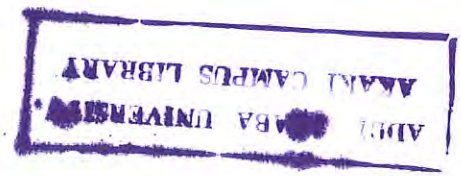
Assessment of Local Farmers' Adaptive Capacity to Climate Change: The Case of Geshe Woreda North Shoa Zone.Amahara Region



By

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Assessment of Local Farmers' Adaptive Capacity to Climate Change: The Case of Geshe Woreda North Shoa Zone, Amahara Region

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ACRONYMS

ACSI	Amahara Saving and Credit Institution
AIACC	Assessments of Impacts and Adaptations to Climate Change
FAO	Food and Agriculture Organization
FDRE	Federal Democratic Republic of Ethiopia
FGD	Focus Group Discussion
FSS	Forum for Social Studies
HH	Household
IFPRI	International Food Policy Research Institute
IPCC	Inter Governmental Panel on Climate Change
KII	Key Informant Interview
LVI	Livelihood Vulnerability Index
NR	Natural Resource
SPSS	Statistical Package for Social Science
TLU	Total Livestock Unit
NMSA	National Methodical Service Agency

ABSTRACT

The main objective of this study was to assess the adaptive capacity of farmers to climate change in terms of access and possession of key livelihood assets in three traditional agro-ecology (Dega, Weinadega, and kola) of the study area. A total of 133 households were selected from three kebeles- Mezerazir (kola), Wogit (Weinadega) and Giraramba kebeles (Dega) by using random sampling techniques for the study. Descriptive statistics and Chi square test were used to analysis farmers' perceptions, adaptive capacity and adaptation strategies. In addition the adaptive capacity indices were calculated by using LVI approach in terms of access and possession of key livelihood assets. The data collected from FGD, KI and secondary source of data were analyzed by triangulating with household survey. The result shows 85% of the farmers in the study area perceive increasing in temperature and there is no difference between farmers' perception and the recorded temperature data. However 91% of the respondent perceive decreasing precipitation trend which is in line with the 'Kremt' season recorded data. According to the chi square result there is a perception difference in age, education and sex of household heads. The adaptive capacity of Mezerazir kebele which represent kola agro-ecology is low (0.298). While that of Wogit kebele (0.42) and Giraramba kebeles (0.381) which represent Weinadega and Dega agro-ecology respectively are moderate. The most common adaptation strategies in the study area include planting trees around farm land, stone bound, reducing the number of herds, and conservation of water and protect soil erosion. However lack of knowledge, shortage of labor, lack of finance, shortage of water and unsuitable topography of land to use irrigation, the difficulty to get fast growing and drought tolerant crop species, and shortage of land *was identified as constraints to adaptation options. Therefore the government policies and programs should build the adaptive capacity of farmers through empowering farmers with skill training, information and education, improving natural resource management to reduce the ongoing natural resource depletion, improving credit service provision, strengthen informal social networks, improving access to agricultural technology, infrastructure and institution with accessible distance, and supporting the existing adaptation strategy in terms of technology and finance so as to reduce the adaptation constraint.*

CHAPTER ONE

1. INRODUCTION

1.1 Background

From many environmental problems facing mankind today climate change remained as a global concern for the increasing number of impacts on all aspects of human lives. In Africa, climate change affects agricultural production through increased water stress, reduced suitable areas for production and decreased yield potential (Sissay et al., 2012).

It has become common knowledge that the poor are likely to be hit by climate change and the capacity to respond to climate change closely related to poverty, as the poor are least able to respond to the climatic stimuli. 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. Because the availability of these resources and services is limited in many developing countries, their adaptive capacity in the face of climate change is correspondingly low compared to developed countries. Adaptation and vulnerability to climate change are urgent issues among many developing countries. For this reason there exist provisions in the United Nations framework convention on climate change to assist those countries that are thought to be most vulnerable and least able to adapt (Santiago, 2001).

Ethiopia is one of the poorest countries most affected by the impact of climate change and weather extremes. Particularly, global climate change poses the most serious risk to Ethiopian farmers and pastoralists who have an immediate daily dependence on climate sensitive livelihood

and natural resource (Aklilu and Alebachew, 2009). The observed trend shows the mean annual temperature has increased by 1.3°C between 1960 and 2006. Daily temperature observations show significantly increasing trend in the frequency of hot days, and much larger increasing trends in the frequency of hot nights. The strong inter annual and inter-decadal variability in Ethiopia's rainfall makes it difficult to identify long-term trends. There is no a statistically significant trend in observed mean rainfall in any season in Ethiopia between 1960 and 2006 (Simon et al., 2011).

Consequently the changing patterns and intensities of rainfall and increasing temperature will have consequences for all Ethiopians, but especially for more than 70 million poor people whose survival depends on rain fed agriculture (farming and/or pastoralism). The agricultural sector is dominated by small-scale mixed crop-and-livestock production with very low productivity. The major factors responsible for this low productivity include: reliance on obsolete farming techniques; soil degradation caused by overgrazing and deforestation; poor complementary services such as extension services, credit, markets and infrastructure; and climatic factors such as drought and flood (Simon et al., 2011).

Therefore empirical studies are necessary to suggest policy intervention in the adaptation process of the Ethiopian's agricultural sector. Different scholars studied the climate change and agricultural adaptation. Most of the studies emphasized in the analysis of the impact of climate change on agriculture, climate change adaptation strategy, and vulnerability of Ethiopian farmers to the adverse impact of climate change at higher level analysis. However, little has been done concerning the adaptive capacity of farmers' to the impact of climate change at lower scale assessment. Therefore, this paper is intended to study the local farmers' adaptive capacity to climate change at woreda level.

1.2. Statement of Problem

Ethiopia is one of the developing countries, which are more vulnerable to climate variability and change. Low level of socio-economic development, inadequate infrastructure, lack of institutional capacity and a higher dependency on the natural resource base make the country more vulnerable to climatic factors including climate variability and extreme climate events (FDRE, 2007).

Risk minimization is no longer sufficient survival strategy for poor people in livelihood systems increasingly exposed to frequent extreme event. This calls comprehensive adaptation to climate change. The need for adaptation is urgent in the context of developing countries, where adaptation coupled with efforts to improve rural livelihood especially the poorest and most vulnerable (Anne and Lennart, 2008). The ability of a community to cope with and respond to change depends heavily on access to, and control over, key assets. Typically, it is the poorest that are most vulnerable to the impacts of climate change, in large part because of their lack of, or restricted access to, key assets and capitals (Lindsey et al., 2010).

