supervision and guidance for his Project Work for the Course MRDP-001. His Project Work entitled "ASSESSMENT OF ADAPTATION MECHANISMS OF AGRO-PASTORALISTS TO CLIMATE CHANGE IN OROMIA REGION; THE CASE OF KOFELE AND KORE DISTRICTS" which he is submitting, is his genuine and original work.

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TABLE OF CONTENTS

List of tables

List of figures

Figure Title

ACRONYMS

ARDO – Agriculture and Rural Development Office

CBOs – Community Based Organizations

CEEPA – Centre for Environmental Economics and Policy in Africa

CNCR – Carbon Neutral Climate Resilient

CSA – Central Statistics Agency

CSOs – Civil Society Organizations

DPPC – Disaster Prevention and Preparedness Commission

ECSNCC – Ethiopian Civil Society Networks on Climate Change

EPA – Ethiopian Environment Protection

FEDO – Finance and Economic Development Office

FGD – Focus Group Discussion

GDP – Gross Domestic Product

GHG – Green House Gas

GTP – Growth and Transformation Plan

HH – Household

IDE – International Development Enterprise

IFPRI – International Food Policy Research Institute

IGAD – ICPAC - Inter-Governmental Authority on Development – Climate Prediction and Adaptation Center

IPCC – Intergovernmental Panel on Climate Change)

KI – Key Informant

NAPA –National Adaptation Programme of Action

DCG – Dry lands Coordination Group

Masl – Meter above sea level

NMA – National Metereology Agency

NMSA – National Meteorology Service Agency

NGOs – Non Government Organizations

PPM – Parts Per Million

ROBA – Rural Organization for Betterment of Agro-Pastoralists

SNNPRS – Southern Nations, Nationalities and People's Regional State

SPSS – Statistical Package for Social Sciences

UNEP - United Nations Environmental Programme

UNFCCC - United Nations Framework Convention on Climate Change

WHO – World Health Organization

ABSTRACT

Climate change is now widely recognized and presents a significant threat to the word and humankind. The scientific data analyzed by the Intergovernmental Panel on Climate Change (IPCC, 2007) provided strong proof that climate change is occurring as result of human activity leading to GHGs emissions in the atmosphere. Unfortunately, developing countries contribute insignificantly to the global warming, though climate change projections show that they are hardest hit in its consequences. Ethiopia is among the most vulnerable to climate change as its economy base is relied on the agriculture and experiencing drought and flood because of the frequent changed patterns in rainfall and temperature. The livelihoods of subsistence agro-pastoralists is vulnerable and hampered by the adverse impacts to climate change as they completely depend on mixed farming and utilization of natural resources though locally exercised adaptation mechanisms to respond to the burdens of climate change on which this study paid attention. On the basis of quantitative and qualitative data and the analysis made, this study analyzed the agro-pastoralists' knowledge and understanding and their adaptation mechanisms to climate change in eight kebeles of Kofele and Kore Districts of Oromia Region.

The research result indicated that Extension Workers, the media (radio) and training/workshops organized were main sources of information about climate change to majority of households though significant number of respondents have no information or knowledge about the factors that may possibly necessitate adaptation to climate change. Changes in the climate conditions in the last two decades have caused damages to the socio-economic and environmental fabric of the Agro-pastoralists. The study findings showed that the majority of the surveyed HHs (78 %) perceived that they have witnessed long-term changes in temperature and rainfall and an

increasing trend in the situation of hot times and decreasing trend of rainy times over the past 20 years. Even though the rainfall and temperature data for some months of the reported years were missed, it has been difficult to observe the trend in the amount during the reported years. But, unpredictable nature and pattern of rainfall distribution with late start and early cease of rainfall from usual condition, torrential and less rainfall during the rainy season, prolonged periods of dry seasons and increased temperatures, were observed as important threats.

FGD participants witnessed a change in the climate in terms of late on-set and shortage of rainfall than usual in the years 2005/06 and 2007/08, as well as in 2010/11 there was a prolonged rainfall pattern at Kofele district which resulted in drastic decline of crops yields, quality and price of wheat and barley which compelled agro-pastoralists to sell their livestock and lost their assets.

The data obtained from NMSA had also shown a decreasing trend in the amount of rainfall and temperature. The climate data which showed a declining trend of rainfall was in agreement with what the surveyed HHs perceived over the past two decades. The increase in the maximum temperature was again in agreement with the surveyed community members' perception. However, the decrease in minimum temperature was contrary with the perception of the respondents and with the overall prediction for temperature in the country even though their claim that the temperature in the area has decreased sometimes causing frost and damaging crops was somewhat acceptable in light of the variability of the changes in climate.

The study had revealed that the major factors that call for adaptation to climate change were frequent variations in rainfall patterns or distributions (early or late on-set and cease) associated

with frost and water logging, deforestation and natural resources degradation, lack of awareness and agricultural inputs. It was also disclosed that most respondents had agreed to change crop varieties and planting date, crop and cattle diversifying, implement soil and water conservation practices and tree planting, construct water harvesting for irrigation and provisional migration, etc as options that could be applied to respond toward the long-term climate changes. In response to the changing climate, agro-pastoralists had tried to adjust their livelihoods through strengthening already existing farming practices and actually employed various adaptation mechanisms like sale of domestic animals, planting different trees/seedlings, changing variety of crops, early planting and diversifying crops, reduced feeding amount and time of meals and temporal migration to other places.

Even if there was differences in responses about agreed options for adaptation and actually practiced mechanisms, the survey result spelt out that lack of information/knowledge coupled with skill/technology and experience limitations, lack of money and agricultural inputs were the grave constraints that weaken agro-pastoralists' capability for adaptation to the changing climate.

The study result had identified the women, children and elders, the landless, households with large families and small farmland as the most vulnerable groups that have been severely affected by adverse effects of climate change and lack the ability to respond to climate change as result of lack of wealth (land and livestock), empowerment, alternative productive employment and basic assets for means of livelihood, food insecurity, etc. The study also discovered that government and NGOs technical and financial supports in areas of credit and improved agricultural input supplies, market facility, etc, capacity building in terms of awareness creation, education and training, engaging in forestry development and soil and water conservation and access to water

resources for irrigation development, etc were cited as crucial actions needed to improve their adaptation mechanisms to climate change.

CHAPTER I: INTRODUCTION

1.1. Introduction

Global Climate change is a truth now and its adverse effects are highly pronounced in the world and humankind, especially the poor, has become vulnerable. The effect is very much pronounced and being felt by poor segments of the society located in the third world countries, such as, Africa, Asia and Latin America, where the economy base is highly dependent on rain-fed agriculture, with little or no capacity to adapt to climate changes.

Ethiopia is one of the most vulnerable countries experiencing drought and flood as a result of climate variability and change (DCG, 2010). Despite its high contribution to the overall economy, Ethiopia's agriculture sector is challenged by many factors, of which climate-related disasters like drought and flood (often causing famine), are the major ones (Deressa, 2007). Vulnerability analyses for Ethiopia under climate change (Deressa, 2006) indicated the changes in rainfall patterns and increasing temperature are expected to have significant negative impacts on environment and water resources, crops and livestock, human health and other farming livelihoods. Smallholder subsistence farmers and pastoralists, especially whose livelihoods entirely depend on agricultural production and utilization of natural resources, are likely to be most vulnerable and bear the burden of adverse impacts to climate change. The National Adaptation Programmes of Action (NAPA) process in Ethiopia identified agriculture as the most vulnerable sector where smallscale rain-fed subsistence farmers and pastoralists are at risk. National Metereology Service Agency (2001) identified potential adaptation measures for coping to adverse impacts of climate change on crop and livestock production, although it could not be able to indicate the factors that dictate the choice of adaptation measures.

The smallholder farming community's level of understanding on the basic factors of climate change is still low and there is a need to educate and inform on available adaptation options (Training report on climate change adaptation, 2010). It is clearly understood that the extent to which the burdens of climate change are felt rely on the action to be taken on adaptation mechanism on which this study will focus to augment the knowledge in the respective subject.

Although the Ethiopian highland represent about 45 percent of the total crop area, and where four–fifths of the total population live and supports about 70 percent of the livestock population of the country, there are no significant studies have been carried out on adaptation to climate change in the highland and midland areas. Such a study is important in order to propose supportive adaptation mechanism to deal with the effects of climate change.

Abate (2009) identified coping mechanisms for climate change and the impact on livelihoods at one peasnat association (Garmama Shenato) among the Kofele highland areas. However, the study failed to specifically indicate the perceptions and adaptation strategies and the determinant factors that prevailed in agro-pastoralist areas in order to adapt to climate change and frequent variability.

This assessment focuses mainly on Kofele and Kore districts in order to generate knowledge whereby the findings will be utilized by many districts of Oromia region, as well as, other regions of the country with a comparable socio-economic and climatic condition.

The study, therefore, will examine farmers and/or agro-pastoralists' perceptions in comparison with climate data recorded at Kofele district meteorological station, identifies and analyzes how

agro-pastoral livelihoods are promoted as a result of climate change in the study sites and the adaptation responses to the climate change and variability. This study will also help to ultimately generate knowledge and may provide reliable information for future adaptation strategies and policy formulation.

This research paper will be organized in five chapters. The first chapter includes the introduction part coupled with the review of the problem statement and rationale for the study, importance of the study and limitations, as well as, the research questions and the objectives. The next chapter presents literature review. In this chapter, previous works related to climate change causes, effects, adaptation responses and measures in addition to the factors affecting farmers' adaptation capacity, etc are discussed in detail. Chapter three describes the design and methods of the research associated with study and issues related to socio-economic situation, climate condition of that specific area and methodologies used in the collection and analysis of data for this study. Chapter four presents the findings of the study. The paper ends at chapter five by presenting the conclusion and recommendations drawn from the study.

1.2. Statement of the Problem

Climate change is widely recognized as a growing problem whose impact could be disturbing and costly (IPCC, 2007; Stern, 2006a). The developing countries of Africa are among the most vulnerable to climate change as their major economy base is the agriculture sector. The majority of the population is also dependent on economic activities that are highly exposed and extremely sensitive to climatic variability. The adaptive capacities are very low due to abysmal poverty,

and unfavorable and deteriorating environmental conditions (IPCC, 2007; Woldeamlak Bewket, 2009).

Ethiopia is one of the developing countries in Africa, where agriculture is the main economic base coupled with low level of production and susceptible to climatic related disasters. The major livelihoods of the population are derived from agriculture which is highly sensitive to changes in rainfall and temperature. According to the study of Deressa (2008), the decline in precipitation and increase in temperature are both damaging to Ethiopian agriculture. The population growth and resource degradation in the highland areas (which covers about 45 percent of the country) have induced population mobility into lowland areas, which are vulnerable to frequent water deficit and prone to drought (Haile, 2004). Coupled with those factors climate change is more likely to result in vicious cycle of poverty and resource degradation in Ethiopia (Abate, 2009). Climate is highly linked with agricultural production, human and livestock health, environmental resources, socio-cultural systems (UNEP, 2006). The climate change resulted in reduction of length of growing periods and marginal areas are left out of the productive system. The IPCC report (IPCC, 2007) projected that yield will be reduced up to 50% by 2020 due to climate change in some poor countries. This means that poor countries with periodic and frequent drought cannot carry the effect of climate change due to the reason that they have very little capacity to adapt to the changes.

A recent mapping on vulnerability and poverty in Africa (Orindi et al. 2006; Stige et al. 2006) put Ethiopia as one of the countries most vulnerable to climate change and experiencing drought and flood disasters with the least capacity to respond. As explained in the IGAD-ICPAC (2007)

report, the recent trends in Ethiopia already had shown that climate change has already put pressure on Ethiopian livelihoods and the country has consistently faced food insecurity due to recurrent droughts and rain-dependent agriculture and over-cultivated soils. Vulnerability is further exacerbated by unavailability and unaffordability of agricultural inputs, landlessness and unemployment, and water shortage (Senbeta, 2009). Owing to the abovementioned facts, it is, thus, imperative to understand the actual dynamics of climate change impact at the lowest level of the society, such as households, communities and districts (Deressa et al. 2008).

Nevertheless, there is no sufficient research evidence as to whether or not climate change is perceived as a major problem or even a reality by the Ethiopian society, particularly by the poor and most vulnerable households in the rural areas. There are limited publications, but Meze-Hausken (2004), Mahmud Yesuf et al. (2008), Aklilu Amsalu and Alebachew Adem (2009), and Temesgen Deressa et al. (2009), so far known, have fairly dealt with climate change perceptions. Understanding local perceptions of climate change with its real impacts are important to propose and implement appropriate adaptation strategies.

1.3. Rationale of the Study

Climate change is a global issue. The proof that climate change is occurring and is related to anthropogenic GHGs emissions is well documented (IPCC 2007a). The global implications of climate change are important and readily observable at the regional and local level. They pose many problems for communities, regions and governments around the world (Smith and Smith 2009; McLamb 2009). Adverse effects of climate change continue to be a major threat to rural livelihoods (IPCC, 2007a, 2007b; Nhemachena, 2009; Pouliotte, Smit, & Westerhoff, 2009).

Adaptation to the effects of climate chnage is now acknowledged as necessary for responding effectively and equitably to the impacts of both climate change and climate variability (Report on the UNFCCC Climate Change Negotiations in 2009, pp 20). Adaptation to climate change is needed to enhance the adaptive capacity and resilience of poor people to the impacts of climate change, in order to help ensure that they can break out of poverty. Strategies for adaptation have to focus on the needs of the people most affected by climate change impacts and aim to reduce the most important vulnerabilities they face. Action on adaptation, for the most part, at the community level was considered by the vulnerable themselves (Mark Smith, 2008). Several studies indicate that capability to tackle the effects of climate change by taking advantage of potential opportunities or curbing the damage is determined by adaptive capacity. Developing countries very often lack adaptive capacity because of meager economic resources, lack of access to technology, information and skill, poor infrastructure and weak institutions, and the poor being disadvantaged more by these inadequacies (Munasingha and Swart, 2005).

It could be recognized that rural farming community are exposed to harsh environment and have accumulated substantial experiences and indigenous knowledge in living with and becoming accustomed to climate variability. This has to be reviewed in comparison with the current practices of adaptation mechanisms to climate change and variability at local levels. Most of the current available researches have been concentrated to certain parts and issues of climate change and geographically on lowland and drought prone areas.

As climate change has a wide range of implications, further research need to include diverse perspectives, sectors and geographic regions, as a collection of selected abstracts of climate

change researches in Ethiopia revealed additional research in highland regions is also identified as a gap as such areas receive insufficient attention (Ethiopian Civil Society Networks on Climate Change, 2010). This research also tries to further bridging the gaps through studying and identifying the local practices experienced for adaptation mechanisms to climate change along with the perception of the local agro-pastoral community of the different kebeles in kofele and Kore Districts, which are among the highland areas in West Arsi Zone of Oromia Region. Assessing the local perceptions, mechanisms, responses and capability of the rural households for adaptation to climate change and variability in the districts will definitely help various development actors including the government, NGOs/CSOs, donor agencies, etc to formulate and design policies aimed at improving the adaptation mechanisms and eliminate factors that are barriers for adaptation.

1.4. Important Terms used in the Study Title

This section introduces and defines the major important terms used in the research. The details of the key concepts related to the context of the research are included in the literature review.

Climate is usually defined as the "average weather", or more rigorously, as the statistical description of the weather in terms of the mean and variability of relevant quantities over period of several decades. These quantities are most often surface variables such as temperature, precipitation and wind (IPCC, 2007).

Climate change generally refers to longer term changes in mean or in climate variability itself and often specifically to change resulting from human activities, for example global warming due to the burning of fossil fuels (IPCC).

Climate variability- the weather represents variability in the atmospheric condition on a daily and weekly basis. The term generally refers to variations of the climate system, which includes oceans, and the land surface, as well as, the atmosphere over months, years and decades (IPCC).

Adaptation is the ability to respond and adjust to actual or potential impacts of changing climate conditions in ways that moderate harm or takes advantage of any positive opportunities that the climate may afford (IPCC).

Adaptation to climate change is the process through which people reduce the adverse effects of climate variability on their health and wellbeing, and take advantage of the opportunities that their climatic environment provides (Burton, 1992).

1.5. Objectives of the Study

The major objectives of the research were to assess and analyze the agro-pastoralists' community knowledge and understanding and the adaptation mechanisms to climate change and variability in Kofele and Kore Districts. The study also attempts to predict the extent of climate changes that will affect the adaptation capacity of the economically weak and vulnerable rural households.

The specific objectives of the research include:

- Assessing the perceptions and awareness of the kofele and Kore rural community about the climate change at their locality;

- Studying and analyzing of adaptation mechanisms of the community to the climate change, as well as, the determinants to long term changes in rainfall and temperature;
- Identifying the types of responses made to minimize the effects of climate on their livelihoods;
- Identifying the factors determinant to and obstacles for adaptation to climate change.

1.6. The Research Questions

The main questions for which the research focused were;

- Whether or not the agro-pastoralists (mixed farmers) are aware of and realize long-term changes in rainfall and temperature over the period of the past twenty years?
- What adaptations mechanisms are practiced by agro-pastoralists in response to the changes in rainfall and temperature?
- What are the main determinants or factors that necessitates and influence adaptation to the climate change?
- What are the main obstacles for the community's inability to adapt to climate change?

1.7. Significance of the Study

The research analyzed the perception of and adaptation mechanisms to climate change employing both quantitative and qualitative methods where the limitation of the two methods covered by their respective comparative advantage one has over the other. The research is timely and relevant in generating knowledge and information through analysis of the local communities' experiences on climate change appearances, perceptions, stresses, adaptation mechanisms and their determinants and constraints. Such understandings of the change at micro-

level will enable development actors, practitioners to link up and inform policy at macro or national levels as it explains realities on the ground. As the research involved development practitioners (NGOs, government and civil society members), it has a potential added value to exchange of ideas on the findings and enable to influence or be in favor of an ameliorated livelihood situations of the vulnerable groups of the society. Besides, this research was undertaken aiming at enhancing the organizational capacity of ROBA in research development and use of research findings for further planning and extending of development projects in the study areas. As different researches pointed out, the need to conduct research pertinent to climate change, the research findings and recommendations will also be used as a strong input and source of information for those interested to study adaptation to climate change in the high and midland areas.

This study serve as the basis to conduct feasibility study so as to initiate development projects to exploit the opportunities in the study areas to bring local developments that might reduce the pressure on the natural resources, particularly the forest coverage. The study may also urge the organizations and local people in the study area to strengthen their cooperation, which can help to promote sustainable livelihoods development, and resources management that will create fertile ground for co-existence. Since the research has brought the local level knowledge of the consequences of changing livelihoods and indigenous adaptation strategies employed by the surveyed community, it will contribute to the existing endeavor of understanding the adaptive strategies, capabilities and constraints in a climate changing scenario.

Thus, institutions working in the area of climate change adaptation intervention could highly benefit in getting knowledge from the people's own perspectives. Besides, its contribution to serving policy-makers in their effort to formulate appropriate policy alternatives through providing specific ecological, economic and societal change characteristics of agro-pastoralists would be imperative.

1.8. Scope of the Study

The study covers agro-pastoralists who are accustomed in sharing homogenous way of life, culture and traditions, etc and earned their source of livelihoods through crop and livestock production in Kofele and Kore Districts of Oromia Region. The research encompasses the local perception, understanding, experiences or practices as well as the alternative reactions of agro-pastoralists to respond to long-term climate changes prevailed in the areas. The research will also touch the agro-pastoralists realities at the ground, including assets or resources, major barriers and constraints on top of their capacity and adaptation mechanisms. The research also pointed out the gaps and the required action and further suggestions to enhance future adaptation strategies at all levels.

1.9. Limitation of the Study

The research was conducted in eight kebeles of two districts in West Arsi Zone of Oromia Region and difficult to generalize for the region, let alone the country. The study has some limitations and the major ones are figured out as follows. In light of this, the data obtained may suffer from uncertainty in some aspects. Agro-pastoralists' were reluctant to respond to and provide correct information for questions regarding the income they get either from sales of

crop production, livestock or other off-farm sources. This hindered to make comparisons of income and capacity of the respondents to adapt to climate change. This could prevent from identifying the real influence of the level of off-farm income on agro-pastoralists' adaptation choice and decision. Responses could be in anticipation of supports to be provided with experiences of the projects that they have been affiliated and heard at their vicinity.

A series of meetings between the communities and local government administrative units on Muslims' religious issues at the research study sites has also forced to interrupt and postpone the data collection tasks. Especially conducting focus group discussions and key informants' interview was not as such possible considering the issue's sensitivity as the meeting participants include influential religious and traditional leaders.

Due to different rural community's campaign/massive communal works, which were instructed by the local government to exercise watershed development works associated with soil and water conservation practices on farmers' fields, the time frame for data collection was pushed to be during the peak harvesting time, thus, it was also become difficult to get farming community members for the interviews. Besides, the celebration process for the Anniversary of the Oromo Peoples' Democratic Organization had also taken time as it engaged key staff of the administration and sector offices. However, efforts were made to get the necessary data by rescheduling the time for different kebeles with due consideration of week-ends and also in some cases, extending data collection days.

During conducting this research certain constraints have also been encountered. Most files of the sector offices like Finance and Economic Development, Agriculture and Rural Development and Land and Environment Protection Offices were not adequately managed and not possible to locate some of their relevant and important past files because of frequent staff turnover. In spite of these limitations, maximum effort was exerted to attain the necessary data required that makes this study informative and valuable.

CHAPTER II: REVIEW OF LITERATURE:

2.1. Conceptual understanding

It has taken a long time for the world to face the facts: the Earth getting warmer and human beings are mainly to blame. Concentration of greenhouse gases (GHGs) produced by human activity has increased significantly. These GHGs trap a greater quantity of rays which are reflected on to the Earth and cause it to heat up. Scientists agree that more extreme weather patterns are on the horizon and the worry is at what speed it is taking place and its recurrent effects to global system. Climate change has been an agenda of political, socio-economic and environmental debates; and it has been a major issue for more than three decades being debated at different levels (international, regional, national). Since industrialization began, emissions of GHGs, in particular carbon dioxide, have significantly increased, primarily due to increased burning of fossil fuels. As a result, heat has been trapped in the atmosphere and the earth's global mean surface temperature has begun to rise, reaching its highest level for 140 years. Even if GHG emissions were entirely halted global temperatures would still be expected to rise over at least the next 50 years. This would happen because of the time lag between emissions and the atmosphere's response, and because the existing GHG concentrations have already reached a

significant level. This signals that development activities should integrate adaptation responses to climate risks and thereby minimize the effects of climate change.