Likewise, the farming communities living at Geshe woreda are progressively becoming vulnerable to climate and non climatic factors. Climatic factors include extreme event such as drought and change in the mean temperature and precipitation. The productivity of crops at the woreda frequently failed due to rainfall variability. As a result most of the farmers are food aid recipient for many years and still they are food aid dependant. There are problems in socio-economic condition of farmers in the study area that limit the level of farmer's adaptive capacity. This includes land fragmentation due to population growth, low level of education, soil erosion and poor soil fertility, inadequate use and access of agricultural technologies such as pesticide, insecticide, quality seed and chemical fertilizers, and poor infrastructural development (micro-

finance institution, health center, road , market, telephone electric power etc.). These all indicate farmers who live in the woreda have a limited asset which are the bases for diversify adaptation strategies. All these indicate the existence of problem in access and possession of livelihood assets that undermine the adaptive capacity of farmers to climate change and variability. The purpose of this study is, therefore, to assess the adaptive capacity of farmers' to climate change in terms of their access and possessions of key livelihood assets.

1.3. Objective of the Study

1. General objective

The major objective of the study is to assess the adaptive capacity of local farmers' to climate change.

2. Specific objective

To this end, the specific objectives are:

1. To assess the households perception towards climate change and variability.
2. To assess key livelihood assets of farmers in terms of their access, and possessions that determines the status of farmers' adaptive capacity.
3. To identify local farmers' adaptation strategies for perceived climate change and variability adverse impact.

1.4 Research Question

The following are key questions that the research tried to address:

1. What are farmers' perceptions on temperature change?
2. What are farmers' perceptions on rain fall change?
3. What are the key livelihood assets that determine the adaptive capacity of farmers?

4. What are the current adaptation strategies of farmers towards perceived climate change and variability adverse impact?

1.5. Significance of the Study

Conducting this study will have certain significances. It helps to raise awareness of local farmers regarding climate change and variability and hence they develop relevant adaptation strategy to combat the adverse impact of climate change. Furthermore local government may use the finding of the study to formulate relevant agricultural adaptation policy in order to build farmers' adaptive capacity to climate change and variability. Moreover, this study may stimulate other researchers in the study area and may serve as a basic document for further reference.

1.6. Scope and Limitation

This study was conducted in three kebeles of the woreda which represent three dominant traditional agro-ecologies such as kola, Weinadega and Dega. The study limited to assess the adaptive capacity of farmers in terms of access and possession of key livelihood assets which determine the level of farmers' adaptive capacity and adaptation options. The main limitation of the study is that there is only one meteorological station, Mehal Meda meteorological station, nearby the study areas. The temperature and rainfall data recorded at the meteorological station represents merely the average climatic parameters of the study woreda, not exactly any of the three study kebeles.

1.7. Organization of the paper

The paper is organized in five chapters. The first chapter deals with the introductory part that contains the background of the study, a statement of the problem, objectives, and research questions, significance of the study, limitations and scope. Chapter two deals with literature review. Third chapter describes the research methodology. The Forth chapter deals with result and discussion. The last Chapter deals with conclusion and recommendations.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Definitions and Concepts of Climate Change and Adaptive Capacity

Climate change: in IPCC usage it refers to a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity.

Vulnerability: is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity (Ellen & Katia, 2006).

Adaptation: Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation (Christoph, 2005).

Adaptive capacity: is the property of a system to adjust its characteristics or behavior, in order to expand its coping range under existing climate variability, or future climate conditions. In practical terms, adaptive capacity is the ability to design and implement effective adaptation strategies, or to react to evolving hazards and stresses so as to reduce the likelihood of the occurrence and/or the magnitude of harmful outcomes resulting from climate-related hazards.

The adaptation process requires the capacity to learn from previous experiences to cope with current climate, and to apply these lessons to cope with future climate (Ellen & Katia, 2006).

2.2 Climate Systems in Ethiopia

The Ethiopian climate is mainly controlled by the seasonal migration of inter tropical convergence which follow the position of the sun relative to the earth and the associated atmospheric circulation, in conjunction with the complex topography of the country (NMSA,2001). There are different way of classifying the climatic system of Ethiopia including the traditional; the koppen's; Thornthwaile's; the rainfall regime and the agro-ecological zone classification system (Yohannes, 2003).

The most common classification systems are traditional and agro-ecological zone. According to the traditional classification system which mainly relies on altitude and temperature, Ethiopia has five climate zones

Table 1: Traditional Zone and Their Physical Characteristics

Zone	Altitude in meters	Average annual temperature (c^o)
Watch (upper highland)	3200 plus	<11.5
Dega (highland)	2300-3200	11.5-17.5
Weinadega (midland)	1500-2300	17.5- 20
Kola (low land)	500-1500	20-27.5
Bereha (desert)	Under 500	>27.5

Source: MoA, 2000

2.3. Climate Change in Ethiopia

Ethiopia is one of the least developed countries in the world, with a gross domestic product of slightly more than US $10 billion and a population of more than 70 million (Mahmud et al., 2008). At present, agriculture dominates the Ethiopian economy, accounting for nearly half of GDP and for the vast majority of employment. While the country is highly dependent on the agricultural sector for income, foreign currency, and food security, the sector is dominated by small-scale farmers who employ largely rain-fed and traditional practices a state which renders Ethiopia highly vulnerable to climate variability, and thus to climate change(Mahmud et al., 2008).

According to the World Bank (2007), climate change is projected to reduce yields of the wheat staple crop by 33% in Ethiopia .This amounts to a serious threat to food security and to the achievement of major developmental goals. Rainfall and temperature are important determinants of crop harvests, and unfavorable realizations of either the amount or the temporal distribution of rainfall triggers food shortages and famine. A recent mapping of vulnerability and poverty in Africa put Ethiopia as one of the country most vulnerable to climate change with the least capacity to respond. Indeed, Ethiopia has experienced at least five major national droughts since 1980, along with literally dozens of local droughts. Cycles of drought create poverty traps for many households, constantly uneasy efforts to build up assets and increase income. Survey data show that between 1999 and 2004 more than half of all households in the country experienced at least one major drought shock. Food shortage and famine associated with rainfall variability cause a situation of high dependency on international food aid. And Ethiopia is one of the biggest food aid receipt countries in Africa that accounts for 20-30% of all food aid to sub-Saharan Africa (Bezu and Holden, 2008).

unlikely to be sufficient in and of themselves as a risk management strategy. Nevertheless, they may provide critical capacity that facilitates specific adaptation measures. As broad strategies, generic adaptation measures are likely to be implemented by public institutions.

Specific adaptation, in contrast, targets individual systems, processes or activities whereby the adaptation measure is 'built-to-suit' and the adaptation measure may only be relevant to those entities. For example, water infrastructure projects, such as pipes to enable inter-basin transfer, will likely only provide direct benefits to the connected basins and the direct effects will be confined to those entities involved in the water resource management sector (although the indirect effects may spill-over to affect a broader range of activities or stakeholders). As the costs and benefits of such measures are likely to be borne by a relatively small number of institutions, these are likely to be implemented locally, and the benefits may be more readily assessed.

2.4.1.2 Autonomous Vs. Planned Adaptation

Adaptation policies and measures are also frequently divided into two categories: autonomous (occasionally referred to as reactive) adaptations and anticipatory (or proactive) adaptations (Easterling et al., 2004). Autonomous adaptations are often those that are undertaken spontaneously as routine adjustments to conditions. For example, activities with short planning horizons (e.g. cropping) are constantly implementing autonomous adaptations based upon weather and market conditions, such as timing of planting and harvesting, switching from cropping to grazing, etc. Such operational decisions are made independently of policy or regulatory incentives, and are tactical rather than strategic. Such autonomous adaptations have often been the norm with respect to managing climate risk, under the assumption that the climate is stationary.

Autonomous adaptation will certainly comprise a significant and important fraction of the overall adaptation response to climate change, there are drawback s that deter one from relying upon it as the sole response. For example, autonomous adaptations may be inefficient in that they are often undertaken only after losses are incurred through existing management strategies. In addition, Easterling et al. (2004) suggest that autonomous adaptations tend to be incremental and therefore may be only partial solutions to particular challenges which may require continual and costly adjustment. Furthermore, autonomous adaptations that are perceived successes over the short-term may delay transformational changes to operations that are required for long-term sustainability.

In contrast, planned adaptation is explicitly strategic and tends to involve planning in anticipation of future states and structural or transformational changes in operations. Planned adaptation is often facilitated by external parties, such as governments and research institutions. It tends to affect activities associated with long planning horizons. As such it is particularly relevant to infrastructure decisions, where infrastructure has a high capital cost and is long-lived. Planning infrastructure to accommodate future climate change upfront may often be less costly than having to retrofit or upgrade infrastructure at a future date. However, even in primary industries there is scope for strategic planning, such as securing irrigation entitlements and allocations or planning for large-scale expansion or contraction of certain production systems.

2.4.1.3 Positive vs. negative adaptation

Not all adaptations are equal with respect to how they address a particular challenge or in how they are perceived by stakeholders. Davies and Hossain (1997) make a distinction between 'positive' and 'negative' adaptations in the context of sustainable livelihoods:

> *"**Positive adaptation** is by choice, can be reversed if fortunes change, and usually lead to increased security and sometimes wealth. It is concerned with risk reduction and is likely to involve an intensification of existing livelihood strategies or a diversification into neighboring livelihood systems."*

> *"**Negative adaptation**, which is of necessity, tends to be irreversible, and frequently fails to contribute to a lasting reduction in vulnerability. It occurs when the poor are forced to adapt their livelihoods because they can no longer cope with short-term shocks and need to alter fundamentally the ways in which they subsist."*

2.5. Determinants of Adaptive Capacity

The IPCC (2001) defined adaptive capacity as the ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantages of opportunities or to cope with the consequences. This means that adaptation measures should be to increase the capacity of a system to survive external change.

According to Brooks and Adger (2005), "adaptive capacity is the property of a system to adjust its characteristics or behavior in order to expand its coping range under existing climate variability, or future climate conditions". The adjustments in practices, processes or structures can moderate or offset the potential for damage or take advantage of opportunities to cope with

and adapt to climate change (Schneider et al., 2001). In practice, adaptive capacity is the ability to identify, choose and implement effective adaptation strategies or reduce risk in the livelihood and the magnitude of harmful outcomes resulting from climate-related hazards.

An inverse relationship exists between adaptive capacity and vulnerability among rural households especially in the third world where there is a heavy dependence on agriculture purely under the dictates of the unreliable climatic conditions. Enhancing the adaptive capacity of rural farmers will therefore greatly reduce their vulnerability. The first step in the effort at enhancing capacity is to identify the underlying factors that influence the capacity of farmers to adapt using coping interventions available. There exist considerable understandings of factors that influence the adaptability of households which cut across socio-economic, technological and institutional factors. These target variables include socio-economic factors of age, gender, education of the adaptor and household characteristics such as household size, income and land size accessible to the household (Smit & Pilifosova, 2003).

Adaptive capacity is multi-dimensional and the elements that make up an individual's adaptive capacity are not entirely agreed. It essentially relates to whether people have the right tools and the necessary enabling environment to allow them to adapt successfully over the long term. It is also important to bear in mind that adaptive capacity is context-specific and varies from country to country, community to community, between social groups and individuals, and over time (Smit and Wandel, 2006).

2.6 Approach to Climate Research

Socio- Economic Approach

The socioeconomic vulnerability assessment approach mainly focuses on the socioeconomic and political status of individuals or social groups (Adger 1999). Individuals in a community often vary in terms education, gender, wealth, health status, access to credit, access to information and technology, formal and informal (social) capital, political power, and so on. These variations are responsible for the variations in vulnerability levels. In this case, the vulnerability is considered to be a starting point or a state (i.e., a variable describing the internal state of a system) that exists within a system before it encounters a hazard event (Kelly and Adger 2000). Thus, the vulnerability is considered to be constructed by society as a result of institutional and economic changes (Adger and Kelly 1999). In general, the socioeconomic approach focuses on identifying the adaptive capacity of individuals or communities based on their internal characteristics.

Biophysical Approach

The biophysical approach assesses the level of damage that a given environmental stress causes on both social and biological systems. For example the monetary impact of climate change can be measured by modeling the relationship between climatic variable and farm income (polsky and Esterling, 2001). In general, the biophysical approach focuses on sensitivity (change in yield, income, health) to climate change and misses much of the adaptive capacity of individuals or social groups, which is more explained by their inherent or internal characteristics or by the architecture of entitlements, as suggested by Adger (1999).

The Integrated Assessment Approach

The integrated assessment approach combines both socioeconomic and biophysical approaches to determine vulnerability. Füssel (2007) argued that the IPCC (2001) definition which

conceptualizes vulnerability to climate as a function of adaptive capacity, sensitivity, and exposure which accommodates the integrated approach to vulnerability analysis. According to Füssel and Klein (2006), the risk-hazard framework (biophysical approach) corresponds most closely to sensitivity in the IPCC terminology. Adaptive capacity (broader social development) is largely consistent with the socioeconomic approach (Füssel, 2007). In the IPCC framework, exposure has an external dimension, whereas both sensitivity and adaptive capacity have internal dimension, which is implicitly assumed in the integrated vulnerability assessment framework (Füssel, 2007).