GHGs are produced by human activity, including:

- burning fossil fuels, such as coal, oil or gas
- using energy generated by burning fossil fuels
- some aspects of farming, such as raising cattle and sheep, using fertilizers and growing some crops
- clearing land, including logging
- breakdown of food and plant wastes and sewerage
- some industrial processes, such as making cement and aluminum.

This increase in GHG concentrations is increasing the natural greenhouse effect, and is considered to be responsible for most of the measured increase in global temperature that has occurred over the last century. This is known as the anthropogenic (human-caused) greenhouse effect, or the enhanced greenhouse effect. Subsequently, the key concepts that are relevant to this reserach thesis are described hereunder.

2.2. Key Concepts

Numerous terms and concepts have come into common usage as a result of IPCC reports, discussions in the context of the UNFCCC and dialogues by the climate community at large. This section examines the key climate change and adaptation related terms and concepts used by the climate change community. The key concepts are presented below and the definitions are taken without editing from the original sources.

As the United Nations framework Convention on Climate Change (UNFCCC) described;

Climate change is "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods." Climate change is a clear, sustained change (over several decades or longer) in the components of climate, such as temperature, precipitation, atmospheric pressure, or winds. Such changes must constitute a clear trend, and be clearly distinguished from the small random variation in these parameters that takes place all the time. Climate change can only be determined after careful analysis of several decades of observations. Climate variability encompasses predictability, i.e. the march of the seasons, but also includes an inherent uncertainty. The rainy season is a predictable occurrence, but the amount, timing and distribution of the rain is uncertain.

Climate change vs. global warming

The terms 'climate change' and 'global warming' are often used interchangeably, but there is a difference.

- Climate change is a broader term. It refers to long-term changes in climate, including average temperature, rainfall, etc.
- Global warming is the gradual increase of the Earth's average surface temperature, due to GHGs in the atmosphere.

The principal contributor to the present phase of global warming is considered to be the enhancement of the natural greenhouse effect.

Different organizations also described Adaptation as follows;
Adaptation - Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploit beneficial opportunities (IPCC).

Adaptation - Practical steps to protect countries and communities from the likely disruption and damage that will result from effects of climate change (UNFCCC).

Adaptation- is a process by which strategies to moderate, cope with and take advantage of the consequences of climatic events are enhanced, developed, and implemented (UNDP, 2005).

Adaptation- The process or outcome of a process that leads to a reduction in harm or risk of harm, or realization of benefits associated with climate variability and climate change (UK Climate Impact Program (UKCIP, 2003).

Adaptation includes policies and measure to reduce the exposure to climate variability and extremes, and the strengthening of adaptive capacity. Adaptation can be anticipatory, where systems adjust before the initial impacts take place, or it can be reactive, where change is introduced in response to the onset of impacts. The term adaptation denotes any adjustment, whether passive, reactive or anticipatory, that is proposed as a means for ameliorating the anticipated adverse consequences associated with climate change (Stakhi, 1993). Adaptability refers to the degree to which adjustments are possible in practices, processes, or structures of systems to projected or actual change in climate. Adaptation can be spontaneous or planned, and can be carried out in response to or in anticipation of changes in conditions (IPCC, 1996).

Adaptive capacity:- is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damage, to take advantage of opportunities, or to cope with the consequences (IPCC 2001). Thus, the adaptive capacity of a system or a community describes its ability to modify its characteristics or behaviours so as to cope better with changes in external conditions. Adaptation to climate change is very crucial in order to reduce the impacts of climate change that are happening at present time and increase resilience to future impacts.

Climate change perception:- Perception is the process of attaining awareness or understanding of sensory information. The word “perception” comes from the Latin words ***perceptio***, ***percipio***, and means “receiving, collecting, and action of taking possession, apprehension with the mind or senses. Farmers learn and adopt new innovations in many ways. Based on their perception and observations from neighbours, success stories and practices, farmers tend to update and try to adapt to the adverse effects of weather changes. However, this depends on the resource available in their hands and opportunities in accessing extension services, credits as well as inputs. Two steps are involved in taking climate change adaptation: first perceiving change and then deciding whether or not to adopt a particular measure (David Madison, 2007). Farmers tend to adopt new variety of measure whenever they have opportunities to the perceived changes in weather conditions. The supports from extension workers, information gained and technologies available to them will highly influence their adaptation and responses capacity. For instance, farmers use water conservation techniques whenever they have rainfall distribution and amounts are changing. They tend to plant different crop varieties and use short term crops with adjustment of planting dates. These adjustments are done when they perceive reduction in rainfall and changes in the onset and offset of rainy seasons.

Livelihood:- ‘A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base (DFID 2001).

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 (IPCC). Vulnerability is also mean the degree to which an individual, group or system is susceptible to harm due to exposure to a hazard or stress, and the (in)ability to cope, recover, or fundamentally adapt (become a new system or become extinct) (Tompkins, E., 2005).

2.3. Conceptual framework

The study focuses on identifying agro-pastoralists' perception on climate change, their adaptation strategies and ultimately to come up with recommendation for future adaptation strategies. This needs to examine the interrelationship and interaction of various factors revolving around the livelihoods of the rural community. Livelihood is the core center of development and it is impacted by different internal and external forces. Communities and households (HHs) face climate change related stresses and consequences such as an increased surface temperatures, changes in rainfall, hailstorm, sea level rise, floods, droughts, new diseases, landslides, wind stability, conflicts, etc. (IPCC 2007). Therefore, the life of rural community is threatened by such stresses and their associated consequences. The conceptual framework is based on one of the most widely accepted definitions of livelihoods, including adaptation and adaptive capacity to climate change. The conceptual framework is one that reflects the need to build adaptation from the micro level, rather than from the macro perspective that has dominated thinking in much of the climate, disaster and resource management fields.

This practical approach is proposed to narrow the gap between the needs and priorities of the vulnerable people at the grass-root level and policy procedures at the national level. Thus, to show up for the uppermost level policy development and planning formulation, the need have to be drawn at local level on the basis of the knowledge, coping and adaptation strategies and associated practices. The bottom-up method serves to propose suggestions to decide on the top needs for further action towards enhancing adaptation capability and resilience to climate related risks at all levels. Livelihood strategies can be classified as 'coping' and 'adaptive' strategies. Coping strategies according to De Satge` (2002, p.159) are, "…short-term responses to specific shocks…These are 'next best' efforts to make do in a difficult situation with the hope that the household can return to normal activities and their normal livelihoods strategy". Adaptive strategies on the other hand are "longer term changes in behaviour and practice in response to continuing stresses" (ibid). Scoones (1998, p.7) further explains coping strategies as "temporary adjustments in the face of change" while adaptive strategies are "longer term shifts in livelihood strategies".

Generally, there are five forms of livelihood assets identified in most approaches:

Natural capital: The natural resource stock from which resource flows useful to livelihoods are derived.

Human capital: The skills, knowledge, ability to labor and good health important to the ability to pursue livelihood activities.

Physical capital: which is **t**he basic infrastructure for transport, buildings, water management, energy, and communications and productive capital enables people to pursue their livelihoods.

Financial capital: which is the financial resources that are available to people (savings, credit supplies, regular remittances and pensions) and provide them with different livelihood options.

Social-political capital: are the set of social relationships upon which people draw in pursuit of their livelihood which includes the range of contact networks, membership of groups and organizations. Taken together, these livelihood assets determine much about how livelihoods work, and in particular are the basis for understanding how people will respond to climate-induced vulnerabilities. This in turn means that they are the basis for the development of adaptation strategies.

The livelihood assets determine the resilience of households to vulnerabilities. These are the means of production available to a given individual, household or group that can be used in their livelihood activities. These assets are thus the basis on which livelihoods are built and, in general, the greater and more varied the asset base, the higher and more durable the level of sustainability and security of the livelihoods of households.

Hence, livelihood strategies are those activities undertaken by households to provide a means of living. Ensuring economic and social security is the principal aim of livelihood strategies. For instance, households diversify source of income to lower risk of economic vulnerability (Koczberski & et al. 2001). As reported by different researchers, Deresa et al (2008), Yusuf et al (2008) climate change adaptation livelihood strategies include: changes in crop variety and planting date, crop diversification, irrigation development, water harvesting, tree planting, herd splitting, herd mobility, cattle breeding, migration, etc.

2.4. Global climate change trend and effects

2.4.1. Global climate change trend

Climate change is basically a sustainable development issue. Scientific studies and reports show that human and animal health, ecological systems and socioeconomic sectors (e.g., hydrology and water resources, food and fiber production, wetlands and natural habitats, coastal systems and human settlements), all of which are vital to sustainable development, are sensitive to changes in climate including both the magnitude and rate of climate change as well as to changes in climate variability. Whereas many regions are likely to experience adverse effects of climate change some of which are potentially irreversible, the effects are more pronounced and disastrous in those regions and countries where the economic and technological capacity for adequate preparation and mitigation of climate change-induced hazards and shocks is very weak or nonexistent. Thus climate change represents an important additional stress on those systems already affected by increasing resource demands, unsustainable management practices and environmental degradation. These stresses will interact in different ways across regions but can be expected to reduce the ability of some environmental systems to provide, on a sustained basis, key goods and services needed for successful economic and social development, including adequate food and feed, good health, water and energy supplies, employment opportunities and social advancement.

Climate is changing more rapidly than the earlier time. The evidence comes from direct measurements of rising surface air temperatures, ocean temperatures and from phenomena such as increase in sea level, retreating glaciers and changes to physical and biological systems. The existence of GHGs in the atmosphere is vital to life on earth – in their absence, average

temperatures would be about 30 degree centigrade lower than they are today. The IPCC report shows that human activities are causing atmospheric concentration of GHGs including carbon dioxide, methane, troposphere ozone and nitrous oxide- to rise well above pre-industrial level. The composition of GHGs is 9-26% for CO_2, 4-9% for NH4, 3-7% for Ozone and 36-70% for water vapour (IPCC 2001). The IPCC claims that "carbon dioxide is the most important anthropogenic GHG" and that "the global atmospheric concentration of carbon dioxide has increased from a pre-industrial level of about 280 parts per million (ppm) to 379 in 2005. The figure is rising by 1.502 ppm annually.

According to the IPCC report, the atmospheric concentration of CO_2 and ozone has increased each by 35% and the global average temperature has increased by about 0.6 degree centigrade (^{0}C) and the concentration of methane has increased by 151%. The atmospheric concentration of carbon dioxide in 2005 exceeds by far the natural range over the last 650,000 years (180 to 300 ppm as determined from ice cores (IPCC Report 2001 and 2009). Even if the world is successful in getting emissions under control, climate scientists affirm that climate change will continue for many decades from long-lived GHGs that have already accumulated in the atmosphere.

It is predicted that the global mean annual surface temperature will increase by 1 up to 3.5^{0}C by 2100 and the global sea level will rise by 15 to 95 centimeter (cm), and change in the spatial and temporal patterns of precipitation would occur (IPCC 1996). The predicted effects of climate change over the coming decades, according to the IPCC, include extreme weather events, drought, flooding, sea level rise, retreating glaciers, habitat shifts and the increased spread of life threatening disease.

Scientists believe that the earth's average temperature should not rise by more than 2^0C over pre-industrial levels. European Union indicated that this is essential to minimize the risk of what the UNFCCC calls dangerous climate change and keep the costs of adapting to a warmer world bearable. Scientists indicated that there is a 50% chance of keeping to 2^0C if the total concentration remains 450 ppm.

2.4.2. Causes and effects

Principally the climate variation occurs as a result of internal variability within the climate system due to natural hydrological, geological, atmospheric and biotic factors. For many decades, the climate has been affected by both natural processes and anthropogenic (human made) activities. The natural influence on the climate system has caused variations in the earth's climate over hundreds of thousands of years, as well as on shorter timescales of decades. Exchange of heat and gases between the earth's atmosphere and its oceans and land vegetation are also natural influences on the climate system.

Massive deforestation is releasing stored carbon back into the atmosphere. For every hectare of forest cleared, hundreds of tons of carbon are added to the atmosphere, depending on the type of tree removed. Deforestation and land clearing have many causes, from large-scale, organized clearing for crop and grazing land and infrastructure, to the small-scale movement of marginalized people into forests in search of farming or employment opportunities.

As forests and grasslands continue to grow, they remove carbon from the atmosphere and contribute to climate change mitigation. Natural and undisturbed forests are particularly

important. Intact natural forests in Southeast Australia, for example, hold 2,349 tons of carbon dioxide equivalent per hectare, compared with 796 tons on average for temperate forests. Thus, in terms of total emissions reduction from land use interventions, protecting Earth's existing carbon in forests and grasslands could have the largest impact, if achieved.

The increase in human and livestock population and drastic economic development during the last century has intensified pressure on the climate through industrialization. As it has been noted, the human activity contributed a great deal to the climate change in the form of GHGs emissions (includes CO_2, methane and nitrous oxide) and changes in land use and land cover. Particularly, after the industrial revolution natural gas (fossil fuel), oil and coal have been burnt to produce energy for transport, electricity generation, factories, heating and other services. These actions resulted in accumulation of CO_2 and other GHGs in the atmosphere to unprecedented rate and depleted the stratospheric ozone. The level of greenhouse gases emissions is likely to change the yearly average values and annual patterns of temperature and rainfall worldwide.

Climate change directly affects variation in temperature and rainfall patterns, soil moisture and sea level as well as ice caps and glaciers in polar and coastal regions along with increased incidences of catastrophic drought, flooding and disease epidemics in the tropical and sub-tropical regions (IPCC 2007). These changes adversely contribute to disorder in ecological system. In this case, the tropical and sub-tropical regions will be experiencing in an increase with frequent incidences of drought, flooding and diseases. On the other hand, the polar and coastal

regions will be encountered with the challenges of sea rise and ice melting. It has been underlined that poor and developing countries will be more affected by climate change.

The IPCC Fourth assessment report can be taken as supporting this view, but mention of disaster is dispersed across its structure of spectral and regional chapters. Disasters are generally subsumed in a broader category of “extreme events” with statistical anomalies whose human impacts, if any, may be subtler. Nevertheless, the IPCC clearly states with high confidence that: Drought affected areas will increase and increased frequency of droughts will affect agricultural production in the tropics. Coastal area will see an intensification of cyclones, larger extreme waves and storm surges; coastal floods associated with rising sea levels will affect millions of people. Urban areas will be affected by increased heavy rainfall, floods and slides. The poor, and the citizens of developing countries generally, having the most limited adaptive capacities, will be most vulnerable to the effects of such disasters.

Africa mainly in Sahel, the horn of Africa and Southern Africa has been challenged by the impact of drought since 1960s. Millions of people are affected due to crop failures and water scarcity as caused by climate change. The frequent phenomenon resulted in an increase dependency of food importation and food aids from rich developed countries. The climate change is also affecting the small Island developing states and countries in Asia and Latin America are at special risks (IPCC 2007). These countries have very few resources to adapt and are little responsibility for the climate change (UNFCCC 1992: Article 4). Poor countries are heavily dependent on climate sensitive economy, and least adaptive capacities to climate

changes. The majority of people in developing countries based their livelihood on the agriculture sector (crop and livestock) which is severely affected by climate change.

Climate is highly linked with agricultural production, human and livestock health, environmental resources, socio-cultural systems (UNEP 2006). The climate change resulted in reduction of length of growing periods and the marginal areas are left out of the production system. The IPCC report (IPCC 2007) projected that yield will be reduced up to 50% by 2020 due to climate change in some poor countries. This means that poor countries with periodic and frequent drought situation cannot carry the effect of climate change burden due to the reason that they have little capacity to adapt the changes.

2.5. Adaptation to Climate Change

Adaptation to climate change is an ongoing and reiterative process that includes information development, awareness raising, planning, design, implementation and monitoring. Reducing vulnerability requires having mechanisms in place and technologies, expertise and other resources available to complete each part of this process. The mere existence of technologies for adaptation does not mean that every vulnerable community, sector or country has access to these options or is in a position to implement them.

There are various ways to classify or distinguish between adaptation options. First, depending on the timing, goal and motive of its implementation, adaptation can be either reactive or anticipatory. Reactive adaptation occurs after the initial impacts of climate change have become manifest, whilst anticipatory (or proactive) adaptation takes place before impacts are apparent. A

second distinction can be made between private and public Adaptation. Private adaptations are those undertaken only for the exclusive benefit of the individual decision maker. Public adaptations are those government-sponsored adaptive measures which can be determined by factors such as the institutional environment, community structure, and existing public policies.

Key premises for adaptation include;

- Countries are maladapted to current and future climate risks
- National policy context does not adequately incorporate climate change risks
- Serious physical impacts accompany extreme climatic events
- Poor populations at greatest risk to climate shocks and hazards
- In many countries, the capacity to adapt to climate change is often limited by a lack of resources, poor institutions and inadequate infrastructure, amongst other things
- Gendered access to resources influences land tenure rights, education, availability of credit undermines women's adaptive capacity

According to IPCC (2004), adaptation measures may be legal, financial, economic, technological, public education, and/ or research and training. The same source (IPCC, 2004) classifies climate change adaptation strategies into six categories:

- Prevention of loss: involving anticipatory actions to reduce the susceptibility of an exposure unit to the impacts of climate.
- Tolerating loss: where adverse impacts are accepted in the short term because they can be absorbed by the exposure unit without long-term damage.
- Spreading or sharing loss: where actions distribute the burden of impact over a larger region or population beyond those directly affected by the climatic event.

- Changing use or activity: involving a switch of activity or resource use to adjust to the adverse as well as the positive consequences of climate change.
- Changing location: where preservation of an activity is considered more important than its location, migration occurs to areas that are more suitable under the changed climate.
- Restoration: this aims to restore a system to its original condition following damage or modification due to climate.

2.6. Responses to Climate Change: Adaptation and Mitigation

The UNFCCC has identified adaptation and mitigation as two responses to climate change.

2.6.1. Climate change adaptation

The term “adaptation” is now widely used in international climate change negotiations, but various stakeholders define and interpret it quite differently. For example, community-based adaptation practitioners use a more technical interpretation of the term that focuses on actions, while adaptation policymakers use a broader definition and emphasize the institutional and policy sides of adaptation including building knowledge in support of policies and programs, technologies, financing, capacity building and other institutional arrangements. International negotiators face the dilemma of differentiating adaptation to long-term climate change from adaptation to short-term climate variability, as the convention intends to support primarily those activities falling under the first category.

Like mitigation, adaptation to climate change is a dynamic and multi-dimensional process integrating various components such as sound planning, research, technologies, funding, training, capacity building, public awareness, and education. In order to address adaptation

comprehensively, climate risks at local, national or regional levels must be assessed first using different decision support tools (involving data, information, knowledge, understanding, skills, methods and tools).

For proper implementation of various programs, policies, strategies and actions on adaptation, however, we need a good enabling environment, which includes legislations and institutions that can support mainstreaming of adaptation concerns in development planning. Effective implementation of adaptation actions, therefore, requires more than the mere output of climate data. Furthermore, we need to determine the effectiveness of the implemented adaptation activities through the development of reliable indicators and then revise the existing practices, if necessary. Successful adaptation to climate change, therefore, requires flexible institutional and policy processes, increased public awareness and dialogue, sharing of knowledge on adaptation measures, mobilization of community members, tools and technologies, capacity building, and appropriate monitoring and evaluation.

2.6.2. Climate change mitigation

Climate mitigation is any action taken to permanently eliminate or reduce the long-term risk and hazards of climate change to human life, property and natural resources. Mitigation is distinguished from adaptation, which involves acting to minimize the effects of global warming. Most often, mitigation involve reductions in the concentrations of GHGs, either by reducing their sources or by increasing their sinks. In general the more mitigation there is, the less will be the impacts to which we will have to adjust, and the less the risks for which we will have to try and

prepare. Conversely, the greater the degree of preparatory adaptation, the less may be the impacts associated with any given degree of climate change.

In the UNFCCC three conditions are made explicit when working towards the goal of GHG stabilization in the atmosphere:

- That it should take place within a time-frame sufficient to allow ecosystems to adapt naturally to climate change;
- That food production is not threatened and;
- That economic development should proceed in a sustainable manner.

The idea that less mitigation means greater climatic change and consequently requiring more adaptation is the basis for the urgency surrounding reductions in GHGs. Climate mitigation and adaptation should not be seen as alternatives to each other, as they are not discrete activities but rather a combined set of actions in an overall strategy to reduce GHG emissions.

2.7. Climate change and adaptation to climate change in Ethiopia

2.7.1. Effects of climate change in Ethiopia

Climate changes are already being seen in Ethiopia in the last decades. Ethiopia has been subjected to drought, floods, new insect pests, new vector borne diseases and other problems made worse by climate change. According to the UNDP Climate Change Profile for Ethiopia, the mean annual temperature in Ethiopia has increased by 1.3^0C between 1996 and 2006, at an average rate of 0.28^0C per decade. The increase in temperature has been most rapid from July to September (0.32^0C per decade) It is reported that the average number of the hot days per year has increased by 73 (additional 20% of days) and the number of nights has increased by 137

(additional 37.5% of nights) between 1960 to 2006. The rate of increase is seen most strongly in June and August. Over the same period, the average number of cold days and nights decreased by 21 (5.8% of days) and by 41 (11.2% of nights), respectively. These reductions have mainly occurred in the months of September to November (Mc Sweeney et al., 2008).