Thus, adaptive capacity determined by the availability of livelihood resources in which given community possesses and effectively allocate the resource in times of climate change challenge. Therefore this study would adapt integrated assessment approach.

2.7 Sustainable Livelihood Approach

A livelihood comprises the capabilities, assets, and activities required for a means of living. It is deemed sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities, assets, and activities both now and in the future, while not undermining the natural resource base (DFID, 1999).

Conceptually, livelihoods connote the means, activities, entitlements and assets by which people make a living. Assets, in this particular context, are defined as not only natural/biological (i.e., land, water, common property resources, flora, fauna), but also social (i.e., community, family, social networks, participation, empowerment), human (i.e., knowledge, creation by skills) and physical (i.e., roads, markets, clinics, schools, bridges) The International Institute for Sustainable Development (IISD) defines sustainable livelihoods as being concerned with people's capacities

to generate and maintain their means of living, enhance their well-being, and that of future generations (Cannon et al., 1992).

2.8. Empirical Review on perception, Adaptive Capacity and Adaptation in Developing Countries

This study documented below present empirical findings on farmers' perceptions, adaptive capacity and adaptations to climate change in Africa.

Maddison (2006) reports that perceptions about climate change showed that a significant number of farmers believe that the temperature has already increased and that precipitation has declined for eleven African countries. Farmers with the greatest farming experience were more likely to notice changes in climatic conditions. The study also reported that farmers' experiences, access to free extension services and markets are important determinants.

Gbetibouo (2009) argues that farmers with access to extension services in South Africa are likely to perceive changes in the climate because extension services provide information about climate and weather. Consequently, awareness and perceptions of changes in climatic conditions shape action or inaction on the problem of climate change. In a similar study, Mertz, et al (2009) analyzed farmers' perceptions of climate change and adaptations in the savanna zone of Senegal. The results of the study showed that farmers in this zone are aware of climate variability, and identified intensive wind and occasional excess rainfall as the most destructive climatic factors. They therefore attributed poor livestock health and reduced crop yield to these adverse climatic factors. However, the farmers also attributed crop failures and other perceived climate impacts to the political problems in the country of adaptation.

Sofoluwe, et.al (2011) surveyed 100 farmers to gather information on their perceptions about changes in temperature and precipitation in Nigeria. The study used the Multinomial Logit Model to analyze the factors that determine farmers' adoption of various climate change adaptation measures. The results show that more than 75% of the respondents were aware of increase in temperature and precipitation in the region. The farmers reported that late planting, irrigation, soil conservation, planting different crop varieties are the common adaptation strategies used, and that lack of information on climate change impacts and access to credit, labor shortages, shortage of land and poor potential for irrigation are the barriers to adapting to the perceived changes in climatic conditions. The regression results showed that livestock ownership, access to loans, off farm income generation, gender and household size are the significant determinants of adapting to climate change impacts.

Heredia (2011) conduct case study to characterize the adaptive capacity in developing countries by using exploratory model and a principal component analysis. He constructs a methodology that bridges existing approaches to study adaptation, providing an alternative that includes high level deterministic approaches to quantify adaptive capacity and case-by-case strategies to enhance region-specific adaptive capacity. A case study focused on three regions of Peru: Ayacucho, Loreto and Piura. The results of the methodology show that Ayacucho, a region facing low temperatures and glacier retreat, has the lowest adaptive capacity and he suggests the priority should be given to the Ayacucho region in the adaptive capacity strengthening process. He identifies the main factors that affecting Ayacucho's adaptive capacity. These include infrastructure, poverty and low economic capacity. Loreto, with changes in biodiversity and ambient temperatures, has the second highest adaptive capacity to climate change as a result of a diverse population and low literacy levels. He also suggests trans cultural education and family

planning might be required to increase Loreto's adaptive capacity more. Finally, Piura has the highest adaptive capacity due to its high economic capacity, but this is affected by the region's social inequality.

Another study conducted by Hari, et al (2010) in Nepal. They examine the ability of the poor to adapt to climatic change and explore the adaptive capacity of communities in the Koshi Tappu area, by examining whether or not they have the required capital assets (human, social, natural, physical, and financial capital) to remain resilient in the face of continuing climate event impacts. The result shows the poor communities in the Koshi Tappu floodplain lack capital assets and other vital institutional support needed for climate change adaptation. They identify factors that contribute to low adaptive capacity to climate change. These include low levels of literacy, the ongoing depletion of natural resources; lack of land and livestock ownership; and inadequate financial services (in the form of microcredit, micro insurance and micro savings).

Swanson et al., (2007) also conduct study to characterize indicators of adaptive capacity to climate change for agriculture in the prairie region of Canada based on statistics Canada's census of agriculture. They select 17 indicators and organized into six determinants, namely: (1) economic resources; (2) technology; (3) infrastructure; (4) information, skills and management; (5) institutions and networks; and (6) equity. In order to compare of adaptive capacity across census divisions they calculated scores for each indicator be normalized, aggregated to a determinant value and then aggregated into an overall index of adaptive capacity for each of the 53 census divisions. The result shows the census divisions exhibiting the highest adaptive capacity were clustered near large urban centers. Census divisions exhibiting the lowest adaptive capacity were typically along the northern boundaries of the Prairie agricultural region. Census divisions exhibiting higher rankings were associated with the proximity to major urban centers;

higher off-farm earnings; greater diversity of employment opportunities; greater use of computer technology; more use of computers in farm management; a higher density of transportation networks; more e-mail and use of the World Wide Web; and closer proximity to agricultural education institutions.

Nhemachena and Hassan (2007) examined farmers' adaptation strategies in South Africa, Zambia and Zimbabwe. The study describes farmers' perceptions about long-term changes in temperature and precipitation, as well as various farm-level adaptation measures adopted, and barriers to adaptation. The results indicated that using different crop varieties, crop diversification, changing planting dates, switching from farm to non-farm activities, increased use of irrigation, and increased water and soil conservation techniques were the different adaptation measures employed by farmers in these countries. The study also reported that most farmers perceived long-term increase in temperature and that the region was getting drier, with changes in the timing of the rains and frequency of droughts. The farmers reported that lack of credit facilities and information on adaptation options and insufficient inputs are the main barriers to adopting any climate change adaptation options. The results of the multivariate discrete choice analysis show that gender, years of farming experience, access to extension services, access to credit facilities and markets are the significant determinants of adaptations to climate change in the region.