It is very difficult to detect long-term rainfall trends in Ethiopia, due to high inter-annual and inter decadal rainfall variability. Between 1960 and 2006, no statistically significant trend in mean rainfall was observed in any season. The decrease in rainfall observed in July to September in the 1980's recovered in the 1990s and 2000s. In addition, there are insufficient daily rainfall records to identify trends in daily rainfall unpredictability and changes in intensity of rainfall (Mc Sweeney et al., 2008).

Agriculture is the main stay of the Ethiopian economy where more than 80% of the workforce is engaged. The sector, which includes crop and livestock production and development accounts for about 50% of GDP and generates 90% of export earnings. Besides, the agricultural production system, water supply and energy sources have been noted as forefront sectors affected by climate change. Ecologically arid, semi-arid and dry sub-humid parts of the country are the most vulnerable to drought. In terms of livelihoods, small scale rain-fed subsistence farmers and pastoralists are the most vulnerable. The natural resource base has been depleted because of intensive human interference and mismanagement and utilization without proper precautions causing to deforestation, degradation of arable lands through soil erosion and loss of fertile soils. The pasture lands and wetlands have been diminished due to human interventions being accelerated by climate change.

Ethiopia is well known to its recurrent drought and famine in the world. The climate hazard particularly, drought and flood occurrence has increased both in frequency and intensity in recent years. The factors include change in climate leading to more frequent droughts, widespread land degradation, limited alternative income, increased population pressure**,** poor market integration and limited access to basic services, inputs, credit, information and technological issues.

As indicated in the Food Security Strategy of Ethiopia (2002), it is reported that up to 45 percent of the population is food insecure or below the poverty line.

The most drought prone and affected areas of the country are in the northern, eastern and southern parts. Total failure of shortage of rainfall is often cited as the major cause for the recurring droughts and harvest failures. Such a problem or situation is further exacerbated by the social, economic and ecological situations (DPPC, 2003). Currently the country is facing a serious food shortage problem mainly due to crop failure for consecutive seasons, eroded coping strategies. The food aid need in 2009 was estimated at about 1.8 million metric tons for about 6.2 million drought affected populations including internal displaced people. As per the report of DPPC, the year 2003 was recorded as the highest with 13.2 million people affected by drought in the country.

2.7.2. Responses of climate change in Ethiopia

Ethiopia has ratified the UNFCCC and Kyoto Protocol in April 1994 and 1997 respectively. It has also designated institutions to follow up the implementation of the environmental and climate issues in the country. A set of various policies and institutional framework has been put in place in order to reduce the vulnerability of the country to climate change and variability.

Among others, the Environment Policy of Ethiopia (EPE) and the Conservation Strategy of Ethiopia (CSE) approved in 1997 enabled the country to develop specific mechanisms to fulfill its obligations regarding the UN Framework Convention on Climate Change (UNFCCC). The Ethiopian Environment Protection Authority (EPA) issued the Climate Change National Adaptation Programmes of Action (NAPA), thus identifying the integration of climate change adaptation activities with national development policies. The NAPA process in Ethiopia identified arid and semi-arid areas of the country as being most vulnerable to drought; in addition, agriculture was identified as the most vulnerable sector where small scale rain-fed subsistence farmers and pastoralists are identified as the most at risk. The NAPA process has identified and prioritized eleven project areas that address the immediate climate change adaptation needs in the country.

The Ethiopian EPA is also leading the process to ensure effectiveness of the climate agenda in a coordinated yet decentralized manner. In its national response, EPA will build on the existing climate change policies and strategies; (1) the National Adaptation Framework Programme comprising of 20 vulnerable sectors and groups is developed, negotiated and accepted with some notification and (2) the National Appropriate Mitigation Action (NAMA) of Ethiopia which comprises of various sectors and 83 concrete projects has been registered by the Secretariat of the UNFCCC in line with the Copenhagen Accord. Ethiopia is also synthesizing the existing strategic policies and thinking of the Government with the sole objective of facilitating the national process to construct a carbon neutral/climate resilient economy (CNCR Ethiopia). The aim of the programme is to put in place strategic and action oriented framework that enable Ethiopia to respond effectively to climate change starting from the lowest effective

administrative unit. It is expected to provide strategic directions and guidance on how and what elements should be mainstreamed into Ethiopia's core socio-economic development programme in order to construct a carbon neutral/climate resilient economy.

CNCR Ethiopia provides support to a comprehensive research programme on climate issues led by the Addis Ababa University. The programme is expected to address the current research gaps on both climate resilient and low carbon economy in Ethiopia. The research activities are to be coordinated with other ongoing international climate research programme. The Federal Government of Ethiopia also gives much more emphasis to climate change adaptation and mitigation in its Growth and Transformation Plan (GTP). It pointed out that Environment and Climate Change is among the major components of the plan and highlighted that building a "Green Economy" and on-going implementation of environmental laws as crucial strategic directions on top of putting in place climate change adaptation and mitigation of GHGs with targeted action plans. In this direction, the GTP aimed at formulating and effectively implements policies, strategies, laws and standards which will foster social and green economy development so as to enhance the welfare of citizens and environment sustainability.(GTP 2010, p 120).

The Oromia National Regional State, where the study conducted, is largely an agrarian economy, which is rain-fed and small scale farming providing livelihoods for the majority of the population. The Agriculture is tremendously dependent on the timely onset, amount, duration and distribution of rainfall. The effects of climate variability and change have harshly jeopardized the agriculture sector, put at risk the natural environmental situations and deteriorate the economic development of the region and the country. The region broadly acknowledged that

active responsiveness to the problems caused by climate change could bring about increasing agricultural productivity and production towards improving the livelihoods of the community at large. In light of this, the region came up with the preparation of regional climate change adaptation programmes associated with projects that enable it to timely and effectively take action to the climate changes.

In view of this, regional task force drawn from different government sector offices and NGOs formulated the paper of Regional Climate Change Adaptation Plan.

The document studied the unpredictability of climate and its effects, the main vulnerable sectors, adaptive capacities and response measures and reviewed the good practices and technologies to adapt to climate change coupled with the types of the future adaptation actions in the region. Furthermore, it addressed the potential non-climate related side effects of the adaptive strategies to prevent undesirable consequences on the human health and social wellbeing generally.

According to the document of Regional Climate Change Adaptation Plan (2011) recommendation, the following adaptation measures and strategies are outlined among others;

- To counteract the adverse climate and poverty trends in pastoralist and agro-pastoralist areas, the region requires urgent changes in its rural and pastoral development priorities. The region has aimed at addressing the underlying drivers of vulnerability. This means implementing poverty reduction and development interventions that promote pastoral livelihoods and entitlements; enhance access to vital infrastructure,

resources and services in pastoral areas; enhance the security of agro-pastoralist land holdings; restore and protect the environment in rangelands; create more efficient markets and help control population growth.

- Ensure that development programmes and project activities promote climate change resilience and increase adaptive capacity, it is important to understand which livelihood resources are sensitive to climate risk and resources are important for adaptation.
- Enhance and promote development interventions that aimed at diversifying livelihoods of the farming communities, develop their capacities through persistent and continuous awareness creations on climate.
- Change the impacts, adaptation to climate change shocks and response measures to withstand effects of climate change hazards, pay due attentions to conservation of natural resources and development, carry out extensive interventions aimed at minimizing deforestation and soil degradation through participatory forest development and conservation of soil and water resources from further excessive depletion,
- Promote traditional and indigenous knowledge helpful to reduce impacts of climate change and enhancing local people' s adaptive capacity to climate change shocks, and implementation of development interventions that improve livelihoods of the farming, communities including appropriate relief strategy and social protection, etc

Hence, this research try to find and generate knowledge and share scientific information through analysis of the local experiences on climate variability and changes, perceptions, stresses and consequences, trends, adaptation strategies and their factors, etc. Such understandings of the

change at micro-level will enable development actors to link up and inform policy, CNCR Ethiopia, at macro or national and regional levels as it explains realities at the ground.

Chapter III: RESEARCH DESIGN AND METHODOLOGY

3.1. Description of the Study Areas

3.1.1. Oromia National Regional State

Oromia is the biggest and heavily populated region in Ethiopia. It's land area cover 359,620 square kilometers (kms^2), spreading across the center of the country with a very wide-ranging topography having elevated mountains, valleys including part of the rift valley, undulating plains with diverse agro-ecology conditions, etc. The region is characterized by high plateau and very limited lowland areas. Its altitude also ranges from below 500 meters above sea level (masl) at the rift to 4377 masl at Mount Tullu Dimtu. The region experiences annual temperature ranging from 10^0C to 30^0C, with mean annual temperature of 19^0C and has bi-modal rainy seasons with the annual rainfall ranges from 400 millimeter (mm) a year in the south to 2,400 mm a year in the Western Highlands (Oromia Region Adaptation to Climate Change Program of Plan, 2011).

According to the population and housing census report of CSA (2007), the total population of the region is 27, 158,471million, which accounted 36.7% of the total population of Ethiopia. The rural population is 23,788,431 (87.8%) of the total population of the region, while the urban population is 3,858,567 (12.2%). Of the total population in the region, women constitute about 49.6%, while men constitute 50.4%. According to CSA (2007), the annual population growth rate of the national regional state was 2.9.

The main economic base of Oromia depended on subsistence and rain-fed agriculture, which contribute 69% of its GDP and employing 89% of the labour force. The yields and productivity of the agriculture are constrained by several factors, including traditional farming methods and rapid population growth, which is causing fragmentation and reduction of farm sizes and contributing to natural resource degradation. The Oromia region is divided into 18 administrative zones, 304 districts with more than 6,342 rural and 482 urban kebeles.

The study Districts, which are among the 304 Districts in the region, are found in West Arsi Zone (one of the 18 administrative Zones of Oromia). West Arsi Zone is newly established administrative unit and has 11 Districts and a capital town, Shashemene. According to the information obtained from West Arsi Zone Finance and Economic Development Office (FEDO), the Zone is located in the Rift Valley area approximately at a distance of 250 km from Finfine**.** Having the total area of 12409.99km^2, the Zone extends from $6^0$12'29" to $7^0$42'55" latitude and $38^0$04'04" to $39^0$46'08" longitude. It shares boundry line with East Shewa Zone to the north, SNNPRS to the west, Arsi to the northeast, Guji to the south and Bale Zone to the east. Most parts of the zone have elevations ranging from 1500 to over 2300 masl. The total length of the boundary line is about 174km.

As per the information of FEDO, West Arsi zone is divided in to three major agro-climatic zones mainly due to variation in altitude. This great variation of temperature provides wide opportunities for the production of different types of crops ranging from warm to cool thermal zone. The mean annual temperature of the zone ranges between 10-16^{0}c in the high land and 20-25^{0}c in the low land area. However, there is a slight variation of temperature

from month to months. October to May are the hottest months while June to September are the cold ones. In most of the areas, the rainy season starts in March and extends to November with the highest concentration in June, July and August. The number of rainy days varies from highland ("Dega") to midland ("Weina Dega") and this number slightly decreases as one goes down to the lowland ("kola") areas. Based on the available climatologically data, the mean annual rainfall varies from district to district. Generally, West Arsi Zone receives abundant but unevenly distributed rainfall both in amount and season. On average, the Zone gets an annual mean rainfall of 1300mm. which is conducive for growth different types of vegetation and agricultural activities.

3.1.2. The study Districts

Kofele and Kore districts, the research sites for this study are and among the 11 districts in West Arsi Zone. Kofele district is within the Wabe Shebele watershade and has three major rivers, namely Anjelelo, Ashoka and Totalamo. Kore district was formerly administered under Kofele district before the establishment of West Arsi Zone.

Based on figures published by the Central Statistical Agency in 2009, Kofele district has an estimated total population of 196,553 as of July 2010, of whom 98,546 are men and 98,007 are women; 16,294 or 8.29% of its population are urban dwellers, which is less than the Zone average of 12.3%. With an estimated area of 660.97 km^2, Kofele has an estimated population density of 297.4 people per km^2, which is greater than the Zone average of 183.7 km^2. Kofele is located between 6^0N - 7.05^0N latitudes and 37^0 E - 39^0 E longitudes at a distance of about 275kms from Addis Ababa. It has 43 rural and three urban Kebeles. The number of kebeles

increased from 38 to 43 because of the recent transfer of five kebeles from SNNPR to Oromia Region. Similarly, based on figures published by the same agency Kore district has an estimated total population of 113,901 as of July 2010, of whom 56,596 are men and 57,305 are women. With an estimated area of 660.97 km^2, Kore has an estimated population density of 227 people per km^2, which is also greater than the Zone average of 183.7. The District covers 20 rural and one urban kebeles administration. Geographically, the district is characterized by plane to steeply sloping land features.

The two largest ethnic groups in Kofele and Kore are the Oromo (94.86%), and the Amhara (3.83%); all other ethnic groups made up 1.31% of the population. Oromifa is spoken as a first language by 94.59% of the population while Amharic speakers accounted to 4.55% and the remaining 0.86% speaks other primary languages. The majority of the inhabitants are Muslims, which accounts about 55.63% of the population while 44.01% of the population are said to be Orthodox Christians and Protestants.

The altitude of the Districts ranges from 1800 to 3050 m.a.s.l and the highland areas accounted 88% while the midland accounted 12%. A survey of the land in these districts showed that 30% is arable or cultivable, 29% pasture, 2.9% forest, and the remaining 38.1% is considered swampy, mountainous or otherwise unusable (ROBA Baseline survey 2010).

According to the records of Districts' ARDO, the area gets high annual rainfall ranging between 1200 – 1300 mm. Mean annual temperatures varies between 14^0C to 20^0C with the highest temperature observed in the dry season from February to May. Kofele and Kore have two rainy

seasons, the short rainy season is from January to March which is locally known as “Belg” and the long rainy season extends from June to September, which is known as “Meher” and is the main cropping season. The districts are characterized by successive years of unreliable and uneven distribution of rainfall and prolonged dry seasons. Besides, the areas are also experiencing early on-set and early cease of rains. According to the information gathered from Districts’ ARDO, the seasonal farming calendar is presented below.

Table 1: AGRICULTURAL CROPPING CALENDAR OF STUDY DISTRICTS

Activity	Belg season	Meher season
Land preparation	January - February	March - May
Planting	February - March	July - August
Weeding	April - May	August - September
harvesting	June - July	December - March

Source: Districts ARDO

The study covers agro-pastoralists who reside in the districts and share homogenous way of life, culture and traditions, etc and earned their livelihoods through crop and livestock production. About 65 percent of cultivation is done by oxen and 34 percent of cultivation is practiced by human labor using local hand tools and insignificant number of the well-to-do HHs use tractor.

Cattle, sheep and equines are common livestock types, while wheat, barley, maize, linseed, field peas and faba beans as well as, vegetables like potato, carrot, beet root, head and local cabbages are major crops grown in the areas. Enset *(Ensete ventricosum)* is widely grown in several kebeles and is an important food crop and means of coping especially during food shortages. Maize is now emerging as a new crop after change in weather condition. The areas are also traditionally producing crops during the “Belg” season, although the productivity in general is

relatively low. Some studies have documented that many "Belg" producing areas are significantly affected by climate change (Riché et al. 2009; Oxfam International 2010).

The districts were selected purposely taking into consideration the existence of target community of Rural Organization for Betterment of Agro-pastoralists (ROBA), an indigenous Ethiopian Resident Charity and development partners, prospective development projects intervention and accessibility of resources including logistics capacity. Over the years, the agro-pastoralists' livelihood pattern, is actually declining due to continued depletion of natural resources, frequent changes in climatic conditions and an alarming growth of population. In the rainy season, although unprotected, water is available from intermittent streams and stored water at different sites, however, access to these unsafe sources is denied during the dry season. Ashoka, Wabe and other rivers, though flowing farther out, are sources used by the community after travelling for long hours. Some families forced to migrate with their livestock to other areas due to shortage of water. Despite the problems associated with variability in climatic pattern, prolonged dry seasons in recent years also resulting in scarcity of water and grazing.

The rain-fed agriculture with poor input supply pattern was highly affected by climate variability and decrease of crop and animal production and increasing of pests during the last five consecutive seasons. The situation is critical in some of the villages (kebeles) where they are forced to receive emergency food aid and migrate to other areas in search of food, water, pasture, etc. The predominantly highland and midland districts that were considered among "bread basket" of the country in the past were recently plagued by climatic shocks, but ignored by aid and government agencies during the past climatic crisis (Senbeta, 2009).

The Study Areas

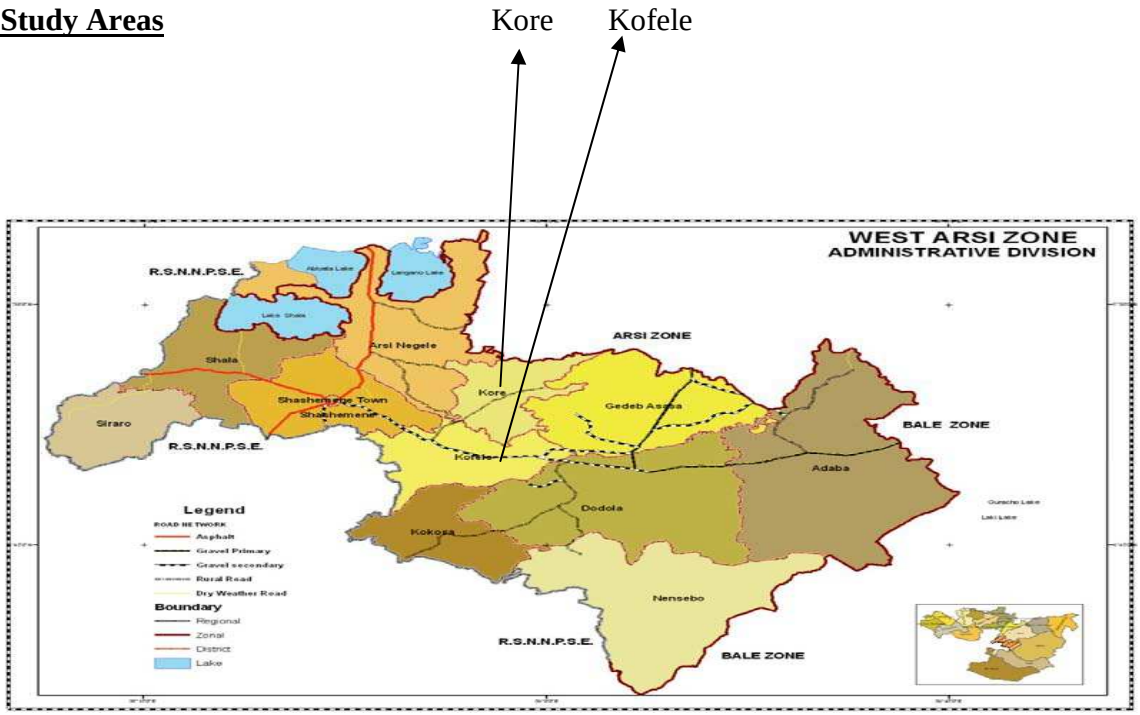


Figure 1: Location map of the study Districts

Source: West Arsi Zone FEDO

Crop Production

Kofele and Kore Districts have an agro-pastoral farming system with mixed crop and livestock production, which are the basic means of livelihoods. Over the years, the districts are among those areas, typically recognized for their surplus grain production and had not experienced any food insecurity situation. The crop production is almost entirely rain-fed, with the exception of very small areas that practiced traditional irrigation around homesteads. Rainfall variability is a major constraint to agricultural production and food insecurity is becoming a widespread phenomenon in parts of the study areas. Since the last five years, the trends of the crop production was continually reduced due to unpredicted rain fall patterns, reduced land holding sizes among smallholder farmers, limited access and supply of inputs, insufficient technical advice/support, pre and post harvest crop losses and decline in productivity per area of cultivated

land. Besides, the ever increasing demand for arable land due to high population pressure, which contributed to fragmentation of farmlands and clearing of forests even on rugged mountains sides to sustain livelihoods, are also the key constraints to sustainable agricultural development. As a result, exceptionally large number of smallholder farmers become vulnerable to food insecurity problems from time to time. Furthermore, the coming of the rainfall following a long dry season, for the 2008/09 crop season was also with several problems. Among the problems indicated by the FGD participants was infestation of the crops with pests, particularly, on linseed, which is the most important cash crop of the community. The infestation of wheat and barley by weed, which was not known before also became wide spread. The green and tender grasses that emerged following the rainfall also killed several animals due to blotting during grazing. The trends of major crops' yields in the last five cropping season is presented below (Tables 2 and 3).

Livestock production

Livestock production is also one of the main sources and means of livelihood of Agro-pastoralists. The areas are now almost moving to crop production even though livestock production was predominantly serve as basic means the livelihood of Agro-pastoralists in the earlier times. Because of the shift to crop cultivation, grazing land for livestock is declining and lack of feed is progressively emerging, which in turn decline livestock production. According to the information obtained from the Districts' ARDO, cattle dominate the type of livestock followed by sheep and horses. Kore District has a total of 126,056 cattle and 101, 060 shoats (sheep and Goat), while. Kofele has a total of 146,457 cattle, 64,744 shoats, 23,272 horses, mules and donkeys as well as 28114 poultry.

Table 2: CROP PRODUCTION TREND IN KOFELE DISTRICT

Year	2007/08			2008/09			2009/10			2010/11			2011/12		
Types of crop	Area (ha)	Yield (ha.)	Total yield in quintal	Area (ha)	Yield (ha.)	Total yield in quintal	Area (ha)	Yield (ha.)	Total yield in quintal	Area (ha)	Yield (ha.)	Total yield in quintal	Area (ha)	Yield (ha.)	Total yield in quintal
Barley	17,132	16	274,112	19,102	23	439,346	19,228	26	499,928	17,940	28	502,320	19,316	25	482,900
Wheat	4,647	14	97,587	4,654	22	102,388	7,939	25	198,475	4,565	23	104,995	4,697	23	108,031
Maize	1,514	30	57,532	3,010	35	99,330	4,200	36	151,200	2,875	35	100,625	2,875	32	92,000
Linseed	1443	3	4,329	1,149	9	10,341	1,871	7	13,097	1,325	5	9,275	1,325	7	9,275
Peas	146	13	1,898	400	15	6,000	288	16	4,608	240	15	3,600	240	15	3,600
Faba Bean	184	14	2,576	120	22	2640	402	17	6,834	420	14	5,880	420	14	5,880
Potato	6,070	60	364,200	5,380	90	484,200	3,620	80	289,600	3715	80	315,775	3275	80	262,000
Head Cabbage	501	115	57,615	184	326	59,984	185	168	31,080	200	170	34,000	200	170	34,000
Beet root	122	83	10,126	78	30	2,340	90	107	9,630	90	102	9,180	90	102	9,180
Carrot	126	90	11,340	96	126	12,096	85	93	7,905	87	95	8,266	87	95	8,266
Total Yield			**881,315**			**1,218,665**			**1,212,357**			**1,093,916**			**1,015,132**

Source: Kofele District ARDO

Table 3: CROP PRODUCTION TREND IN KORE DISTRICT

Year	**2007/08**			**2008/09**			**2009/10**			**2010/11**			**2011/12**		
Ttypes of crop	Area (ha)	Yield (ha.)	Total yield in quintal	Area (ha)	Yield (ha.)	Total yield in quintal	Area (ha)	Yield (ha.)	Total yield in quintal	Area (ha)	Yield (ha.)	Total yield in quintal	Area (ha)	Yield (ha.)	Total yield in quintal
Barley	18172	34	617,948	17594	30	527,820	20390	29	591,310	19602	28	548842	18193	27	491211
Wheat	8370	45	376,650	8023	39	312,897	8101	34	275,434	7967	35	278845	8015	30	240450
Maize	5718	50	285,900	5605	54	302,670	3302	39	128,778	3814.5	30	114435	5145	35	180075
Faba Bean	165	12	1,980	200	9	1,800	192	11	2,112	180	12	2160	180	14	2520
Peas	45	11	495	89	10	880	69	10	690	45	10	450	45	16	720
Linseed	1030	10	10,300	970	8	7,760	885	8	7,080	1020	8	8160	1020	11	11220
Total Yield			**1,293,273**			**1,153,827**			**1,005,404**			**952892**			**926196**

Source: Kore District ARDO

3.1.3. Causes of Climate Change in the Study Districts

The underlying reasons for changes in climate are universal and unpredictable in nature. Nevertheless, in solid and sound expression, continuous human actions on the environment are among the crucial factors to bring about changes in the climate. In light of this, similar situations were certainly taken place in the research sites by way of unwise intervention of the human beings. As the communities perceived and witnessed, devastation of natural resources as well as forests without replacing through forestry development on top of the ever increasing of population pressure with large family sizes that put extra burden on the land than the labour added up for production, are disheartening situation that contribute to climate changes. Besides, extending the agricultural or farming lands coupled with huge livestock population and overgrazing, exhaustion of soil fertility by continuous farming and wind and water erosion that leads to restricted cultivation of crops and grasses as well as lack of awareness are factors that contribute to climate changes in the areas.

3.2. Sampling methods

Multi-stage stratified sampling procedure associated with purposive and random sampling methods was used to determine sample households. In the first stage, two districts were selected taking into account the presence of ROBA's project target groups and future programming in the areas, climate related stresses and shocks, logistics and coordination issues as well. The two districts were composed of agro-pastoralists including smallholder farmers and landless groups.

At the second stage highland and midland agro-ecology zones purposely identified in both districts taking into account easy access for transport facility, data collection and ease of organization and management of the study tasks. At third stage, purposive sampling was also employed to select the kebeles, thus five kebeles from Kofele District and three kebeles from Kore District, a total of eight kebeles were selected with due consideration of agro-ecology, climate related stresses and disasters and accessibility. At the final stage a simple random sampling method was then employed to select the households from the eight kebeles of both districts. Lastly, a total of 80 sample households were selected using random sampling method from selected kebeles where the future target groups of ROBA were identified.

The total sample covered by the study was 400 households, with 150 in Kore and 250 in Kofele. After securing completed list of households in each sample kebeles, 10 sample households were selected from each kebele systematically using a random start from the pre-assigned column table of random numbers. The population was first divided by the sample size to get the interval for choosing the sample population. Then a number was randomly selected between zero and ten to start the selection. Every 5^{th} household was selected until the desired numbers (80 households) were obtained. The sample size sufficiently represents the population in view of the homogeneity of the rural households in the study areas. Table 4 presents some details about the study sites.

Table 4: THE STUDY'S SAMPLE DISTRICTS, KEBELES AND NUMBER OF RESPONDENTS

S/N	Districtss elected	No. of Agro-Ecology zones	No. of sample kebeles	Number of Respondents				Total
				Number of sample households	No of Key Informants	No of FGD Participants at kebele level	No of FGD participants at Zone and District levels with NGO and government sector offices	
1	Kofele	2	5	50	5	10	5	70
2	Kore	2	3	30	5	10	5	50
	Total		8	80	10	20	10	120

The study's sample Kebeles

Out of the eight sample kebeles where the study was conducted, five of the kebeles, namely Koma Bitacha, Hulebra, Gofingira Gurmicho are highland kebeles and Chatmena Kerensa, and Tulu Boke are the midlands in Kofele District. The other three kebeles, Gofingira Chocha and Doda Deyu kebeles are highlands, while Ekka Deyu is a midland in Kore district. The list of study sites with their estimated number of HHs and population by sex is shown below (Table 5).

Table 5: NUMBER OF POPULATION IN THE STUDY KEBELES

Disticts	**Kebeles**	**No. of households**			**Total population**		
		Male	Female	Total	Male	Female	Total
Kofele	Koma Bitacha	546	280	826	2878	2765	5643
	Tulu Boke	536	214	750	3918	5084	9002
	Gofingira Gurmicho	471	155	626	3238	3062	6300
	Hulebera	476	226	702	2621	1277	3898
	Chatmena Kerensa	330	210	540	1490	2130	3620
	Total	**2359**	**1085**	**3444**	**14145**	**14318**	**28463**
Kore	Doda Dayu	937	159	1096	3994	4030	8024
	Ekka Dayu	425	168	593	1302	1314	2616
	Gofingira Chocha	444	157	601	2174	2204	4378
	Total	**1806**	**484**	**2290**	**7470**	**7548**	**15018**
Total population of study areas		**4165**	**1569**	**5734**	**24541**	**21886**	**43481**

Source: Districts' ARDO

Selection and training of Enumerators

Totally three enumerators and one supervisor were assigned for the household survey's data collection purpose. Enumerators with college diploma and an excellent knowledge of Afan Oromo (the local knowledge of the study area) and the beliefs and traditions of the communities were selected from both districts for the household interview. Prior to the training, an intensive orientation was provided by qualified and experienced trainer on the exact meaning of each interview item, how to approach respondents properly, how to pose questions, how to obtain and record appropriate responses and other relevant topics. After the training data collectors exercised an interview by turn in front of the participants to rehearse the interview, which helped to become more confident. Finally, the trainees were taken to other villages out of the study area for practical field work and testing the data collection tool. The enumerators filled a number of questionnaires, understand well and noted what problems they encountered in the process. The field practice was instrumental to make the training of data collectors successful.

3.3. Data Collection and Analysis

3.3.1. Tools and methods of data collection

The research employed both qualitative and quantitative data collection methods. The data were gathered from various sources. These sources are broadly classified into primary and secondary sources. An in depth review of literature was made to develop a conceptual framework that has guided the whole research process. Beside different literature reviews, relevant government and non-government organizations' reports, published and unpublished documents and records related to climate change and adaptation were reviewed. Policy and strategic guidelines and other official documents of the National Meteorology Service Agency and Environmental Protection Agency were

used as sources of secondary information. As primary information, the data required for the study were collected through a structured and semi-structured questionnaire, focus group discussion and key informants interview methods. The main primary and secondary data collection were carried out between February 2012 and September 2012.

Household survey: quantitative data was collected using structured questionnaire. The survey questionnaire was designed comprising of both closed and open-ended questions categorized as basic household information, climate change perceptions and understanding, climate change adaptation, the factors that require to adapt to climate change and the major constraints to adapt to climate change, etc. In line with this, a total of 80 randomly sampled HHs were interviewed from the eight kebeles by using a detailed questionnaire. The questionnaire generated a quantitative data at HH level that focused on household socio-demographic characteristics, perceptions of climate change, and knowledge on adaptation options, actual adaptation mechanisms they employed, etc

Focus group discussion (FGD): a total of four FGDs composed of men and women groups (with 6 -10 participants) were conducted in selected sample kebeles that were convenient for the purpose. Checklist was used to guide the discussion information on climate change perceptions and understanding, climate change adaptation, etc and helped to further verify and balance the information collected by other methods including the household survey. The checklist was designed to include relevant manifestations, local climate change adaptation mechanisms and the factors. The FGDs involved 30 participants from sample kebeles and government offices and NGOs representatives (Appendix - D).

Key informant interview (KI): A total of 10 individual interviews were conducted with knowledgeable and influential community members and leaders including kebele elders, religious leaders, leaders of Gada institutions, women groups, model farmers, council members and ARDO experts of the districts. The kI interviews with individual community members (on average two from each kebele) were undertaken by developing checklists to guide the interview and generate additional in-depth qualitative information. The timeframe considered to assess climate change perceptions was the past two to three decades. Unlike the selection of the HHs in the household survey, the selection of kIs or respondents for the key informant interviews and participants in focus group discussions was purposive. Thus, in the kI interview the questions were answered by 10 different informants drawn from Kofele and Kore Districts. Hence, the qualitative data from FGDs and KIs were used to augment and validate the quantitative analysis.

3.3.2. Data Processing and Analysis Methods

The study has employed a combination of qualitative and quantitative data analysis methods appropriate and relevant to data collected using different methods described in section 3.3.1. (data collection methods). Qualitative data consolidation and analysis was made independently as supportive information for the output of the research at field level. The questionnaires were pre-coded for the purpose of facilitating the data processing. Thus, master-code sheets were prepared for coding purposes after verifying and organizing the interview schedule properly. The data collected using the household survey was entered to and analyzed by employing Statistical Package for Social Sciences (SPSS) software. Basic household information, agro-pastoralists/farmers' level of climate change perceptions/awareness, factors which require and influence adaptation to the climate change as well as the main barriers for the community's inability to adapt to climate change.

Chapter IV. RESULTS ANALYSIS AND DISCUSSION

4.1. Socio economic characteristics of the sample households

A total of 80 HHs were interviewed for this study, of which 51 (64%) were males and 29 (36%) were females. Out of the 51 male HHs, 32 (63%) were from Kofele District, while 19 (37%) were from Kore District. Among the 29 female HHs, 18 females (62%) and 11 females (38%) were from Kofele and Kore Districts, respectively. In all kebeles of both districts, male-headed HHs were dominant with about 64 % representation.

The surveyed HHs had a total of 668 persons in their households. The average family size of surveyed HHs was 8.3. The family size showed variation among the HHs in the study districts. The largest average family size was found in Gofingira Chocha kebele in Kore District and the smallest in Koma Bitacha kebele of Kofele District. Besides, the survey revealed that the average family size is more than that of the Zone (5.5 persons per household). This implies that HHs with large family size put more pressure on cultivable land and if the population growth is intensified in the future, given the present trend, there would be low employment opportunity in off-farm activities in the area (Table 6).

With regard to family size of the surveyed households, 40 % replied that they had from 8 up to 10 families, 31.25 % had 5 up to 7 families, while 11.25 % had more than 11 families, and 17.5 % had less than 5 families per household (Table 7).

Table 6: NUMBER OF HHS AND TOTAL POPULATION OF STUDY KEBELES

Study Kebeles (Kofele)	HHs and their Families				Total Population		
	Male	No of family	Female	No of family	Total HHs	Total Family	Total Population
Koma Bitacha	6	29	4	18	10	47	57
Tulu Boke	6	49	4	29	10	78	88
Gofingira Gurmicho	6	44	4	26	10	70	80
Hulebera	7	76	3	20	10	96	106
Chatmena Kerensa	7	59	3	22	10	74	84
Total	32	250	18	115	50	365	415
Study Kebeles (Kore)	**HHs and their Families**				**Total Population**		
	Male	No of family	Female	No of family	Total HHs	Total Family	Total Population
Dod Dayu	6	57	4	16	10	73	83
Ekka Dayu	6	36	4	14	10	50	60
Gofingira Chocha	7	83	3	17	10	100	110
Total	19	176	11	47	30	223	253
Grand Total	**51**	**426**	**29**	**162**	**80**	**588**	**668**

Source: Survey data

TABLE 7: NUMBER OF FAMILY MEMBERS OF RESPONDENTS

No of families	No of respondents	percent
Less than 5	14	17.5
5 – 7	32	40
8 – 10	25	31.25
11 – 13	6	7.5
Above 13	3	3.75
Total	80	100

Source: field survey

Regarding their age, among the 51 male respondents, the majority (35.5 %) were between 41-50 years old and 31.4 % were between 31-40 years old. On the other hand, out of 29 female respondents, 44.8 % of households were between 31-40 years old and 34.5 % were between

20-30 years old. Hence, in both districts, the majority of surveyed households were between 31-40 years, which accounts to 36.2 %, followed by 30 % of them were between 41-50 years old. This means that 63 respondents (78.7%) were between 31 and 50 years old (Table 8).

Table 8: NUMBER OF RESPONDENTS BY AGE AND SEX

Age category	Male	Percent (%)	Female	Percent (%)	Total	Percent (%)
20 – 30	4	7.8	10	34.5	14	17.5
31 – 40	16	31.4	13	44.8	29	36.2
41 – 50	18	35.3	6	20.7	24	30.0
51 – 60	11	21.6	-		11	13.8
Above 60	2	3.9	-		2	2.5
Total	51	100	29	100	80	100

Source: Survey data

As indicated in the above table, the majority of respondents were relatively in active age group. Out of 80 household heads interviewed, 84% were below 51 years old while the remaining 16% were over 50 years old. The surveyed households have been living in the study areas for varying number of years. The majority of households had lived between 31 and 50 years within their kebeles they are currently residing. However, 31 % lived between 31 – 40 years, 24 % lived between 41-50 years and 22.5% had lived between 21 – 30 years in their kebeles of residence. Those who lived more than 60 years and less than 10 years accounted to 2.5 % each. The majority (87.5%) of interviewees had lived more than 20 years, while the rest (12.5%) lived in the surveyed kebeles below 20 years or less. This would have a good contribution to the knowledge or perception of the HHs about their living environment and the trends of climate change over the years (Table 9).

Table 9: NUMBER OF YEARS LIVED BY RESPONDENTS IN THE SURVEYED KEBELES

No of years	No of Respondents	Percent (%)
Less than 10	2	2.5
10 – 20 years	8	10
21 – 30 years	18	22.5
31 – 40 years	25	31
41 – 50 years	19	24
51 – 60 years	6	7.5
Above 60 years	2	2.5
Total	80	100

Source: Survey data

When considering the marital status, out of 80 respondents, 74 interviewees reported that they were married, while 4 (5%) were divorced (Table 10).

Table 10: MARITAL STATUS OF RESPONDENTS

Marital status	**No of households**	**Percent (%)**
married	74	92.5
not married	1	1.3
divorced	4	5.0
widowed	1	1.3
Total	80	100.0

Source: Survey data

In terms of educational achievement, out of 80 household heads, 47.5 % were illiterates (not attended any kind of education), 11.25% can read and write, 30 % had attended from grades one to six, 10 % had covered grades 7 to 10 and only one household head (1.25 %) attended beyond grade 10 (Table 11).

The survey revealed also that 69% were female illiterates while male illiterates which is 35%. This implies that women were not adequately accessed to education services than their counterparts as well as the illiterate agro-pastoralists who dominated the crop and livestock farming activities in the study sites.

Table 11: EDUCATIONAL LEVEL OF RESPONDENTS BY SEX

Education level	**Sex**		**Total**	**Percent (%)**
	Male	Female		
illiterate	18	20	38	47.5
Read and write	8	1	9	11.25
grade1-6	18	6	24	30
grade7-10	6	2	8	10
grade11-12	1	0	1	1.25
Total	51	29	80	100

Source: Survey data

4.2. Land holding

Similar to most highlands of the country, the size of landholding of surveyed agro-pastoralists was very small in the study area. In both districts, 51.2 % of agro-pastoralists cultivate between 0.5 and one hectare (ha) of land. Households who cultivate more than one hectare of land accounted for 30 %, while those cultivate less than 0.5 ha are 18.8 %. In surveyed sites of Kofele District, out of 50 households, 54 % of the householders cultivate between 0.5 and one ha, while 16 % cultivate below 0.5 ha and 30 % own more than one ha of cultivable land. In Kore study

sites, out of surveyed respondents, 46.7 % own from 0.5 up to 1 ha, 23.3 % own below 0.5 ha while 30 % hold more than one ha.

According to the Districts' Land Administration and Environment Protection Office's information (2011), the minimum and maximum size of landholding were 0.25 and 2.5 ha, the average being 1.05 ha. Reports at a Zonal level (Socio-economic profile of West-Arsi Zone, 2009) landholding size had indicted that 68% of households cultivate 0.1 - 1ha. The midland kebeles, Ekka Deyu, of Kore and Tulu Boke and Chatmena Kerensa kebeles of Kofele Districts relatively cultivate more than one ha of land, which is greater than the other kebeles (Table 12).

The majority (51.2%) of interviewed HHs indicated that the land they cultivate is insufficient to support their household. During the FGD at kebele level more than 80% of respondents suggested that the individuals' landholding size had shown a declining trend. This seems to lend evidence for what was projected by IUCN (1990). According to this report, the per capita landholding of the country is expected to decline from average of 1.76 ha in 1985 to 1.1 ha and 0.66 ha in years 2000 and 2015 respectively (IUCN, 1990 in Kassaye, 2004).

The agricultural land of the study areas had been potentially suitable for mixed farming. However, the land in midlands of Kofele is subjected to water logging during high rainfall in areas where the topography is flat and exposed to erosion where there are steep slopes. As the KI of Agricultural Extension staff revealed, the agricultural land is also in constant competition with grazing land as there is no balanced management through land use planning. Often it is argued that fragmentation has a negative impact on the intensity of management of the land which in turn has influence in the productivity and degradation status of land (Woldeamlak, 2003).

Table 12: SIZE OF FARM LANDHOLDING OF RESPONDENTS

District	Kebeles	Size of land and No of respondents			Total Respondents
		less than 0.5 ha	0.5-1 ha	more than 1ha	
Kofele	Koma Bitacha	0	8	2	10
	Tulu Boke	2	3	5	10
	Gofingira Gurmicho	6	3	1	10
	Hulebera	0	8	2	10
	Chatmena Kerensa	0	5	5	10
	Total	**8 (16%)**	**27 (54%)**	**15 (30%)**	**50 (100%)**
Kore	Doda Dayu	4	5	1	10
	Ekka Dayu	2	3	5	10
	Gofingira Chocha	1	6	3	10
	Total	**7 (23.3%**	**14 (46.7%)**	**9 (30%)**	**30 (100%)**
Total		***15 (18.8%)***	***41 (51.2%)***	***24 (30%)***	***80 (100%)***

Source: Survey data

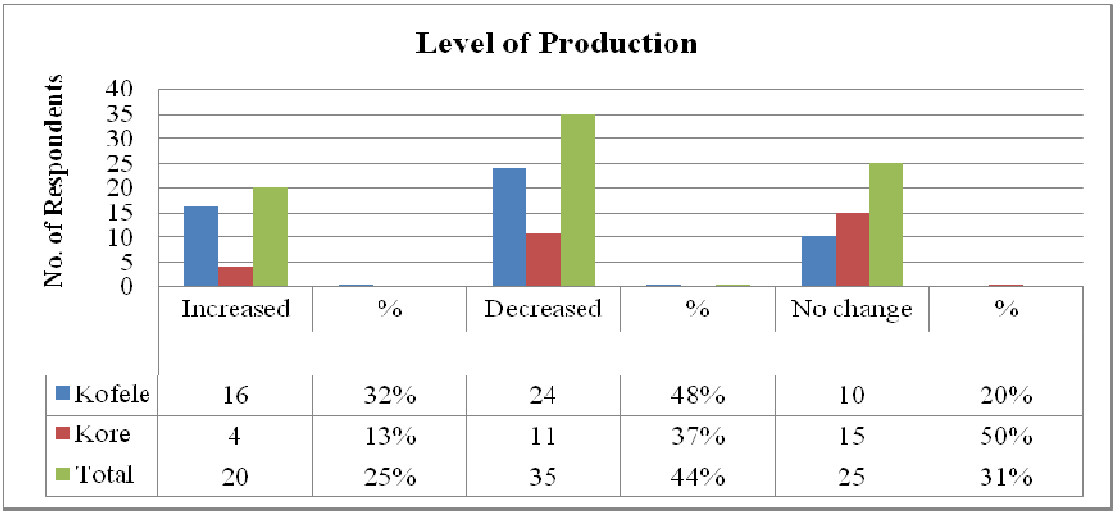
4.3. Means of livelihood

Crops and livestock productions are the key means of livelihood and the leading income sources for the majority of the community in the study areas. Petty trade and casual labor were also important sources of income in the surveyed kebeles. The major types of crops cultivated in the study districts and kebeles (villages) were cereals, pulses, vegetable and root crops. Enset and vegetables are cultivated especially in Kofele District. The major livestock type raised at both districts were oxen, cows and heifers, donkey and horses, sheep as well as chicken. The level of productions over the last five years was surveyed through household interviews. Accordingly, the majority of surveyed agro-pastoralists, which accounted 44 **%**, had stated that their production of crops and livestock had decreased. Among the 35 households who reported that

their production level had decreased, 69 **%** of agro-pastoralists were from Kofele, while 31 **%** were from Kore District. However, 25 **%** of respondents stated that their production had increased, while 31**%** informed that there were no changes on their production over the past five years (Figure 2).