In Ethiopia, Deressa, et al., (2008) analyzed the determinants of farmers' choice of adaptation methods in the Nile Basin. Using cross-sectional data from a survey of farmers to illicit information on adaptation methods, the study found that the adaptation methods currently in place in the study area are; changing planting dates, using different crop varieties, planting tree crops, irrigation, soil conservation and not adapting. The farmers reported that the use of

different crop varies was the most common adaptation method, while irrigation was the least common. They also reported that the reasons for not adapting are lack of information on climate change impacts and adaptation technologies, lack of financial resources, labour constraints and land shortages. The level of education, age, sex and household size of farmers was found to be significant determinants of adaptation to climate change in the study area. Also farmers in different agro-ecological settings employ different adaptation method.

2.8. Conceptual Framework

Frameworks to assess the adaptive capacity of farmers have been developed to provide information on the potential of farm enterprises to adjust their whole farming enterprise under future climate scenario. The rural livelihoods framework (Ellis, 2000) provides one method of assessing major influences on farmers' vulnerability based on the assessment of five capitals: human, social, natural, physical, and financial capitals. This holistic approach is well suited to allow farmers to identify and prioritize adaptation options and barriers for any given change and the available institutions and processes shape livelihood options strategies that farmers often pursue in advent of climate induced extreme events and long term climate change. As adaptation outcomes depend upon the livelihood options/strategies that poor undertake, understanding farmers' endowments and entitlements along with institutional and processes surrounding them is crucial to better understand the vulnerabilities and adaptive capacity of farming household to climate change and devise effective vulnerability reduction strategies.

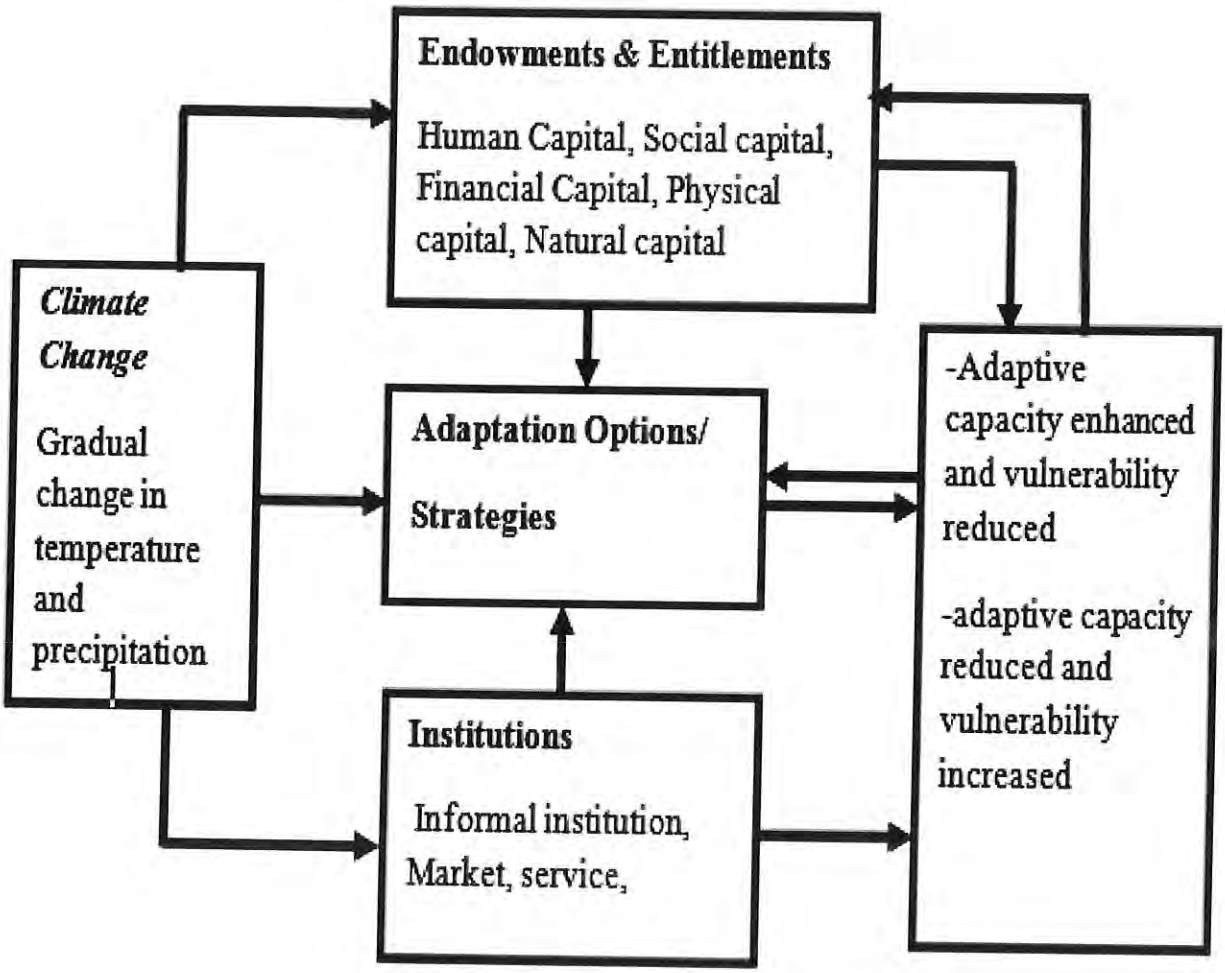

Figure 1 Conceptual framework

Adopted From (Hari, 2010) With Minimum Modification to Suit the Study

Role of Livelihood Asset

The livelihoods assets form the basis of both adaptive capacity and realized adaptation strategies. This includes capital assets of individuals, households, communities, or groups, such as human, physical, natural, financial and social capital (Hari et al., 2010).

CHAPTER THREE

3. MTHEDOLOGY

3.1 Brief Description of Study Area

Geshe is one of the woredas in the Amahara Region of Ethiopia. Located at the eastern edge of the Ethiopian highlands in the Semien Shewa Zone, Geshe is bordered on the south by the Menz Gera Midir, on the west and north by the Debub Wollo Zone, and on the east by Antsokiya Gemza; the Wanchet River defines its western boundary. Elevations of the woreda range from about 1200 meters along the Wanchet to over 3000 meters above sea level on the ridge of mountains that run near the eastern border of this woreda (DSA, 2005).

Based on the 2007 national census conducted by the Central Statistical Agency of Ethiopia (CSA), the woreda has a total population of 61,521, an increase of 19.97% over the 1994 census, of whom 30,448 are men and 31,073 women; 2,774 or 4.51% are urban inhabitants. With an area of 658.78 square kilometers. A total of 13,691 households were counted in this worda, resulting in an average of 4.49 persons in a household. The majority (95.68%) of inhabitant's are followers of Ethiopian Orthodox Christianity while 4.01% of the population said they were Muslim.