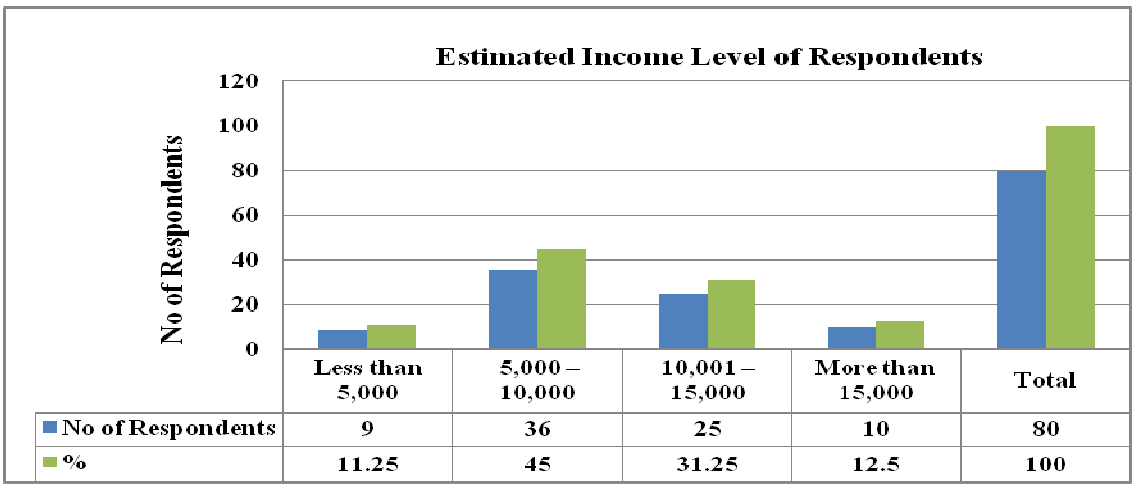
During FGDs, experts of NGOs and government offices elaborated that long term and variable pattern of changes in temperature and rainfall have dramatically affected the livelihoods of many resource poor members of the community, particularly through declining food security and problems with the viability of many livelihood activities, including livestock rearing, and the use of forest products on top of crops production. The other effects include increases in urban food prices and greater problems with services such as water supply and sanitation that affected the urban poor. The frequent climate change patterns, and especially the increased frequency and/or severity of extreme events has increased vulnerability to natural disasters. As the figure indicated in Kore District, the majority (50%) of HHs who reported "no change" on production level were not as such affected by climatic factors.

For the question regarding the annual income earnings of surveyed respondents, 12.5 % of HHs had earned more than Birr 15,000.00, while 11.25 % earned less than Birr 5,000.00. The majority of the respondents who earned between Birr 5,000.00 and Birr 10,000.00 accounted to 45 % and those who had earned between Birr 10,000.00 and Birr 15,000.00 accounted to 31.25 % in both study districts. The income reported by surveyed agro-pastoralists could not be sufficient to sustain their livelihoods especially for those with large family sizes (Figure 3).



	Increased	%	Decreased	%	No change	%
Kofele	16	32%	24	48%	10	20%
Kore	4	13%	11	37%	15	50%
Total	20	25%	35	44%	25	31%

Figure 2: Level of crop production of study Districts
Source: survey data



	Less than 5,000	5,000 – 10,000	10,001 – 15,000	More than 15,000	Total
No of Respondents	9	36	25	10	80
%	11.25	45	31.25	12.5	100

Figure 3: Approximate level of annual income of respondents from crop and livestock production
Source: survey data

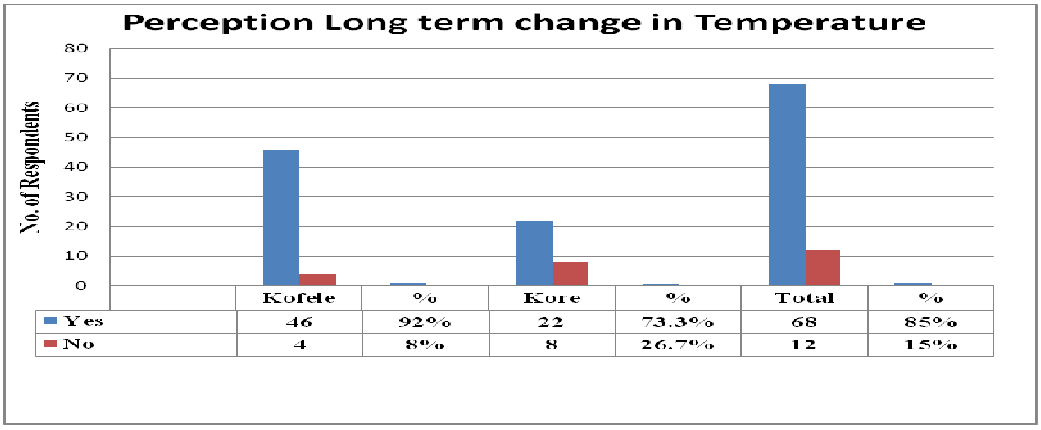
4.4. Agro-pastoralists' Perception on local climate change

Respondent's level of awareness and perception to the local climate change was assessed in the study sites of Kofele and Kore districts. Farmers'/agro-pastoralist households' perceptions and understanding of climate change have significant importance in their livelihood adjustments and adaptations to climate change. Cognizant of this importance, the HHs were asked whether they perceived long-term climate changes in temperature and rainfall.

When Agro-pastoralists' responses on whether there was a long-term change in the temperature over the 20 years period were categorized as Yes and No, the majority had realized that there is a change in temperature. They were also asked whether or not there was a long-term change in the amount and distribution of rainfall over the past 20 years, the majority of surveyed Agro-pastoralists stated that they had perceived a change.

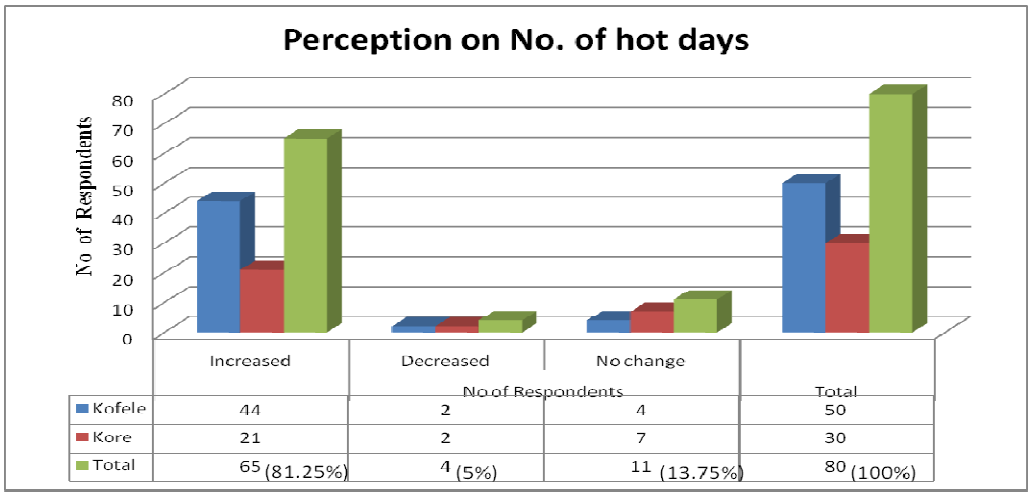
Accordingly, majority of the HHs perceived that there is a change in the climate, where the level of precipitation was sometimes lower and sometimes higher in the study kebeles of both districts. For the question asked about the long-term changes in temperature over the last 20 years, 85 % of HHs replied as "Yes", that there was long term change in temperature, while 15% replied as "No" that there was no change. With regard to the long term changes in the amount and distribution of rainfall, 70 % of HHs responded as "Yes", that there is a long term change, while 27.5 % of HHs said "No", there is no change and 2.5% of respondents replied that they didn't know about the changes.

For the question on describing the situation of increase in temperature and rainy days, the majority of respondents (81 %) replied that there was an increase in temperature over the past 20 years and 51 % of respondents stated that there was a decrease of rainy days over the past 20 years. Besides, 14 % of respondents also answered that there is no change with regard to hot times and 22.5 % replied that there was no change on the situation of rainy days over the past 20 years. Out of 65 respondents, 67.7 % from Kofele and 32.3 % from Kore districts had witnessed that the hot days have increased. On the other hand, out of 41 respondents, 71 % from Kofele and 29 % from Kore had perceived that the rainy days have decreased (Figures 4,5,6,7).



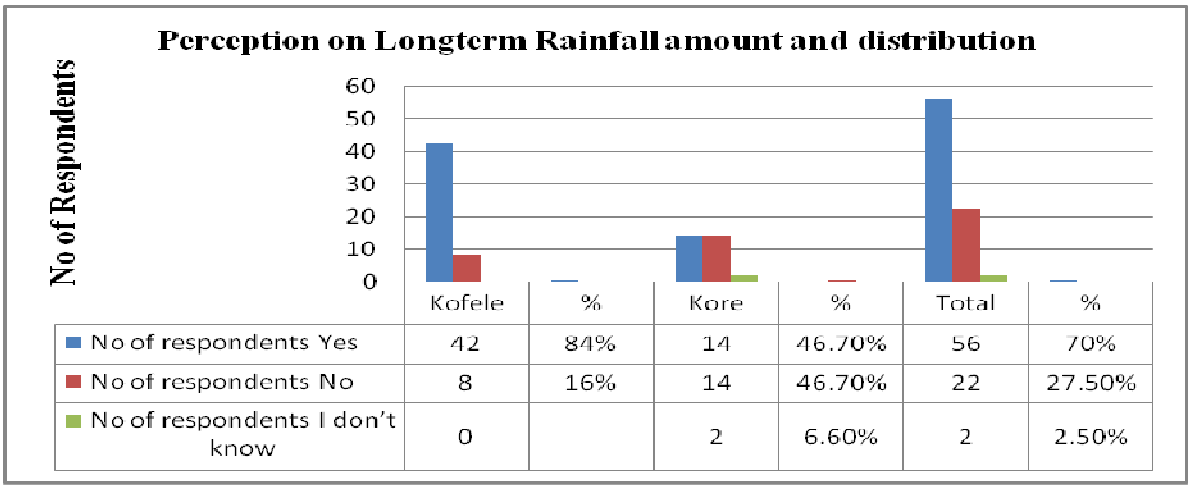
	Kofele	%	Kore	%	Total	%
Yes	46	92%	22	73.3%	68	85%
No	4	8%	8	26.7%	12	15%

Figure 4: Perception of HHs on long term changes in temperature



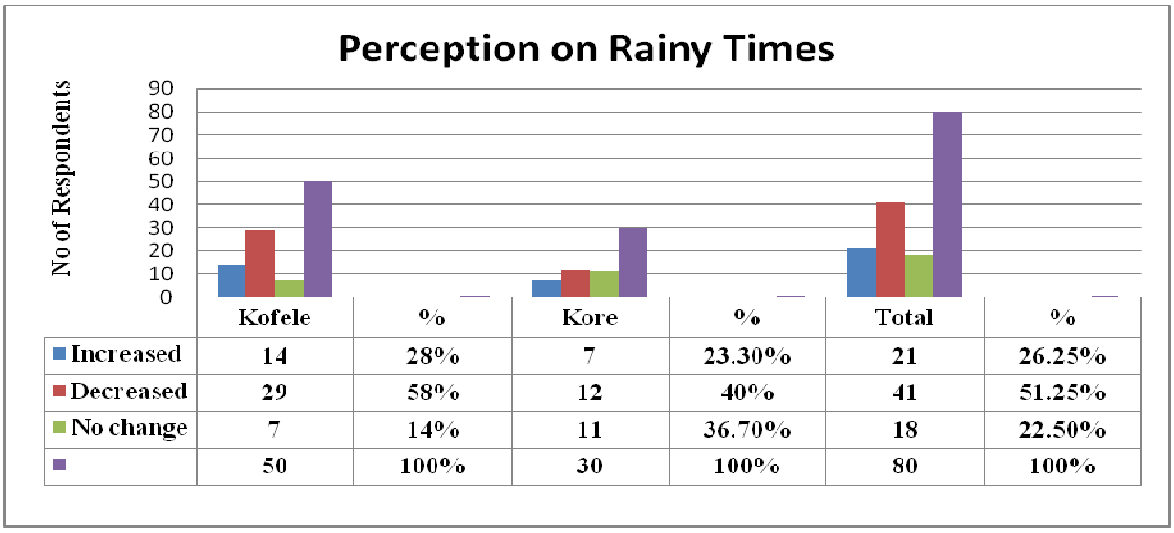
	Increased	Decreased	No change	Total
Kofele	44	2	4	50
Kore	21	2	7	30
Total	65 (81.25%)	4 (5%)	11 (13.75%)	80 (100%)

Figure 5: Perception of HHs on Number of hot days



	Kofele	%	Kore	%	Total	%
No of respondents Yes	42	84%	14	46.70%	56	70%
No of respondents No	8	16%	14	46.70%	22	27.50%
No of respondents I don't know	0		2	6.60%	2	2.50%

Figure 6: Perception of HHs on the amount and distribution of rainfall



	Kofele	%	Kore	%	Total	%
Increased	14	28%	7	23.30%	21	26.25%
Decreased	29	58%	12	40%	41	51.25%
No change	7	14%	11	36.70%	18	22.50%
	50	100%	30	100%	80	100%

Figure 7: Perception of HHs on situation of rainy times

Follow up questions were raised in order to assess agro-pastoralists level of understanding and knowledge of climate change. The result had indicated that surveyed agro-pastoralists had basic knowledge of climate change as the majority of agro-pastoralists heard about climate change from different sources (including the media) and few of them have very little understanding.

Accordingly, when asked about how they know regarding climate change, 47.5 % have been informed about climate change from Extension Workers, while 25 % knew from the media (radio). However, 16.3 %) stated that they became acquainted with climate change through training and workshops organized for the target community at the study sites, whereas, 11.2% knew about climate change from kebele leaders at both districts (Table 13).

Table 13: RESPONDENTS' SOURCE OF INFORMATION ON CLIMATE CHANGE

Study areas	No. of Respondents and Sources of information				
	From extension workers	From kebele leaders	From media (radio, etc)	Training/ workshops	Total
Kofele	**24 (48 %)**	**6 (12 %)**	**12 (24 %)**	**8 (16 %)**	**50**
Kore	**14 (46.7 %)**	**3 (10 %)**	**8 (26.7 %)**	**5 (16.6 %)**	**30**
Total	**38 (47.5%)**	**9 (11.25%)**	**20 (25%)**	**13 (16.25%)**	**80**

Source: Survey data

During the FGD, participants were asked to explain whether there was an event of climate change in their zone or districts. Almost all had replied that there was a change in the climate. For example, in the year 2010/11 there was a prolonged rainfall pattern in Kofele and Kore Districts. This resulted in the reduction of crop yield and loss of quality. Because of the loss of the quality of wheat and barley, the market price of these crops went down drastically. To fill this gap the agro-pastoralists were forced to sell their livestock which in turn led them to lose their assets. As climate change exhibits in different ways, in different parts of the districts, the FGD revealed that, the most common feature of climate change evidences are either late or early on-set of rainfall in a prolonged ways.

In Kofele District in 2005/06 and 2007/08, the late on-set and shortage of rainfall than usual occurred and affected both livestock and crops of the agro-pastoralists. The average productivity

of the major crops in the area, wheat and barley, was recorded very low and on some smallholders' farms it was almost nil. With regard to livestock, due to shortage of feed and untimely disease occurrence both milk and beef production was reduced significantly. As a result children and elderly segments of the community were affected severely. In some cases loss of livestock was observed. Over the years, the communities were not in a position to send their children to schools because of lack of income to cover school fees and related expenses.

During the KI interview, participants were asked to explain whether they experienced any climate changes in their life time and the type of climate shock they encountered with, they pointed out that there was early or late on-set of rainfall and early or late cease of rainfall with low or high level of intensity. However, they had faced severe shortage of rainfall during the "Belg" season in 2010/11, which subjected them to loss of planted potatoes and maize crops. Usually potato is produced during the "Belg" season to bridge the food shortage gaps that prevailed in the main cropping season.

One of the Key Informants, Sheik Mohammed Yahya (age 58) from Tulu Boke kebele, had informed that he experienced the variability of the rainfall and remembered that he lost all his cultivated food and pasture crops due to water logging as a result of heavy rainfall, and due to shortage of rainfall in the Belg season of the year 2010/11 forced him to sell his livestock to sustain the family. There were some observations and expression of study participants on the manifestation of rainfall change.

Among the kIs, one elder's expression in Chatemena Kerensa kebele about the changes in rainfall over the past 20 years was as follows:-

“Prolonged dry season is not a new phenomenon to our area but the frequency used to be three or four years but now encountered after every one or two years and even less than that. The amount and distribution of rain has been reduced and erratic in nature. For instance, “Meher” season used to be for four months (June to September), but since 2005/06 it has been irregular and unreliable and abnormally decreased and it is also in similar condition to the short rainy season or “Belg”, which was not common in our area”.

Elders in Ekka Dayu kebele have expressed by saying, “The starting and ending period of rainfall season has become uncertain and severely challenging our livelihoods”. FGD participants in Kore District have stated, “some years back, the “Belg” rainy season used to start in March (even late sometimes), but now it starts late in April and even some years with little or no “Belg” rain. It no longer become reliable. Such trends come once in four years. The main rainy season (Meher) used to end on September, but now it ceases at the end of August or first week of September and it has become difficult for the existing varieties of crops to mature”.

Besides, KI in Kore District had reported that deforestation has been increasing over the last 30 years. The causes include death of trees due to lack or shortage of rainfall, absence of natural resources management, unwise cutting of trees for fuel, clearing of additional farmland, increase of construction, lumbering and overgrazing. The KI had also expressed that the process of deforestation has been more in the highland areas due to increase in size of population, scarcity of farmlands, which has aggravated the clearing of trees for farming activities.

4.5. Analysis of meteorological information on rainfall and temperature

4.5.1. Rainfall data analysis over Kofele study areas

One of the meteorological information stations is located at Kofele district, which most likely represent the Kore district, which has no a meteorology station. Kore is located about 20kms and was one of the administrative units under Kofele. The main rainy season for Kofele and Kore districts is during June to September (Meher), and the second short season, depending on the altitude, is between January and March (Belg) which contribute significantly for its annual rainfall. The districts have one/two distinct dry periods, October to December and January to May.

In Kofele district, the rainfall pattern has changed either decreases or increases in amount and frequencies. While there were years of short but heavy rainfall seasons and there occurs also long dry seasons. According to the climatic data collected from NMSA, the 26 years' (1985 – 2010) average annual rainfall was 1037.7 mm for Kofele. As analysis made from NMSA monthly climatic data, within the same period, the average rainfall for the peak months of July and August was 125 mm per month, while for the short rainy months of February and March, the average monthly rainfall was 81 mm per month.

The surveyed HHs felt that the trends of rainfall were decreasing while temperature was increasing for the past two decades, As the rainfall data for some months of the reported years were missing, it is difficult to see that exact trend in the amount of rainfall during the reported years. As the climate data obtained from National Meteorology Service Agency had revealed there were uneven distribution of rainfall throughout the years between 1985 and 2010. The

amount of rainfall had increased from 1986 to 1988 and from 1990 to 1992. The highest amount of rainfall was recorded in the years 1992 (1807.9 mm) and 1993 (1537 mm). On the other hand, the trend of the rainfall amount was decreasing from the year 2006 to 2010. These were the years when better monthly rainfall data was registered, while there are more or less missed data for the other years. Nevertheless, the data presented in figures 8 and 9 below shows there was a decreasing trend in the amount of rainfall (NMSA, 2012).

The rainfall data analysis was made on annual basis but agro-pastoralists perception is basically related to rainfall (cropping) seasons as their main concern is whether it is sufficient for crops to grow. The study has also witnessed that the total amount of annual rainfall was in a decreasing trend, and rainfall seasons were getting shorter (late start and early cease) but sometimes with heavy torrential and erratic rainfall. The majority of agro-pastoralists have perceived that rainfall was decreasing at the study sites and the analysis on the amount of annual rainfall data over two decades had shown also a decreasing trend with visible variability. In general, both “Belg” and “Meher” seasons rainfall were highly variable, which is in agreement with the general trend throughout the country (Table 14).

Table 14: MONTHLY RAINFALL DATA IN MM FOR THE YEARS 1985 – 2010

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Total**
1985	17.5	18.3	81.2	175.8	121.3	128.5	x	x	x	x	x	x	**542.6**
1986	4	129	84.1	199.3	104.2	147.2	135	160.8	175	119.2	24.3	24.6	**1306.7**
1987	25	68.9	199.9	126.7	160.7	64.5	77.2	283	129.3	156.6	5.1	11.7	**1308.6**
1988	61.5	90.1	67.5	126.1	88.3	191	193.7	235.1	195.6	138.5	2.9	7.5	**1397.8**
1989	0	0	0	0	0	0	95.1	177.5	151	80.9	74.1	122.1	**700.7**
1990	13.2	61	138.6	171.7	144.8	113.4	145.1	117	121.3	51.7	28.9	15.8	**1122.5**
1991	14.4	106.5	174.5	64.3	161.2	72.9	105.6	194.2	177.9	11.7	29.3	61	**1173.5**
1992	87.3	168.2	113.4	203.5	127.4	106.3	178.6	281.8	216.7	92.7	146.5	85.5	**1807.9**
1993	87.9	61.6	64.3	164.2	292.9	106.2	196	131.4	203.6	190.5	37.6	0.8	**1537**
1994	0	0.6	91.6	107.8	133	x	146	130.3	160.9	15.3	9.3	20.1	**814.9**
1995	0	x	79.8	300.7	75.2	84.5	x	152.3	104.6	58.8	7.8	87.8	**951.5**
1996	137.8	34.4	204.9	244.6	133.9	x	182.1	x	x	78.5	45.4	x	**1061.6**
1997	60	8.2	160.9	188.5	104.4	190.2	83.4	190.4	x	288.5	x	15.4	**1289.9**
1998	80.4	62.9	x	x	x	x	75.3	96.6	167.4	127.8	46.1	6	**662.5**
1999	24.4	0	113.8	114.5	181.6	184.6	207.1	126	234.7	x	0	1.8	**1188.5**
2000	0	0	0	201.1	x	x	102.7	116.4	232.2	x	40.8	48.9	**742.1**
2001	8.6	50.3	198.2	x	161.4	122	92.7	111.7	101.7	158.9	22.2	24.4	**1052.1**
2002	63.6	41.2	194	79.6	105.2	101	116.3	167.1	118.1	x	x	x	**986.1**
2003	36.8	26.6	206.2	x	x	189	x	130.7	213	86.7	28.7	x	**917.7**
2004	61.3	15	x	x	x	x	114.3	x	x	x	x	x	**190.6**
2005	35.2	16.1	134.6	163.1	x	83	93.3	149.1	101.7	92.9	x	25.6	**894.6**
2006	12.2	75.6	213.3	120.1	152.9	104.2	158.3	121.6	129.3	89	10.9	28.2	**1215.6**
2007	48.2	87.6	179.7	165.5	142.1	79.6	95.4	144	138	48.3	12.5	x	**1140.9**
2008	5	14.2	40.7	45.8	238.2	152.7	91.3	131.1	143.1	129.9	77.4	0.7	**1070.1**
2009	79.2	28.7	76.5	62.8	47	97.5	93.3	173.5	127.2	108.9	11.3	196	**1101.9**
2010	53.4	87.4	98.8	144.3	132.4	95	94.7	97	x	x	x	x	**803**

Source: NMSA, September 2012

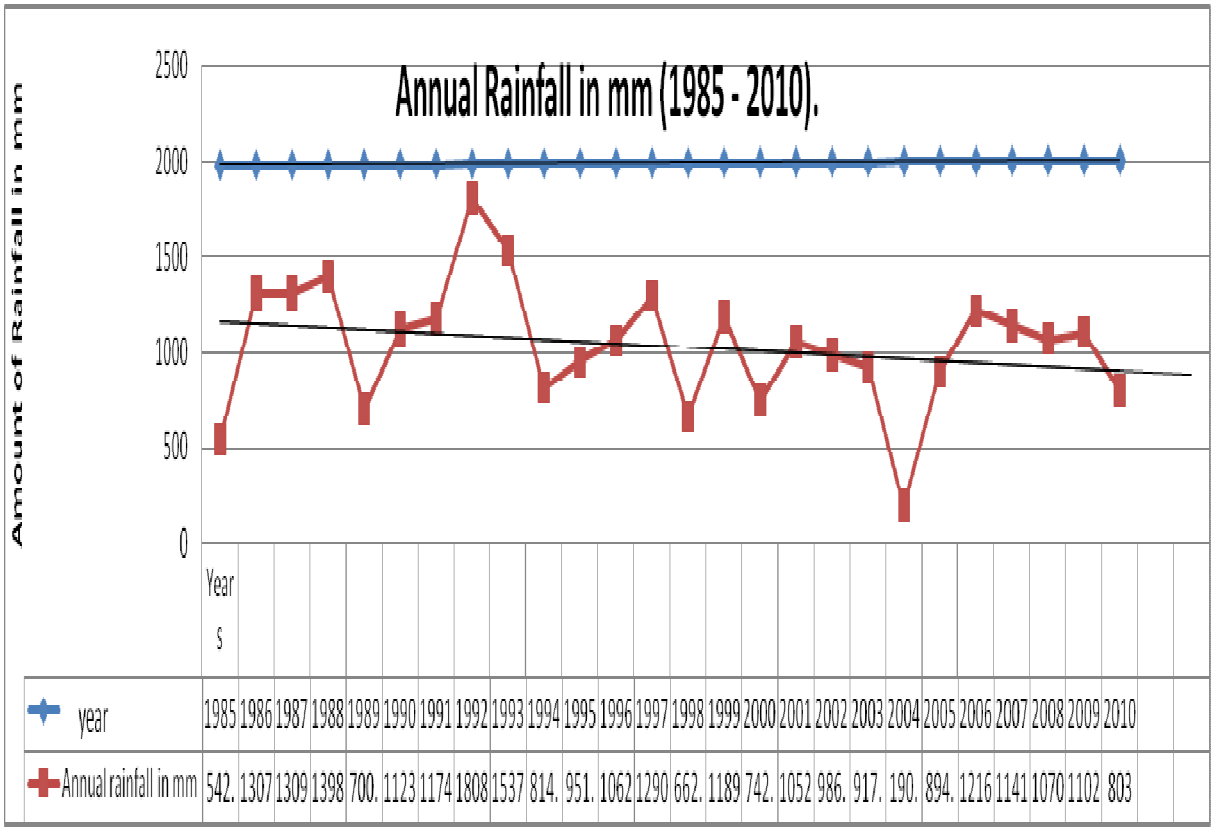


Figure 8: Annual Rainfall Trend at Kofele.

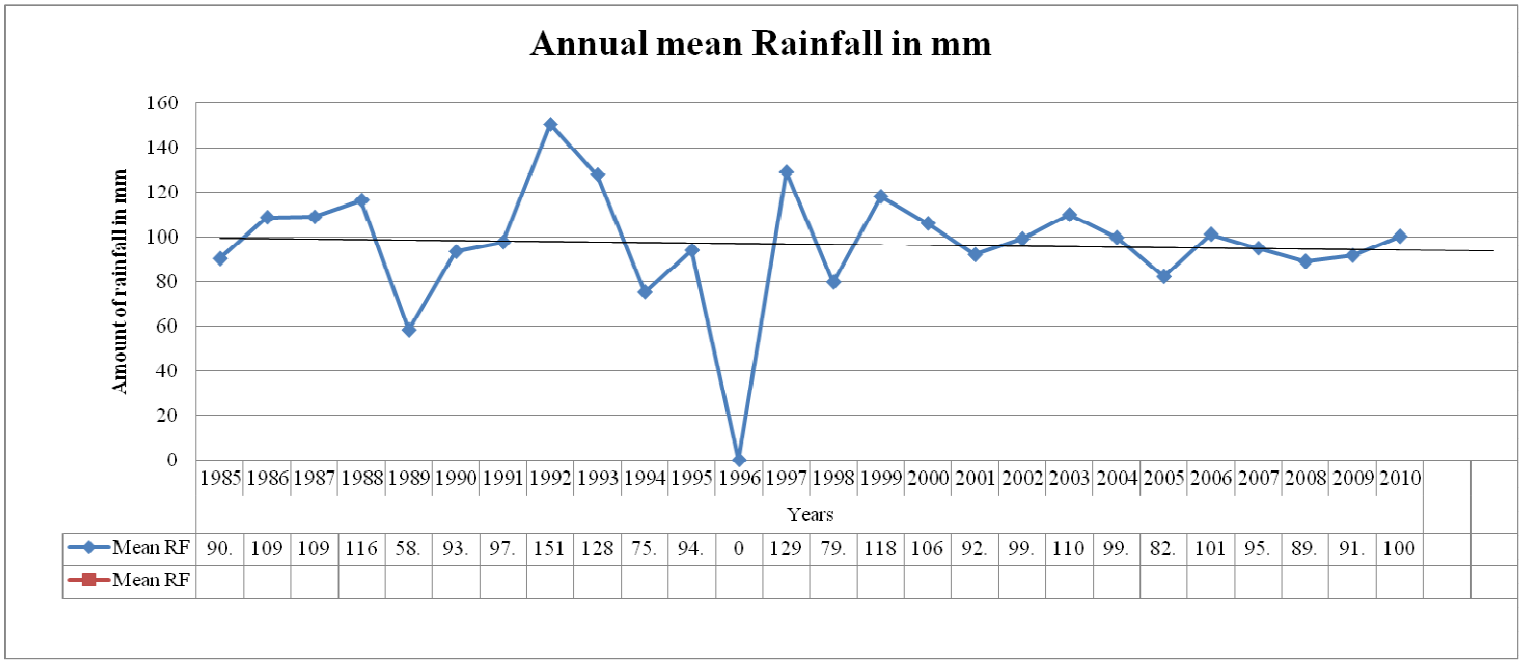


Figure 9: Annual mean rainfall at Kofele

4.5.2. Temperature data analysis over Kofele District

The monthly maximum temperature of Kofele District for the period 1985 to 2010, is shown in table 15. Since data for some months are missing, it is difficult to see the trend, but the monthly maximum temperature for the period had shown an increasing trend. Notably, the increase of maximum temperature pattern is consistent with the trends and scenarios for climate change in Ethiopia and also in harmony with the common worldwide climate changes which are consistently increasing over the years.

Besides, as the data for the last 26 years shows, there was a trend of increase in maximum temperature for Kofele, which was also in agreement with the surveyed HHs' perception in the area. However, the temperature has also decreased sometimes which for a moment had brought about frost and have an effect on crop production as some surveyed HHs and FGD participants had witnessed. Hence, analysis of the trend of maximum temperature and the perception of the majority of agro-pastoralists' on long term temperature are in line with the analysis of meteorological data on temperature (Table 15).

The monthly minimum temperature of Kofele is also presented for the period 1985 to 2010. As indicated in table 16 and figure 11, the average minimum temperature had shown a decreasing trend, although the data for some months are also missing. According to NAPA, the averaged annual mean minimum temperature throughout the country indicates an increase of 0.37^0C every decade (NAPA of Ethiopia, 2007). In contrary with this, a decreasing trend of monthly mean minimum temperature was observed over Kofele, which was not in line with the trend in the maximum temperature as well as with the overall prediction of temperature trend in the country (Table 16, Fig. 11)

Table 15: MONTHLY MAXIMUM TEMPERATURE DATA IN ^{0}C (1985-2010)

Year	Months											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1985	22.1	21.7	22.5	19.2	20.3	19.2	x	x	x	x	x	x
1986	21.2	20.8	20.1	18.7	19	17.3	16.5	17.2	18.5	19.5	20.5	20.4
1987	20.7	21.6	20	20.4	19.6	18.6	17.6	17.2	19.1	19	20.1	21.1
1988	20.7	21	21.6	20.2	19.6	17.3	16.1	16.6	18.1	18.2	19.4	20.6
1989	19.7	19.9	20.6	18.3	18.9	17.4	15.8	16.9	17.5	18.7	19.3	18.8
1990	19.6	20.1	x	x	x	19.3	18.5	17.7	19.4	19.7	20.5	20.7
1991	21.7	21.6	20.8	21.2	21.3	20.3	18.6	19.3	19.4	20.5	20.7	20.9
1992	21.1	20.8	22.4	21.1	20.6	19.3	19	18.4	18.9	18.2	19.4	20.2
1993	19.3	19.9	22	20.1	19.3	18.5	17.9	17.6	18.3	18.6	19.4	20.9
1994	22	23.2	22.8	21.1	19.8	18.8	17.7	18.7	19	19.4	20	20.9
1995	22.3	22.2	22	20.4	20.8	20.5	17.8	18.4	19.7	19.3	21.2	20.8
1996	20	21.9	21.5	20.1	20.2	18.3	19	18.9	19.5	20.1	20.5	20.8
1997	21	22.2	22.9	19.4	20.6	19.7	18.8	18.3	x	19.8	x	20.1
1998	20.6	22	x	x	x	20.4	19.3	19.2	19.4	19.1	19.7	20.4
1999	21.2	23	20.7	21.1	22.3	20.4	18.7	19.2	20.3	19.7	20.7	21.2
2000	21.9	25	26.3	22	18.7	18.3	17.4	16.8	17.9	18.2	19.2	19.6
2001	19.6	21.1	20	x	19.4	17.6	17.1	17.3	18.4	18.7	18.9	20.2
2002	19.5	21.6	20.6	20.6	19.7	18.1	17.9	17.6	18.6	19.3	x	19.8
2003	20.2	22.7	22	20.7	20.8	18.4	16.8	17.3	18.3	19.9	20.1	18.8
2004	20.5	20.9	21.5	19.7	20.4	17.9	17	17.6	18.2	x	19.7	19.7
2005	20.5	23.2	21.6	21.4	x	18	17.3	18	18.8	19.3	x	19.9
2006	21	22.2	20.6	19.7	20.4	19	17.6	17.2	18.1	19.1	19.3	19.2
2007	20.1	21.1	22	20.4	20	17.9	17.2	17.1	18	19.3	20	x
2008	21.6	21.8	23.4	21.3	19.6	18.1	17	17.3	18.4	19.3	19.1	19.9
2009	20.4	21.5	23.3	21	20.9	20.1	17.9	18	18.8	19.7	20.6	19.4
2010	19.7	19.8	20.7	21.2	20	19.1	17.6	18	x	x	x	x

Source: NMSA, 2012

Table 16: MONTHLY MINIMUM TEMPERATURE DATA IN ^{0}C (1985-2010)

Year	Months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1985	5.3	6.5	7.1	8.7	9.1	7.9	x	x	x	x	x	x
1986	4.5	7	6.5	9.2	9	9.3	9	7.7	8	6.4	4.9	4.3
1987	5.2	6.9	8.9	8.4	9.1	9	8.7	8.4	7.9	8	5	4.1
1988	6	7.2	7.5	8.9	8.3	8.8	9.7	8.7	8.3	7.9	3.7	4
1989	5	5.8	7.8	8.8	7.7	8.1	9.1	8.1	7.9	6.7	5.7	7.8
1990	4.3	7.9	x	x	x	8.4	8.7	8.9	8.6	6.8	6.3	5.6
1991	6.8	7.9	9.1	8.4	9	9.6	9.9	9.2	8.2	6.3	4.9	5.4
1992	7.4	8.4	8.1	9	8.9	8.7	9	9.2	8.5	8.1	6.8	7.2
1993	7.3	8.1	5.8	9.2	9.5	9.1	8.8	9.3	8.3		8.3	6.4
1994	5.4	7.1	8.6	9.1	8.9	9.7	9.2	9.6	8.8	6.6	6.8	5.2
1995	5.8	7.4	8.5	9.8	8.3	8.9	9.4	9.7	8.8	7.9	5.5	6.1
1996	7.9	7.2	8.6	9	8.7	9.7	9.1	8.8	9.1	7.3	5	5.8
1997	7.5	5.8	8.9	9.1	8.1	8.4	9.6	9.7	x	8.4	x	7.8
1998	8.9	9.8	X	X	x	9.1	10.3	9.6	8.6	9	5.7	4.4
1999	5.7	6.1	8.7	8.3	8.3	8.3	9	8.4	8.5	8.6	5.4	5.2
2000	4.2	3.4	4.4	8.2	9.4	9.1	9	9.2	8.4	8.3	6.4	5
2001	5.8	5.7	7.8	X	8.8	8.6	8.5	9.1	7.7	7.4	5.5	5.5
2002	6.1	5.7	8.1	7.9	7.9	8.5	8.4	8.4	7.4	6.8	x	8.3
2003	6.9	7.3	8.1	9.3	9	8.7	9	8.2	7.7	7.6	6.8	6.2
2004	8.2	7	8	9.2	8	8.1	8.1	8.4	7.9	X	6.1	5.6
2005	6.3	7.6	8.7	9.2	9.2	8.7	9.1	8.7	8.5	7.3	x	3.4
2006	5.5	7.1	7.5	7.8	6.6	7.2	8.9	7.7	7.7	7.5	5.6	5.8
2007	5.5	6.7	6.7	8	8.4	8.1	7.9	7.4	7.1	5.8	4.3	x
2008	3.6	4.4	5.1	6.1	6.8	6.8	7	6.7	6.6	5.4	3.7	2.6
2009	3.7	4.3	4.8	5.8	4.5	5.5	5.3	5.4	5.5	4.5	2.2	4.5
2010	3.2	5.8	4.2	5.9	5.9	5.4	5.1	5.4	x	x	x	x

Source: NMSA, September 2012

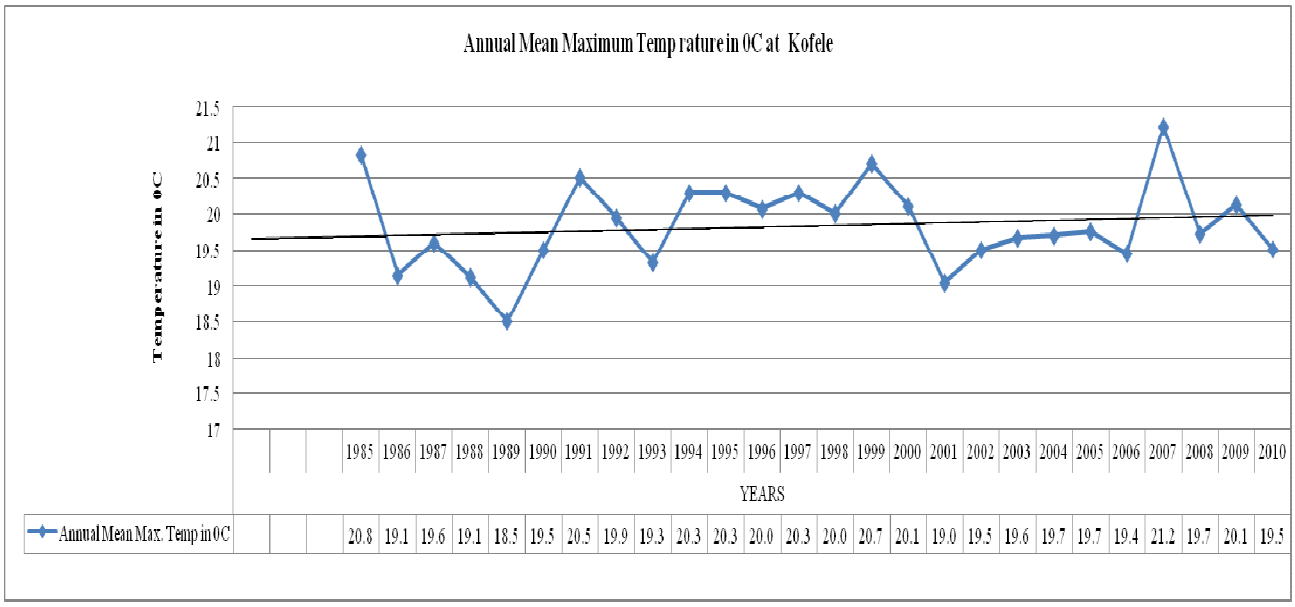


Figure 10 : Annual Mean Maximum Temperature Trend at Kofele

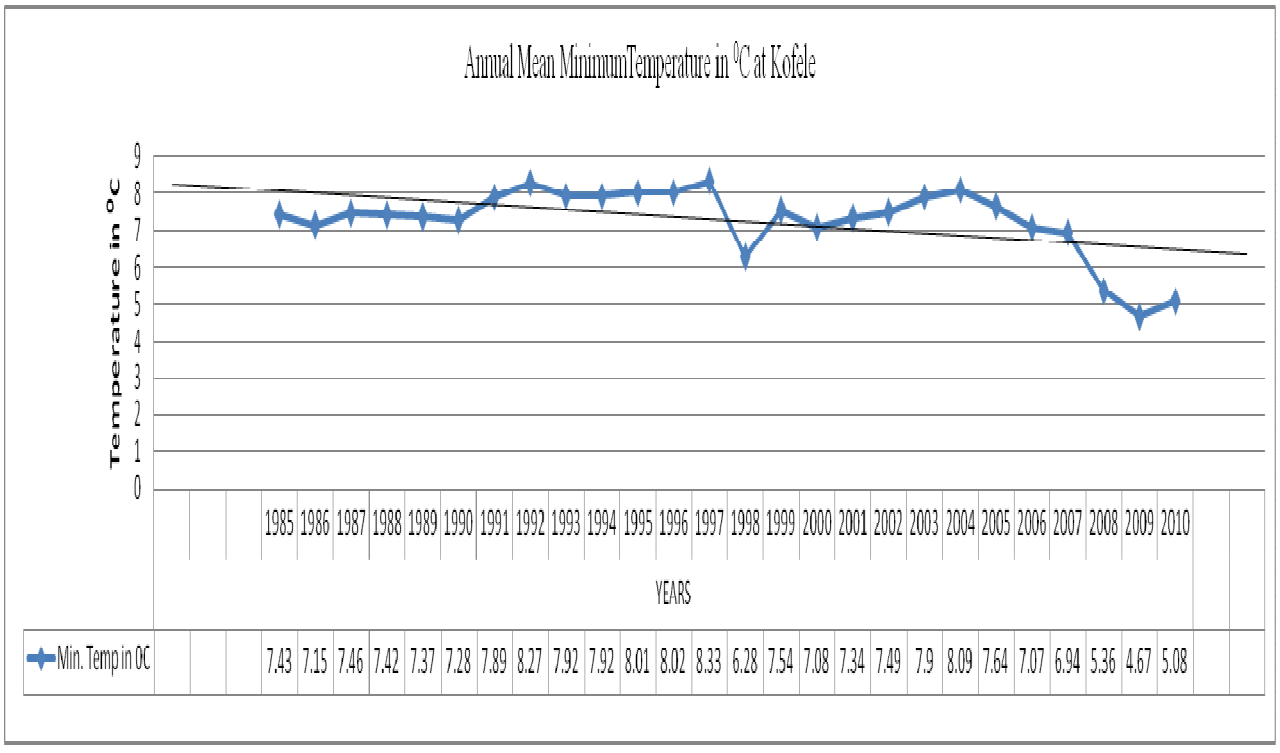


Figure 11 : Annual Mean Minimum Temperatutre Trend at Kofele

According to the information obtained from different FGDs, the timing as well as the type of climate change that took place in the eight surveyed kebeles of Kofele and Kore districts was similar even though the impacts as well as the responses depended on the objective situations that existed at each kebele. For example, up to 2005/06, the past seven years, the surveyed HHs of Ekka Dayu midland kebele in Kore District enjoyed favorable climate condition along with rainfall coming regularly and followed by timely dry season during which there was no problems as such of livestock as well as crop diseases of significant economic importance. FGD participants in that particular kebele, however, claim that climate change had taken place for a continued period up to this date. The climate change was reflected in terms of the length of the rainy and dry seasons, as well as in the intensity of the amount of rainfall received. For instance, in 2006/07, the rainfall continued from May to August, with intensity increased in September as the result of which about 80% of the crops were destroyed. This was followed by continued drought for seven months in 2007/2008, during which all springs and water points had dried up.