The basis of the livelihood system in the woreda is the production of cereals, oil crops pea, and bean along with livestock that is kept on natural pasture and crop residues. Before the depletion of the natural forest cover to its present precarious level, sale of firewood and wood for construction as well as sale of forest products used to contribute significantly to farmers' livelihoods. The major traditional agro-ecology of the woreda includes Dega, Weinadega, and

kola. The woreda experience bimodal rainfall patterns that is kiremt and belg. However belg crop production has failed due to the extended dry season between Januarys to April. The planting of long cycle Meher crops (sorghum, maize and barely) in the lowlands and highlands started in April. According to Mehal Meda meteorological station the study area receives on annual rainfall 591-1050 ml and annual average temperature of 12.56 degree centigrade.

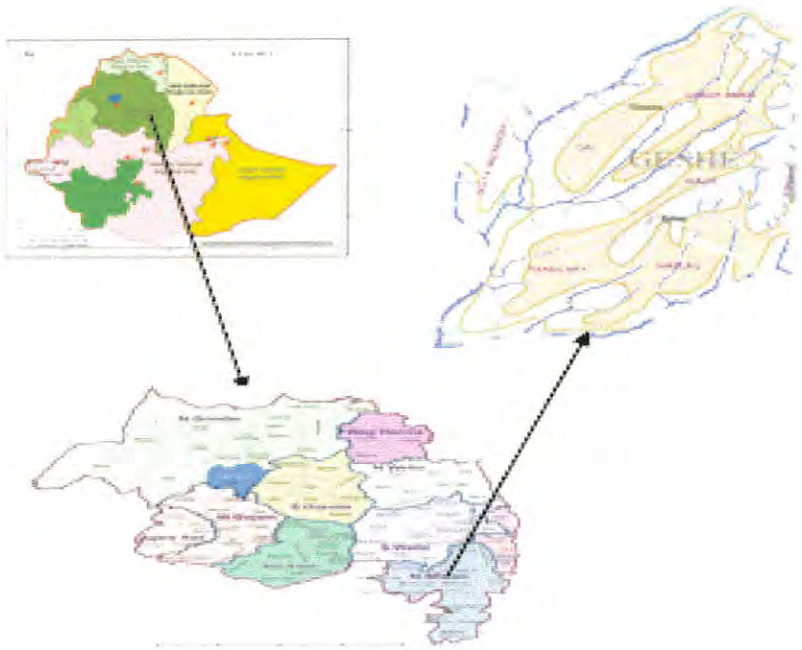

Figure 2 : Map of the study area

Source: (DSA, 2005).

3.2 Research Design

The primary aim of this research is to assess local farmers' adaptive capacity to climate change adverse impact with regard to their access, availability and possession of key livelihood assets. To this end, the descriptive research design was employed to generate relevant and pertinent data

so as to assess the adaptive capacity of farmers to climate change. In order to obtain the relevant and pertinent data appropriate data collecting tools were employed. These include household survey, key informant interview, and focus group discussion. This study requires both quantitative and qualitative data analysis techniques. The adaptive capacity index was calculated so as to make adaptive capacity comparisons among agro-ecology. Purposive, stratified and simple random sampling technique was employed to select the study woreda, kebeles and households.

3.3 Data Source

In order to achieve the research objective, the researcher obtained the data from primary and secondary data source. The primary data were obtained from households, development agent, kebele administrator and elders. The secondary data obtained from NMSA, books, articles, report and journals.

3.4 Data Collection Instrument

The primary data were obtained through household surveys, key informant interview, and focus group discussion. The secondary data obtained through published and unpublished document review. Each of these data collection methods discussed as follows:

Household Survey

In order to collect the relevant data, clear and understandable open and closed ended questionnaire were prepared and translated into Amharic language. To build the respondents' confidence and to express their ideas comfortably, the researcher or enumerators were informing the purpose of the study is only academic. The collection of household survey data through questionnaire were conducted by recruiting enumerators. The enumerators were the development agent who works at kebeles level in the study area. Before the enumerators start the actual data

collection, a one day training regarding the objective of the research, how to approach respondent and record the response was provided by the researcher.

Key Informant Interview

In order to obtain additional information regarding adaptive capacity of farmers key informant interview were held at each sample kebeles in study area. Thus three individuals were interviewed at each three sample kebeles. The interviewee composed of two development agents, one kebeles administrator were asked questions related to livelihood asset access, availability and possession of farmers which are directly or indirectly relate to farmers adaptive capacity to climate change. In additions the key informant interviewee was asked regarding their perception toward climate change and variability.

Focus Group Discussion

In order to ensure the reliability of the data that can be collected through the household survey regarding the change in precipitation and temperature, and farmers' access and possession of key livelihood assets, three focus group discussions (one FGD from each sample kebeles) were conducted. The discussions were led by the researcher with the use of a checklist prepared. The FGD member was composed of 8-12 farmers who have ten/more years of farming experience including at least one female household head from participating group were invited to participate.

Document Review

The secondary data relevant to for this research were gathered from NMSA and relevant books, journals, articles, and report.

3.5 Sampling Procedure and Sample Size Determination

Multistage sampling technique was employed to select the study woreda, kebeles and households. The researcher selects the study woreda purposively, since the researcher is familiar with this woreda. The researcher selects three dominant agro-ecologies (Dega, Wenadega, and Kola) of the study area purposively. By using a stratified sampling technique with the nine rural kebeles classified into three stratums based on the Agro-ecology of the study area. Therefore from Dega agro-ecology 'Giraramba' kebele, from 'Weinadega wogit kebele and from 'kola' Mezerazire kebele were selected by using random sampling techniques. A total 133 households were taken from total population of 4241 by using the following formula quoted from (Chchara, 1997 and Kinfe, 2002 in Ermayas, 2008)

a) $n_o = \frac{z^2pq}{d^2}$ b) $n = \frac{n_o}{1+\frac{no-1}{N}}$

Where n_o=the desired sample when population >10,000, d=is margin of error or the degree of accuracy desired at 0.05, n=number of sample size when the population <10,000, N= is total population, P=is o. 1 (proportion of the population to be included in the sample size I. e10%), Q=is p-1 i.e. 1-0.1 =0. 9, Z= is 95%confidence limit i.e. 1.96

Table 2 Summary of Sample Size Determination

Woreda	Agro-ecology	Sample kebeles	Population (HH)	Sample size
Gishe	Weina dega	Giraramba	2263	71
	Dega	Wogit	1052	33
	Kola	Mezerazir	926	29
Total			4241	133

3.6 .Method of Data Analysis

In order to meet the general and specific objectives of the study the qualitative and quantitative method of data analysis were employed. Descriptive statistics such as percentage, mean, maximum, minimum and standard deviation were used to summarize the collected data. In-addition, inferential statistics such as T-test, chi square test were used. In addition the adaptive capacity index was calculated. SPSS software package version 15.0 and Microsoft Excel 2007 were used in order to calculate necessary indices. And qualitative data from FGD and KII was analyzed contextually.