The KI from midland kebele of Chatmena kerensa in Kofele District stated that climate change has been well experienced since the last **six** years. In the previous periods, the normal "Belg" rainfall season used to be from February to the end of April, during which the land was ploughed and remained in the sun during the month of May, which was normally dry and sunny. The "Meher" season starts in June and end in September, with few showers in October. In year 2006, the rainfall during the "Meher" season was unfamiliar or unusual with too much rainfall, which left most of the land water logged. In the year 2007/08, however, there was very small amount of rainfall for a period of seven months that is up to the end of April, which was followed by heavy

rainfall in May 2008. In the year 2009, the rainfall was with a decreasing trend during the "Meher" season.

In Tulu Boke kebele of Kofele, one the KI had responded by saying that the past six years was full of disasters in the area. In 2006/07, there was long and heavy rainy season. As a result, the land became swampy and too much water logging. This was followed by a long dry season, the impact of which were low water level, drying up of rivers and springs. In the Kebele, the long dry season from January to May in 2007/08 was demonstrated in the low water flow level of Wabe River. There were also incidences of very low temperature with frost damaging crops early in the mornings.

4.6. Adaptation to climate change

4.6.1. Analysis of climate change adaptation options and factors

In Surveyed Kebeles of the districts, climate change of erratic nature took place during the last two decades. The effects of the climate change were almost similar with the severity depending on the actual situation and adaptation capacities of the agro-pastoralists in the study area. Low yields of crops, shortage of feed and water for livestock, death of livestock, pest infestation, shortage of food, prevalence of both human and crop diseases were the major impacts observed at the research sites.

The influences on the community in the study area were aggravated by population pressure, deforestation, landlessness, depletion of livelihood assets, lack of diversity of the Means of livelihood, etc. The majority of the respondents in the study sites are engaged in mixed farming

(crop and livestock production), which are highly susceptible to climatic factors and demand different strategies to cope and adapt to the frequent changes in the climate. Elaboration on possible adaptation options, the major factors that call for adaptation and the actual mechanisms used for the known climate changes will be assessed in an in-depth manner.

Agro-pastoralists in the study area were asked to indicate the possible options that they could apply in responding to long-term climate changes. All options were mentioned though there were overlapping of responses. Accordingly, in Kofele District all 50 agro-pastoralists stated the 10 options; thus, 70% of respondents indicated that they had agreed on options like changing crop variety and planting date, crop and stock diversifying, implement soil and water conservation methods and tree planting, construct water harvesting pools for irrigation and provisional migration, etc, which could be applied to respond toward long-term climate changes. However, 12% of respondents had disagreed for options regarding renting the land, change of production system and stock diversification. A good number (18 %) of respondents had expressed that they lack knowledge on the options, like selecting cattle breeds, change of production and stock diversification, provisional migration and changing date of planting crops, etc.

Similarly in Kore District all the sample households responded for the possible options; hence 73% of respondents pointed out that they have the same opinion on options concerning changing crop variety and planting date, crop and stock diversifying, implement soil and water conservation and tree planting, construct water harvesting pools for irrigation and engage on off-farm activities, while 9% of respondents disagree on options of renting the land, migration and change of production system, and 18% of responded that they don't know about options of

selecting cattle breeds, changing of production system and livestock diversification, etc (Table 17).

Table 17: AGREED OR DISAGREED OPTIONS TO RESPOND TO CLIMATE CHANGES BY HHs

	Kofele District			**Kore District**		
Options	**(a) disagree**	**(b) agree**	**(c) I don't know**	**(a) disagree**	**(b) agree**	**(c) I don't know**
1) Diversifying crops planting	2	45	3	-	30	-
2) changing date of seeding/planting	-	40	10	-	25	5
3) Changing crop variety	2	36	12	-	25	5
4) Changing production system a) livestock to crop b) **stock diversification** c) rearing shoats than cattle	8	27	15	5	10	15
5) Implement soil and water conservation techniques and tree planting	1	44	5	-	30	-
6) Selecting cattle breeds	1	29	20	-	12	18
7) Engage on off-farm work/activity	6	42	2	-	29	1
8) Construct local water harvesting scheme for irrigation	1	42	7	-	30	-
9) Renting the land	28	16	6	15	9	6
10) Provisional migration	10	29	11	7	18	5
Total	**59**	**350**	**91**	**27**	**218**	**55**
percent	**12%**	**70%**	**18%**	**9%**	**73%**	**18%**

Source: Survey data

Even though they have indicated the various options for responding to the climate changes and there are different factors that also necessitate for adaptation to climate change, the agro-pastoralists suggested a number of ways that they could take into account to react to the climate changes in their localities. When asked about other methods they could consider to respond to climate change, out of the total agro-pastoralists surveyed in Kofele and Kore districts, 21 HHs (26.25%) stated that they consider sale of animals, 17 HHs (21.3%) indicated that they believe in consuming less food and reduce meal frequencies, while 15 HHs (18.7%) responded by saying that they think borrowing in cash or in kind from their relatives within or outside of the locality and/or from non-relative neighborhoods to respond to and deal with the climate change

situations. Besides, 18 HHs (22.5%) had reported that they have no other mechanisms they might consider, while five HHs (6.25%) replied that they think about sale of their labour and 4 HHs replied to pray for Allah as another option in order to respond to climate change (Table 18).

Table 18: OTHER MECHANISMS CONSIDERED BY HHS TO RESPOND TO CLIMATE CHANGE

Study areas	Kinds of other mechanisms						
Districts	No other method	Pray to Allah	Borrow From relatives	Sale animal	eat less and reduce feed time	Sale labour	Total
Kofele	11(22%)	2 (4%)	10 (20%)	12 (24%)	12 (24 %)	3 (6%)	50 (100%)
Kore	7 (23.3%)	2 (6.7%)	5 (16.7%)	9 (30%)	5 (16.7 %)	2 (6.7%)	30 (100%)
Total	18 (22.5 %)	4 (5 %)	15 (18.7%)	21 (26.25%)	17 (21.3 %)	5 (6.25%)	80 (100%)

Source: Survey data

As indicated in the table the midland kebeles were highly considered sale of animals as other options to respond to climate change. In order to grasp the opinion of agro-pastoralists on the issues that demanded adaptation to climate change, the survey had identified the following variation in rainfall patterns or distributions (early or late on-set and cease) associated with frost and water logging, accounted for 23.75% of respondents, followed by deforestation and degradation of natural resources (21.25%), lack of awareness (15%) and lack of inputs (8.75%) were the major factors that call for adaptation to climate changes. The study had also indicated that 31.25% of respondents have no information or knowledge about the factors that could necessitate adaptation to climate change. Thus, lack of information/knowledge and awareness, variability of climate change, devastation of forests and degradation of land and related natural

resources, capacity limitation for accessing inputs were the major factors that necessitate adaptation to climate change (Table 19).

Table 19: RESPONSES ON FACTORS THAT NECESSITATE ADAPTATION TO CLIMATE CHANGE

Major factors	Kofele		Kore		Total	%
	Total	%	Total	%		
Lack Awareness	8	16%	4	13.3%	12	15%
Variation in rainfall pattern with water logging and frost	10	20%	9	30%	19	23.75%
Deforestation and degradation of natural resources	11	22%	6	20%	17	21.25%
No information or no knowledge	17	34%	8	26.7%	25	31.25
Lack inputs, small farmland, etc	4	8%	3	10%	7	8.75%
Total	50	100%	30	100%	80	100%

Source: Survey data

4.6.2. Adaptation Mechanisms to climate change

The agro-pastoralists employed a choice of adaptation mechanisms to deal with the problem and confront the concern of climate change in the surveyed study area. The agro-pastoralists in the surveyed kebeles used various adaptation strategies to climate change. In most of the kebeles, the strategies adopted were selling of animals, while some used migration to other locations including their animals fetching for feed and water. There were few individuals who diversified crops as their means of livelihoods to adapt to the climate changes that took place in the study area.

Climate change has also influenced negatively the means of livelihoods of agro-pastoralists in the surveyed area. Agro-pastoralists in the Kofele and Kore districts put into practice different

crop related and other methods as an adaptation mechanism in response to long term changes in temperature and rainfall. Accordingly, the interview result had indicated that 22.5% of HHs were engaged in sale of domestic animals, 15% carried out planting of different tree/seedlings, 12.5% used variety of crops, early planting and diversified crops and 12.5% had replied that they reduced feeding time and consume less food, 7.5% preferred petty trading and 16.25% had indicated migration to other places with their livestock (Table 20).

Table 20: RESPONSES ON ADAPTATION STRATEGY PRACTICED TO LONG TERM CHANGES (% OF RESPONDENTS)

Adaptation strategies	**Kofele**		**Kore**		**Total**	**%**
	Total	**%**	**Total**	**%**		
Tree planting	7	14	5	16.7	12	15
Crop diversification, early planting, use variety, crop rotation, etc	5	10	5	16.7	10	12.5
Reduce time and amount of food consumption	7	14	2	6.7	9	11.25
Migration	9	18	4	13.3	13	16.25
Petty trading	4	8	2	6.6	6	7.5
Sale animals	12	24	6	20	18	22.5
No strategy used	6	12	6	20	12	15
Total	50	100	30	100	80	100

Source: Survey data

As the above table indicated, in eight sample Kebeles of both districts, the major adaptation mechanisms used were selling of animals (further depletion of assets) and migration to other areas including their animals looking for feed and water. In Tulu Boke, for instance, about 90% of the HHs left the area looking for water and pasture and to relatives on the highland areas.

According to the information obtained from survey data, out of 13 HHs, 10 respondents from the midland kebeles of both districts preferred migration to other places as an adaptation mechanism to climate change than the highland kebeles.

Community participants in the FGD emphasized that the long-term changes in the climate has put crops and livestock production in a difficult situation and agro-pastoralists have not been able to adjust their livelihoods to the new phenomena. Some respondents were more in dilemma in that they lack knowledge on adaptation mechanisms. Some of the FGD participants also expressed and believed that climate change is the curse from Allah and they have no options to deal with the changes.

As KI elder from Tulu Boke Kebele in Kofele said, “people in our kebele were predominantly pastoralists for the last 20 years. We used to have large number of livestock and space to move for pasture and water. However, with the devastating and recurrent drought we lost our livestock assets and productivity has been much reduced. We are now forced to get engaged in crop production, and I don’t understand why we are called pastoralists as we are no more pastoralists”.

As the FGD groups in Kofele claimed, the community in Chatmena Kerensa and Tulu Boke were under government support. The HHs were given 15 kg/person of wheat, sorghum and maize three times. Some members of the community, who were unable to survive, left the area to look for alternative means of survival. Some other members had tried to sell the emaciated animals, but prices were very low. Some HHs also reduced their daily food consumption.

It was disclosed that some of the adaptation strategy used by the surveyed HHs was in turn led to further the negative effects of climate change. For instance, during FGD in Kore, the participants said, “To augment our means of livelihoods and overcome poverty, we cut down trees and sell them”. Sale of fuel wood by the poor HHs as an adaptation strategy used has brought a devastating impact on the natural vegetation of the area and the deprivation that led to the destruction of the environment thus aggravating the climate change.

There were also few individuals observed in the Kofele surveyed kebeles, who diversified their means of livelihood and adapt to the climate changes through cultivation of different types of crops. Few of the HHs has economically used their landholding around their homesteads for planting of different varieties of crops, especially vegetables for home consumption and income generation.

FGD participants were also asked about the mechanisms employed by the agro-pastoralist HHs to adapt to climate changes. The summarized information on the adaptation mechanisms practiced was as follows:-

- Seasonal migration/out migration, traditionally pastoralists move with their livestock from highly affected areas to less affected areas in search of pasture and water;
- Selling of emaciated animals;
- Reducing meal frequency, ask for support from parents, loan from relatives;
- Forestry development;
- Crop diversification, cultivating drought resistant crops, use of early maturing varieties, etc;

- Off-farm activities like petty trade, other income generating scheme as well as developing saving habit and experiences.

The discussion with KIs had also revealed that selling of livestock, jewelry, etc, reducing frequency of eating (meals), eating wild plants and migration to other areas, producing crops on hilly areas, use different crop varieties, engage in petty trading and ask support from relatives, etc. were the main mechanisms used to adapt to the climate change.

The findings of the study from quantitative and qualitative data has agreed with what was experienced throughout the country. The Ethiopian NAPA documents that traditional and contemporary coping mechanisms to climate variability and extremes in Ethiopia include changes in cropping and planting practices, reduction of consumption levels, collection of wild foods, use of inter-household transfers and loans, increased petty commodity production, temporary and permanent migration in search of employment, grain storage, sale of assets such as livestock and agricultural tools, mortgaging of land, credit from merchants and money lenders, use of early warning system and food aid (NMA, 2007).

The practice and perceived barriers of these adaptation mechanisms has been different across the study area. With reference to the reasons for not practicing adaptation measures to climate changes, it has been found that the respondents in the study area were compounded by numerous barriers that hindered them from exercising adaptation mechanisms to climate changes. Out of 80 respondents, 30% had claimed lack of money, 41.25% stated lack of information and 28.75% blamed shortage of agricultural inputs at Kofele and Kore districts as the main reasons that

restricted them from employing different adaptation mechanisms for the long term changes in the climate (Table 21).

Table 21: RESPONSES ON MAJOR BARRIERS TO ADAPT TO CLIMATE CHANGE

Study areas	Types of barriers and No. of HHs			Total
	lack of money	lack of information	shortage of inputs	
Kofele	15	21	14	50
Kore	9	12	9	30
Total	24	33	23	80
%	30%	41.25%	28.75%	100%

Source: Survey data

According to the respondents, the major constraint that confront their capacity for adaptation to climate change were lack of knowledge and information gaps associated with the know-how, poor economic status of households, shortage of inputs and farmlands.

In view of that, the household survey result had indicated that the majority of respondents, 36.25%, claim lack of information/knowledge, skill/technology and experience were the core limitations for their inability to adapt to climate change. The respondents also reported that lack of money, which accounted 27.5% and lack of agricultural inputs, which accounted to 25%, were among the other critical constraints that weaken their capacity for adaptation at both districts (Table 22).

Table 22: CONSTRAINTS FOR THE HHS' INABILITY TO ADAPT TO CLIMATE CHANGE

Constraints	Study areas		Total
	Kofele	Kore	
Lack knowledge, information, skill/technology and experience	19 (38%)	10 (33.3%)	29 (36.25%)
Lack inputs	12 (24%)	8 (26.7%)	20 (25%)
Lack of money	13 (26%)	9 (30%)	22 (27.5%)
Small farmland and low production	6 (12%)	3 (10%)	9 (11.25%)
Total	50 (100%)	30 (100%)	80 (100%)

Source: Survey data

The FGDs that was held at Kore and Kofele Districts also presented combination views of reasons as the most important constraints of agro-pastoralists that confronted their abilities for adaptation to climate change. Accordingly, lack of knowledge and awareness on adaptation mechanisms, shortage/lack of information and training, agric inputs to practice crop diversification, illiteracy, communication barrier to media, traditional and backward agricultural production methods, over-population, which as result increased deforestation for survival, explosion of landless youth, depletion of natural resources and occurrence of diseases, as well as lack of technical support from government were suggested as critical obstacles.

The FGDs that were facilitated with the staff of government offices and NGOs had also revealed that:

- The ever increasing population pressures associated with huge demands for alternative means of livelihood demands are very critical as issue of common concern in light of the current situation of natural resources;
- Shortage of farmlands and the fast emerging of the landless youth and the opportunity for labor

employment is rare in rural areas;

- Shortage of farm oxen and inputs during planting time, especially early maturing and drought resistant crop seeds coupled with lack of awareness about their uses on top of lack of financial resources for accessing improved seeds, fertilizer, cattle feeds, store facility, etc.
- Limited skills and financial support and credit access to engage and promote off-farm activities, and different kinds of business opportunities, as well as lacking access to up-to-date information about markets;
- Limited water resources development for HHs consumption and for irrigation in farms;
- Unwise encroachment of forest and other natural resources, especially cutting of trees for sale of fuel wood which lead to reduction of forest resources;
- Lack of knowledge/skills to adapt to the new climatic situations and farm communities have no access and knowledge about climate information and to forecast climate conditions in their areas, were among the important constraints that challenged agro-pastoralists to adapt to the frequent climate changes.

Bob Ewing (2009) explained that shortages of land as the single biggest constraint to adapting to climate change. Consequently, lack of information and credit as well as lack of labour, inputs, water and poor soils were also pointed out as other limitations.

4.7. Vulnerable groups

The study had identified that poverty is one of the major vulnerability factors in the surveyed kebeles. The vulnerability of members of the community depended on their wealth status and the level of impact on community members varied according to their wealth position. Based on livestock and land ownership of HHs, the community members are classified into three

categories. The rich who accounting to 10%, the middle class 30% and the poor 60% of the community. As reported during the FGD, several members of the community shifted from the rich to medium and the medium class to the poor, because of loss of livestock asset due to the 2007/08 long dry season. Consequent to the climate change, the rich is affected because of the deficit of livestock and the damage to crops. The middle class was also affected proportionately, but the poor who did not have much livestock and farmland depended for support on the rich was also affected severely, because such support was not available at their localities anymore.

As the study revealed, women headed HHs, children and elders as well as those who had large family size, small farm size and number of livestock were vulnerable and severely affected because of frequent or recurrent climate change. The main constraints on such deprived groups are lack of land, oxen, agricultural inputs and implements. Poor people cannot work on farm because of wealth problems, old age and the like.

Children, women and elders: The women groups were depressed by polygamy tradition, which is a deep-rooted in the study area and almost all have no power to decide and control over resources, which had also restricted their ability to employ adaptation mechanisms. In most cases women and children are not mobile compared to men who migrate from their resident area with their domestic animals to other areas to look for pasture and water, thus, during the harsh prolonged dry seasons women, children and aged members suffer a lot because of deprivation of food, water, medication services, etc. Within the HHs, as indicated by surveyed members, the situation of children and women was deteriorated as the management over the production and income continue to be a privilege of men household heads. At times of food shortages since most

of the income was mainly consumed by the household heads during market days for their amusement, children and their mothers usually pay the price of starvation. Elders are also the victims and face the burden of climate change severely due to their very weak capacity.

Landless:- The landless households are young married couples, depending on their parents for plots of land for cultivation. These members were not fully employed as they did not have land to work on and have no alternative means of livelihood to sustain their life.

During FGDs, participants were asked to explain the most vulnerable groups affected by effects of climate change and those community members unable to adapt to climate changes. As a response, they suggested that the poor, including children, women and the elderly, the landless youth were more vulnerable due to inaccessibility of land and other means of production, unavailability of enough food including nutritious food like milk, butter, meat, egg, etc and lack of either economic or physical capacity to resist and adapt to climate change. Those who depended only on mono-type crop or depended only on crop production are more affected by climate change. Economically, poor agro-pastoralists were also unable to adapt to climate change as they have no other means of livelihood except crop farming and raising livestock, mostly without significant yields. The FGD participants were also asked about government intervention and supports made to solve the problems and to improve the adaptation measures to the changing climate challenges. Accordingly, it was stated that the government supplied food aid and sometimes early maturing seeds after the problem happened, while NGOs tried to support technically and materially, especially, on-farm crop diversification, introduction of off-farm activity and awareness raising. Moreover, development of backyard vegetable farming was initiated which was not known before in the area. There were also supports in relation to

selection of crop varieties and their planting season, organizing the community into different types of associations or groups, awareness raising and training at village level, tree planting coordinated by Zonal and districts of ARDO and Land and Environment Protection Offices.

To the question of solving the problems and understanding the future required actions towards enhancing their adaptation mechanisms to climate change, the majority (32.5%) of agro-pastoralists had stated that technical and financial supports, including credit and improved agricultural technologies and input supplies, market facility, etc. are required from the government, NGOS, etc, while 27.5% had expressed that capacity building in terms of awareness creation, education and training have to be carried out, and 17.5% had suggested that engaging in forestry development and soil and water conservation program have to be performed, and 13.75% had reported that access to water resources for irrigation development and domestic consumption is very necessary. However, few, 6.25% of agro-pastoralists stated that they have no idea, while the rest 2.5 % had indicated that praying to Allah has to be done to increase their adaptation mechanisms and to respond to the changing climate (Table 23).

Table 23: ACTIONS SUGGESTED TO ENHANCE ADAPTATION MECHANISMS

Districts	No Idea	Access to irrigation/water harvesting structures	Capacity building-awareness, education, training	Technical and financial support (credit, input supply, market facility, etc) from government, NGOS, etc	Pray to Allah	Engage in forestry development and soil and water conservation	Total
Kofele	5	5	13	15	2	10	50
Kore	-	6	9	11	-	4	30
Total	5	11	22	26	2	14	80
Percent	6.25%	13.75%	27.5%	32.5%	2.5%	17.5%	100%

Source: Survey data

The focus group discussants at Kofele and Kore districts had also suggested different mechanisms that agrees with the responses of the surveyed households. Accordingly the major points raised to enhance adaptation mechanisms of agro-pastoralists were:

- Repeatedly work on awareness raising issues using different channels like schools, churches, mosques, public meetings, market days, mass media, etc.
- Employing watershed management strategy and strongly work on water and soil conservation practices, sustainable forestry development and mitigate deforestation practices at all levels;
- Introduce small scale irrigation in areas where possible, improve market infrastructure, including roads and storages, etc.
- Introduce and supply new varieties of productive crops into the area, such as lentils, linseed and chick-peas;
- Organizing landless and unemployed youths into groups through small and micro-development enterprises and linking them with saving and credit and micro-finance institutions, as well as, introduction of off-farm income generating activities;
- Promoting compost and artificial insemination and veterinary clinics constructed.

In almost all study sites, climate change knowledge and understanding (know how) has been substantiated as a very crucial instrument for adaptation to climate changes.

IFPRI (2007) has reported that awareness and basic understanding of climate change increases the opportunity for use of adaptation strategies. Agro-pastoralists who have basic knowledge and understanding of changes in climatic conditions have higher chances of using adaptation strategies in response to observed changes. In this study, understanding of climate changes can

be cited as a significant factor for use in crop diversification, including change of varieties and planting dates, water harvesting schemes, finding different options for means of livelihood, etc.