In order to calculate adaptive capacity index the researcher use LVI approach. A review of vulnerability assessment approaches and methodologies indicates the scale of assessment is an important determinant of the kind of data collection required. Usually for micro level studies primary data and macro level studies an analysis of broader scale indicators is done using secondary data. The LVI and IPCC-VI utilize household-level primary data to measure the chosen sub-components (Hahn, 2009).

For this study LVI approach is more appropriate. Since this study intended to assess the adaptive capacity of farmer's at the different agro-ecology of the study area by calculating aggregate adaptive capacity scores. Farmer's adaptive capacity depended on access to, and control over, key livelihood assets such as financial, physical, human, natural and social capitals. Therefore the adaptive capacity index for this study includes those five assets as major components.

Because each of the sub-components is measured on a different scale, it was first necessary to standardize each as an index. The equation used for this conversion was adapted from that used in the Human Development Index to calculate the life expectancy index, which is the ratio of the difference of the actual life expectancy and a pre-selected minimum, and the range of predetermined maximum and minimum life expectancy (UNDP, 2007).

First each sub- indicators were standardized by using (Eq. 1)

$S_y = S_v - S(min) / S(max) - S(min)$ ---------- (1)

Where, S_y = Standardized value for each variable, s_v = Value for the variable I for a particular agro-ecologies, Smin and Smax is the minimum and maximum values, respectively, for each variable

After each was standardized, the sub-components were averaged using Eq. (2) to calculate the value of each major component:

$M_a = \sum S_v / n$ ---------- (2)

Where M_a = one of the five major components for particular agro-ecology. S_v = represents the standardized value for variables under major component, and n = number of sub-components in each major component

Once values for each major component calculated, their average was obtained by using (Eq.3)

$ACI_a = \sum w_{ai} M_{ai} / \sum w_{ai}$ ---------- (3)

This can also be expressed as

Then after, the five major components were combined in order to obtain an adaptive capacity score by using Eq.4

$$ACI_a = \frac{W_{HC}HCa + W_{SC}SCa + W_{NC}NCa + W_{FC}FCa + W_{PC}PCa}{W_{HC} + W_{SC} + W_{NC} + W_{FC} + W_{PC}} \quad \text{---------- (4)}$$

Where ACI_d=the adaptive capacity index for particular agro-ecology, M_{ai} equals the weighted average of the five major component , w_{ai} are determined by the number of sub component that make up each major component.

Adaptive capacity index ranges from 0 (which indicate low adaptive capacity) to 1(which indicates high adaptive capacity). According to Nakuja (2012,) the range of low, moderate and high adaptive capacities are $0 < \text{Adap Cap} < 0.33$, $0.33 \leq \text{Adap Cap} < 0.66$ and $0.66 \leq \text{Adap Cap} \leq 1.00$ respectively.

CHAPTER FOUR

4. RESULTS AND DISCUSSION

This chapter presents the key findings of the study. The chapter is categorized under four sub-sections. The first sub-section provides the basic characteristics of sampled households. The second sub-section deals with analysis of farmers perceptions towards temperature and precipitation changes. The third sub-section presents the analysis of farmers' key livelihood assets in terms of their access and possession. The fourth sub-section present adaptation strategies' of farmers to cope the impacts of perceived changes.

4.1. Basic Characteristics of Household

4.1.1. Demographic characteristics of respondents

Table 3 indicates, 79.3% of household heads in Mezerazir kebele are male and the remaining 20.7% female. While in wogit kebele 84.8% of surveyed respondents are male headed and the rest 25.2% are female headed. In the case of Giraramba kebele 85.9% and 14.1% of respondents are male and female headed respectively. In the same table, 18.2%, 65.5%, and 16.3% of respondents in Mezerazir kebele fall under the age category of 15-30, 31-65 and beyond 65 years old respectively. Similarly in wogit kebele, 36.4% of surveyed respondents fall under the age category of 15-30, 54.5% of respondents fall under the age brackets of 31-65 years old and 9.1% of respondents are beyond 65 years old. About 28.2%, 60.6%, and 11.3% of respondents in Giraramba kebele falls under the age categories of 15-30, 31-65, and beyond 65 years respectively. Regarding marital status, 58.6%, 27.6% and 13.8% of respondents in Mezerazir kebele are married, single and divorced respectively. In Wogit kebele, 69.7% are married, 18.2% are single, and 12.1% are divorced and in Giraramba kebele, 80.3%, 12.7% and 7% of surveyed

respondents are married, single and divorced respectively. There is no statistically significant variation in less than 5% significance level in sex composition, age categories and marital status among agro-ecologies

Table 3: Distribution of respondents' by sex, age and marital status

Variable	kebele of respondent								X^2
	Mezerazir (kola)		Wogit (Weynadga)		Giraramba (Dega)		Total		
Respondents' sex	Count	%	Count	%	Count	%	Count	%	.689 (df=2, p=. 709)
Male	23	79.3	28	84.8	61	85.9	112	84.2	
Female	6	20.7	5	15.2	10	14.1	21	15.8	
Total	29	100	33	100	71	100	133	100	
Age category									
15-30	5	18.2	12	36.4	20	28.2	37	28.8	2.682 (df=4, p= 0.612
31-65	19	65.5	18	54.5	43	60.6	80	60.2	
>65	5	16.2	3	9.1	8	11.3	16	11.0	
Total	29	100	33	100	71	100	133	100	
Marital status									
Married	17	58.6	23	69.7	57	80.3	97	72.9	5.262(df=4 , P= 0.261)
Not married	8	27.6	6	18.2	9	12.7	23	17.3	
Divorced	4	13.8	4	12.1	5	7.0	13	9.8	
Total	29	100	33	100	71	100	133	100	

Source: Field Survey, 2012

Regarding the family size, the majorities (59%) of household heads have family size greater than five (table 4). The family size of the sampled households varies from 1 to 9 with an average household size of 5.64 with standard deviation 1.837. Statistically significant variation was not observed in family size among agro-ecologies.