The key informant from Kofele District Land and Environment Protection Office and NGO (ROBA) had suggested that working on awareness raising and building knowledge is of paramount importance to the community towards organizing themselves into cooperatives, micro-enterprises, to access credit from micro finance institutions for alternative livelihood opportunities, such as getting engaged in watershed development and management activities, including small-scale irrigation, in forestry development and soil and water conservation works.

4.8. Implications

The adaptive capacity of a community is its ability to adjust to climate change, to restrain or cope with the effects, and to take advantage of the opportunities. Adaptive capacity is often determined by a range of factors, processes and structures such as income, literacy, institutional capacity, social networks, as well as access to information, markets, technology, and services, (IPCC 2007).

Raising awareness and understanding of climate change among agro-pastoralists would have greater impacts in increasing adaptive capacity of agro-pastoralists. It is, thus, important for the Ministry, Bureaus, Offices of the Agriculture and Rural Development, Environment Protection, Water Sector, etc at the Federal, Regional, Zonal and Districts level, NGOs and other actors involved to raise awareness of the change through appropriate educational and context specific

communication channels that are within the reach of the agro-pastoralists. Awareness raising education should also be accompanied by the various crop and livestock management practices that agro-pastoralists could take up in response to predicted changes in climatic circumstances. The majority of the respondents (59%) at the study area was illiterate and at a level of only read and writes. Different researchers, Deresa et al (2008), Yusuf et al (2008) had reported that education increases the probability of adapting to climate change. Hence, improving the education level would be very significant to adapt and use of improved technologies, irrigation and tree planting as adaptation strategies to climate change.

Access to climate information significantly increases the possibility of using adaptation measures in response to climate change. The majority of agro-pastoralists have got access to climate information from Extension Agents (47.5%), and a good proportion have accessed from radio (20%). Agro-pastoralists who have access to climate information have better chances to be aware of changing climatic conditions and also of the various management practices that they can use to adapt to the changes. Thus, improving access to climate information for agro-pastoralist has the potential to significantly increase their awareness level to changing climatic conditions, as well as, for possible adaptation measures in response to climate changes.

Climate change with increasing population density was augmenting pressure on an already fragile natural resource base and mixed farming system that was the mainstay of the livelihoods. Since climate change was the major limiting factor of agriculture in the area, sustainable use and conservation of natural resources such as forest and soil conservation on top of irrigation technologies and skills need to be promoted and should be given a priority among NGOs and

local government in their endeavor to improve the livelihoods at study sites before complete deterioration occurs. Timely warnings and information on weather conditions should also be provided to enable farmers to make informed decisions in their production practices.

Lack of inputs was also one of key constraints that confronted agro-pastoralists' capacity to adapt to climate change. Agricultural production, unless it is supported by agricultural inputs such as improved seed varieties, pesticides, fertilizers, improved breeds, pasture and veterinary medication, etc alone cannot achieve productivity. It was the use of these viable inputs that had insured a boost in productivity during the green revolution in 1970s in Asia (Kebede, 2009). But it should be noted here that these inputs can still be made available by educating farmers at demonstration sites by utilizing organic products from local sources which are environment friendly, sustainable and cost effective. Adequate extension services with appropriate and sufficient agricultural input package supplies will enhance capability towards improving the productivity and production of crops thereby responding to climate change effects.

All rounded and relevant support by both the government, NGOs, research and other development institutions have to be collectively integrated to the needs of the vulnerable and poor segments of the society in the sector. Public institutions need to be strengthened so that they can be able to build the knowledge, skills, and the capacity with which to respond to the needs of the poor farmers. A major challenge, particularly in the agricultural extension and research service was the capacity of the institutions themselves to deliver appropriate and timely responses (Annual Report of ROBA, 2011).

The low level of income earned by agro-pastoralists/farmers has also obvious implications in line with the situation of food security in the study areas. This low income of farm households was a result of the small land holding size and the low productivity of agriculture in general resulted from lack of technology, extension services, erratic nature of the climate, absence of credit and market linkages, lack of sufficient knowledge and skill by farmers among the many other constraints to their farming systems. These have to be addressed through injecting seed money to diversify on-farm and off-farm activities on top of promoting income generating opportunities to enhance the capacity of the HHs.

In this study the majority of respondents lack money and had no access to credit. The reports from IFPRI (2007) and Deresa et al (2006) had shown that access to credit has higher chances of adapting to changing climatic conditions. Access to credit increases financial resources of agro-pastoralists and their ability to meet transaction costs associated with adaptation strategies. As the majority of surveyed agro-pastoralists believed, ever since market is what inspire them to bring in and expand new crops into their farmland, infrastructural development such as the rehabilitation and new construction of infrastructure including roads, grain stores, market facility coupled with establishing value chain development especially for vegetable crops (potato, carrots, beet root, head cabbages, etc) have to be considered as it would provide them further hope and encouragement in producing quality products for markets.

Introduction of small scale irrigation in areas, where possible, is very crucial and has to be given serious attention to diversify and improve the production potential, as well as, strengthening the adaptation ability in the study area. Besides, natural resource development and management

through promotion of participatory integrated watershed development, including agro-forestry, tree planting, soil and water conservation, etc deserve greater attention and are required to fight the severe trends of changing climate. On-farm crop diversification and introduction of new varieties which are adaptable to the areas, such as lentils, chick peas, etc with improved agronomy and protection services and introduction of off-farm activities for income generation for the landless youth, as well as improving the productivity of livestock through introduction of improved management techniques, breeds, feeds, artificial insemination. Livestock population control are also of paramount importance towards enhancing adaptation mechanisms and capacity to respond to the adverse climate changes.

Chapter V: CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusion

In the study sites of Kofele and Kore Districts, it was learned that the agro-pastoralists have suffered from changes of climate from time to time. Especially, since the last five years it became unfavorable and challenged their means of livelihoods. Crop and livestock production, which has highly dominated the livelihoods of the population in the study area were sensitive and were being adversely affected by climate change. The study has also demonstrated that agro-pastoralists with experience in mixed farming perceived the change in climate. The study has also witnessed that there has been a decrease in crop and livestock production in the study districts.

Agro-pastoralists believe that they have witnessed a long term change in temperature and rainfall. These have been reflected in the increase of the duration of dry seasons, hot days and

irregularity amount and distribution of rainfall. Late on-set and early ceasing of rainy season has also been observed. Agro-pastoralists are well aware that their localities are getting warmer with increased dry seasons**.** The surveyed households revealed that the climate change that occurred especially during the years 2005/06, 2007/08 and 2010/11 in terms of unpredictable torrential rainfall and uneven distribution pattern and prolonged dry seasons have been negatively affecting their production condition.

The effect of climate change was apparently observed in terms of unpredictability and heavy rainfall and elongated dry season, while the heavy rainfall resulted in too much moisture that led to water logging and the reduction of produces; the long dry season resulted in shortage of water and livestock feeds subsequently to frost damage and pest infestation of crops.

The agro-pastoralists of the surveyed sites have tried to adapt to the climate changes using various mechanisms depending on their capacity (wealth, experience, inputs use, production, assets including financial status), while those whose livelihood assets had depleted tried to respond to climate changes by selling their animals, those who did not have either had depleted their resources and had resorted to selling firewood or have migrated to other locations. In general, the climate change that had been taking place over the years has affected the livelihoods of the agro-pastoralists which also led to the depletion of their assets and thus creating more food insecure households. Although the surveyed HHs had suggested different options that they could consider, they could not be able to implement as suggested due to lack of capacity in terms of knowledge, finance and inputs, etc.

The cause for the climate change is complex to the agro-pastoralists, although they have some contribution themselves. The problem of lack of capacity to adapt to the climate change situation is embedded within the mode of production and livelihood system as well as in their socio-economic structure. While lack of diversity in the livelihoods and dependence on few activities is the sole cause for the lack of adaptation capacity, weak economic situation and opportunity, absence of diversified and new technologies as well as innovations has exacerbated the problem.

The agro-pastoralists are aware of the problems and have suggested a number of interventions depending on their needs and environmental settings. Any intended interventions to address the problems should, therefore, be based on the priorities of the agro-pastoralists in the respective farming system.

In response to the changing climate, agro-pastoralists have been adjusting their adaptation mechanisms through different farming practices. The study findings had also indicated that access to climate information with opportunity in education and training, credit and input supplies, water resources development with irrigation scheme on top of diversified production system integrated with participatory watershed development along with afforestation, natural resources conservation would be critical measures to enable agro-pastoralists in a better position to adapt to the future potential climate challenges.

5.2. Recommendation

Based on the above conclusions, the following actions are suggested to build-up the adaptation strategies and capacities of the communities in the studied area.

- Agro-pastoralists' level of knowledge on climate change is low and it requires to organize and provide capacity building training to educate, inform and share experiences on critical issues of climate change and on available alternatives of adaptation mechanisms, etc;
- There is a need to support the promotion and strengthening of integrated watershed development and management practices associated with soil and water conservation, forestry and pasture land development, water harvesting structures for irrigation and domestic uses;
- Introduce and promote intensive farming practices coupled with appropriate, adaptable and affordable technologies for the agro-pastoralists such as, pest and drought tolerant/resistant, early maturing varieties of food and cash crops, vegetables, fruits and fodder crops, etc;
- Introduce adaptable high yielding exotic livestock breeds, artificial insemination, improved forage and livestock management with good strategies and practices;
- Support and promote development of homestead gardening along with introduction of apiary/bee keeping activity and promotion of "enset" cultivation to augment food supplies and income sources;
- There is a policy gap in the area of employment of the landless households in rural areas. The landless community members are becoming huge in size subsequent to increasing population pressure and land scarcity. Hence, the number of landless households is quite

critical at the surveyed sites, while the size of families and cultivated land of the households is reduced and deteriorated from time to time. Thus, there is a dire need to initiate off-farm activities and related income generating activities with promotion of saving and credit schemes and skill building training for business and productive self-employment options to diversify the source and means of livelihoods;

- Support the available efforts and strengthen the supply and value chain skill and management practices of agro-pastoralists for a sustainable market networks for viable produces through training and experience sharing on value chain development and management;
- Expand agro-pastoralists' access to climate information within the extension package services and providing location specific meteorological information by means of radio and other available related mass media and communication ways is very essential;
- Introduce and establish weather station and community level early warning system along with preparedness strategy, respectively to give out regular weather information, to make conscious, alert and strengthen the agro-pastoralists responsiveness to climate change related shocks and disaster risk reductions;
- Extend and integrate adaptation measures in various long term national and local development sectors such as agriculture, environment, natural resources and biodiversity, water resources, human and livestock health, etc;
- It is important to build up the collaboration and network between pertinent government sector offices, NGOs and research institutions to enhance joint efforts, with sharing good practices on climate change and adaptation issues and common concerns for collective responsiveness with viable actions;

- There is a need to reinforce the linkage between the extension organs and research institutes to undertake the proven research results at the grass-root community levels;
- Establish a clear and feasible organizational and management structure at all levels of government bodies and responsible government offices or units have to be organized and assigned up to the grass root levels to coordinate and supervise the climate change adaptation programs;
- Promote rigorous family planning practices and painstaking efforts to prevent harmful traditional practices, especially the polygamy practices deep-rooted in surveyed areas;
- It is very crucial to periodically upgrade the knowledge, skill and experience of the agricultural development and health extension agents on issues and impacts of climate change, adaptation, etc in line with their field activities;
- Research attention: climate change has been fueling rural poverty. Attempts have been made in this study to assess the agro-pastoralists' adaptation mechanisms to effects of climate change. However, it is still required further study and analysis the marginal contribution of climate change in line with rural poverty in the country as well as its effects on rural landless segments of the society.

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Appendix-A **Interview Question for Agro-Pastoralist Households**

Introduction:

Dear Sir/Madam,

My name is Abebe Lemma G/Wold. I am studying Master of Arts in Rural Development at Saint Mary College/Indra Gandhi National Open University. I am doing my Master's thesis on Assessment of Adaptation Mechanisms of Agro-Pastoralists to Climate Change in Oromia Regional State. Thus, I am very grateful for your kind cooperation to give me your time for your responses which will be useful towards the success of the research project. All the information to be collected will be kept confidential and will be used only for the purpose of my research work.

Interview Question for Agro-Pastoralist Households

1. Respondent's Name_____ 2. Kebele_____

2. Sex: Male___ Female____ 4. Age_____ 5. No. of years lived in the kebele_____

6. Marital Status i) Married___ ii) Not married___ iii) divorced___ iv) other____

7. Household size (Number of family members) ____No. of children____

8. What is your education level? I) Illiterate ii) Read and write
iii) grade 1 - 6 iv) grade 7 – 10 v) grade 11 - 12 vi) above grade 12

9. What is the major means of livelihood of the household? Tick where possible
i) Crop production _____ii) livestock production _____ iii) Petty trading____
iv) Other (specify)_____

10. Size of farming land i) less than 0.5 ha ii) 0.5 – 1ha. iii) more than 1 ha.

11. List the types of main crops cultivated and livestock reared

	Crops	Livestock
a)	_____	_____
b)	_____	_____
c)	_____	_____
d)	_____	_____
e)	_____	_____

12. How would you describe the level of productions from crop and livestock over the last five years in your kebele? i) increased ii) decreased iii) no change iv) other specify_____

13. How much income do you earn per annum? (approximately)
from crop_____ Livestock_____

14. Have you noticed/perceived any long-term changes in the temperature over the last 20 years? i) yes___ ii) No___

15. How would you describe the situation of hot times over the past 20 years
i) increased ii) decreased iii) no change

16. Have you noticed any long-term changes in the amount and distribution of rainfall over the last 20 years? yes____ No____

17. How would you describe the situation of rainy times over the past 20 years
i) increased ii) decreased iii) no change

18. How do you know about climate change?
i) from extension workers ii) from kebele leaders iii) from media (radio, etc)

iv. Other (specifiy)_____

19. Who is high vulnerable household and could not be able to respond to such climate changes?

20. Please indicate the possible options you apply for responding to the long-term climate changes/trends in terms of your agreement or disagreement **(*Tick in the appropriate place*)**

Options	**(a) disagree**	**(b) agree**	**(c) I don't know**
1) Diversifying crops planting			
2) changing date of seeding/planting			
3) Changing crops variety			
4) Changing production system a) livestock to crop b) stock diversification c) rearing shoats than cattle			
5) Implement soil and water conservation techniques and tree planting			
6) Selecting cattle breeds			
7) Engage on off-farm work/activity			
8) Construct local water harvesting scheme for irrigation			
9) Renting the land			
10) provisional migration			

21. What other methods/mechanisms you would consider to respond to climate changes?

22. What are the major determinants or factors that necessitate adaptation to climate change?

23. What adaptation strategies have you actually practiced in your farmland to those long-term changes in temperature and rainfall?

24. What are the major reasons or barriers why you did not practice the adaptation measures? i) lack of money, ii) lack of information, iii) shortage of labor, iv)lack of inputs v) Other (please specify)_____

25. What were the main constraints/limitations for the household's inability to adapt to climate changing?

26. What should be done to enhance adaptation mechanisms to respond to the climate change?

Thank you

Appendix **- B.** Interview checklist for Focus Groups Discussion **(FGD)** for Zone and District level Experts of pertinent government offices (Land and Environment Protection, Agriculture and Rural Development, Water, Mineral and Energy Offices) and NGOs working in the areas.

1. Is there any type or event of climate change in your zone or district? If your answer is yes, please can you explain?
2. Would you please explain the extent of climate change effects on the Agro-pastoralists' and their crops and livestock productions over the years in the West Arsi your zone/districts?
3. Who is more vulnerable to the shocks and effects of climate change? Who are those households or community members unable to adapt to climate changes? Why?
4. What are the types of mechanisms employed by the agro-pastoralist households to adapt to climate changes?
5. What do you think are the major obstacles that hindered agro-pastoralists to employ adaptation mechanisms to climate changes?
6. What is the government institutions efforts and supports made to solve the problems prevailed in the area and to improve the adaptation measures to the changing climate challenges?
7. What should be done to improve the adaptation strategies of the farming community?

Thank you

Appendix - C. **Interview Checklist for FGD and Key Informants at Kebeles level participants**

1. Have you ever experienced any climate change in your life time? Yes__ No___ If answer is yes, What type of climate shock is your concern?

2. Did the climate change affect the agro-pastoralist households' crop and/or cattle production? Yes_____ No_____ if yes, to what extent the climate changes has affected the households?

3. In your opinion, who is most harmed/ affected by the climate change event? Why?

4. What are the factors determinant/influences to adaptation to climate changes?

5. What did agro-pastoralists actually practice to adapt to the challenges of climate change?

6. What and how did the government and NGOs support the households to respond and adapt to the climate changes?

7. What are the major constraints that hinder the adaptation mechanisms of rural households to the changing climate?

8. What do you recommend to improve the adaptation strategies of agro-pastoralists?

Thank you

Appendix - D **Participants of FGD and KI**

At Zone and Distri level (10)	**At Kebeles Level from Kofele and Kore Districts (20)**	**Key Informants from Kofele ar Kore Districts (10)**
Government Bureaus: -Finance and Economic Development (2) -Land and Environment Protection (2) -Agriculture and Rural Development (3) -Water, Mineral and Energy Offices (1) -Women and Children Affairs (1) **NGOs:** - ROBA (1) - IDE (1)	- Kebele Council members (2) - Kebele administration (2) - Extension Agents (4) - PA Leaders (2) - Cooperative Leaders(2) - Women Associations(2) - Youth Associations(2) - Project Beneficiaries of NGOs (4)	-Village elders and - Gada traditional leaders (3) - District Council members (2) - Religious leaders (2) - Model farmers (2) - Kofele District Expert of ARDO (1)

Appendix - E: Details of findings of different data about surveyed kebeles

The level of production of the surveyed agro-pastoralists (Figure 2).

Study areas		Level of crop & livestock production						Total
Districts	**Kebeles**	**Increased**	%	**Decreased**	%	**No change**		
Kofele	Koma Bitacha	4		4		2		10
	Tulu Boke	1		6		3		10
	Gofingira Gurmicho	2		3		5		10
	Hulebera	5		5		0		10
	Chatmena Kerensa	4		6		0		10
	Total	**16**	**32%**	**24**	**48%**	**10**	**20%**	**50**
Kore	Doda Dayu	0		4		6		10
	Ekka Dayu	0		2		8		10
	Gofingira Chocha	4		5		1		10
	Total	**4**	**13%**	**11**	**37%**	**15**	**50%**	**30**
Total		**20**	**25%**	**35**	**44%**	**25**	**31%**	**80**

Perception on Long term changes in Temperature (Figure 4)

Study areas		Total		
Districts	**Kebeles**	**yes**	no	**Total**
Kofele	Koma Bitacha	7	3	10
	Tulu Boke	10	0	10
	Gofingira Gurmicho	9	1	10
	Hulebera	10	0	10
	Chatmena Kerensa	10	0	10
	Total	**46**	**4**	**50**
Kore	Doda Dayu	8	2	10
	Ekka Dayu	7	3	10
	Gofingira Chocha	7	3	10
	Total	**22**	**8**	**30**
Total		**68**	**12**	**80**

Situation of hot days over the past 20 years (Figure 5)

Study areas		No. of Respondents			Total
Districts	Kebeles	increased	decreased	no change	
Kofele	Koma Bitacha	7	1	2	10
	Tulu Boke	10	0	0	10
	Gofingire gurmicho	8	0	2	10
	Hulebera	10	0	0	10
	Chatmena Kerensa	9	1	0	10
	Total	**44**	**2**	**4**	**50**
Kore	Doda Dayu	7	1	2	10
	Ekka Dayu	7	0	3	10
	Gofingira Chocha	7	1	2	10
	Total	**21**	**2**	**7**	**30**
Total		**65**	**4**	**11**	**80**

Perception on Long-term changes in the amount & distribution of rainfall over the last 20 years (Figure 6)

Study areas		No. of Respondents			
District	Kebeles	yes	no	I don't know	Total
Kofele	Koma Bitacha	8	2	0	10
	Tulu Boke	10	0	0	10
	Gofingire gurmicho	5	5	0	10
	Hulebera	9	1	0	10
	Chatmena Kerensa	10	0	0	10
	Total	**42**	**8**	**0**	**50**
Kore	Doda Dayu	7	2	1	10
	Ekka Dayu	3	6	1	10
	Gofingira Chocha	4	6	0	10
	Total	**14**	**14**	**2**	**30**
Total		**56**	**22**	**2**	**80**

Situation of rain times over the past 20 years (Figure 7)

Study areas		No. of Respondents			
District	Kebeles	increased	decreased	no change	Total
Kofele	Koma Bitacha	7	1	2	10
	Tulu Boke	0	10	0	10
	Gofingire gurmicho	4	2	4	10
	Hulebera	3	6	1	10
	Chatmena Kerensa	0	10	0	10
	Total	**14**	**29**	**7**	**50**
Kore	Doda Dayu	2	6	2	10
	Ekka Dayu	1	4	5	10
	Gofingira Chocha	4	2	4	10
	Total	7	12	11	30
Total		**21**	**41**	**18**	**80**

Respondents information sources about climate change

Study areas		Sources of information				Total
District	kebeles	from extension workers	from kebele leaders	from media (radio, etc)	Training, workshops	from extension workers
Kofele	Bitacha	4	5	1	0	10
	Boke	8	1	1	0	10
	gurmicho	2	0	7	1	10
	Hulebera	5	0	1	4	10
	Kerensa	5	0	2	3	10
	Total	***24 (%)***	***6 (%)***	***12 (%)***	***8 (%)***	***50***
Kore	Doda Dayu	5	0	4	1	10
	Ekka Dayu	1	1	4	4	10
	Gofingira	8	2	0	0	10
	Total	***14 (%)***	***3 (%)***	***8 (%)***	***5 (%)***	***30***
Total		**38 (%)**	**9 (%)**	**20 (%)**	**13 (%)**	**80**