Table 4: Distribution of the respondent by their family size

Respondent kebele (Agro-ecology)	Family size Category			Mean	St.dev	Min	Max	X^2
	1-5	>5	Total					
Mezerazr(kola)	12	17	29	5.65	1.653	1	8	11.388 NS(df= 12,p= 0.496
Wogit(weinadega)	16	17	33	5.51	2.166	1	9	
Giraramba (dega)	27	44	71	5.76	1.711	2	9	
Total	55(41%)	78(59%)	133	5.64	1.837	1	9	

Source: Field Survey, 2012

4.1.2 Socioeconomic Characteristics

1. Education

Out of total surveyed respondents 11.3% are illiterate, 38.3% can read and write, 36.8 % attained first cycle education and that of 13.5 % second cycle education (table 5). There is statistically significant variation in educational level across the agro-ecologies at less than 5% level. Thus in Mezerazir kebele 34.4% of households' attained primary and secondary education while 27.6% and 37.9% of respondents are illiterate and capable of read and write respectively. In the case of Wogit kebele 63.7% of respondents' attained primary and secondary education while 9.1% of respondents were illiterate and 27.3% capable of read and write respectively. Similarly in Giraramba kebele 50.7% of respondents attained primary and secondary education while 5.6 % respondents are illiterate and 43.7% of respondents are capable of read and write. Education may play important role in adopting a new system of farming. As farmers acquire more education, their ability to obtain, process, and use information improves. Education increases the ability of farmers to use their resources efficiently and it enhances the farmers' ability to obtain, analyze and interpret information. However the result of the study indicates the education level of respondents in Mezerazir kebele is relatively low. In general, almost half of the respondents in the study area have no formal education which limits the adaptive capacity of farmers.

Source of Livelihood

The majority (92.5%) of the respondents in the sample kebeles practiced mixed agriculture (livestock and crop) and 7.5% practiced subsistence crop production only (table 5). This indicates farmers in the study area were not diversifying their source of livelihood. In turn this limits their adaptive capacity to respond to climate change impact such as crop failure. There is no statistically significant variation in source of livelihood across agro-ecology of the study area.

Table 5: Distributions of respondent by education status and source of livelihood

Variable	kebele of respondents' kebele								X^2
	Mezerazir (kola)		Wogit (weynadga)		Giraramba (dega)		Total		15.929*(
Education status	Count	%	count	%	Count	%	Count	%	df=6, p=
Illiterate	8	27.6		9.1	4	5.6	15	11.3	0.014)
reading and	11	37.9	9	27.3	31	43.7	50	38.3	
Primary school	9	31	13	39.4	28	38.0	50	36.8	
secondary school	1	3.4	8	24.2	9	12.7	18	13.5	
Total	29	100	33	100	71	100	133	100	
Sources of livelihood									3.034(df
crop production	0	0	3	9.1	7	9.9	10	7.5	=2
mixed agriculture	29	100	30	90.9	64	90.1	123	92.5	
Total	29	100	33	100	71	100	133	100	p=0.21

Source: Field Survey, 2012

4.2. Farmers' Perception of Climate change

Perception of temperature and rainfall pattern changes is a necessary prerequisite for any kind of climate change adaptation, including agriculture, natural resource management, and health. Farmers who perceive the change in climate are hypothesized to make adjustments in their farms to reduce climate change born impacts unless they do face some barriers.

4.2.1 Temperature

Out of total sample respondent about 85% of household heads perceived the increasing trend in temperature. The remaining, 8.3% claimed constant temperature and 6.8% did not perceive any change in temperature over the last two decades (table 6). There is no statistically significant variation in temperature perception across agro-ecologies at less than 5% level of significance. The emergence of human and animal diseases that has not been seen before and degradation or deterioration of rivers through time is major local indicators to trace temperature change by respondents.

Results from KI and FGD confirmed that the increasing trend of temperature through time. They also stated that drying of the stream and the emergence of animal diseases is more prevalent problem in the study area.

Table 6: Condition of temperature for the last 20 years by agro-ecology

Kebele of respondent		Condition of temperature for the last 20 years			Total	X^2
		Increasing	no change	I don't know		
Mezerazir(kola)	Count	26	2	1	29	0.994 NS(df =4,p= 0.911)
	%	89.7	6.9	3.4	100	
Wogit(weinadega)	Count	28	3	2	33	
	%	84.8	9.1	6.1	100	
Giraramba(dega)	Count	59	6	6	71	
	%	83.1	8.5	8.5	100	
Total	Count	113	11	9	133	
	%	85.0	8.3	6.8	100	

Source: Field survey, 2012

The statistical recorded data of temperature from 1991-2010 shows the increasing trend (Figure 3). Thus the perceptions of farmers in the study area appear to be in accordance with the statistical record.

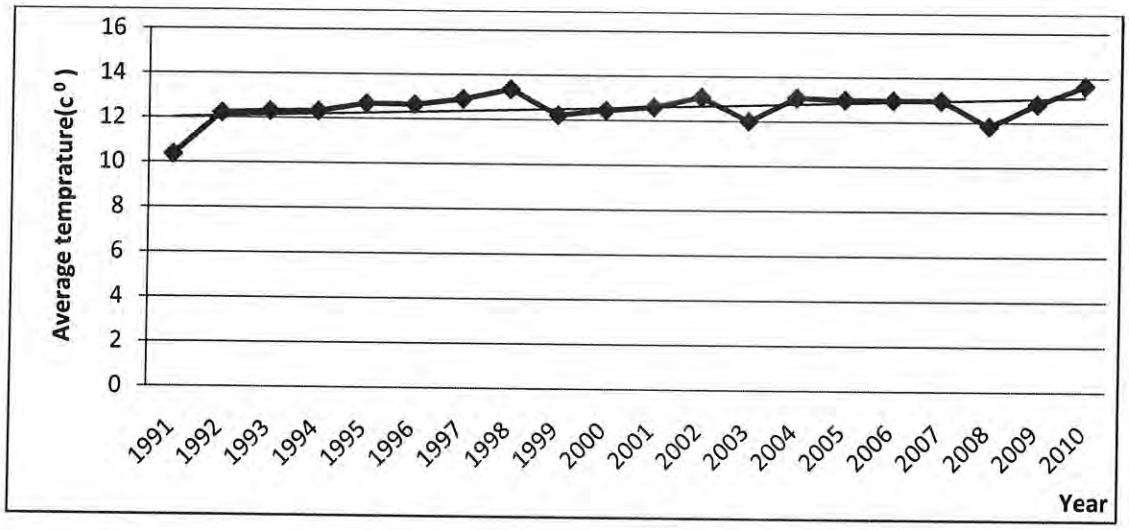

Figure 3 Temperature analysis from 1991-2010

Source: Own Computation, 2012 (raw data obtained from NMSA)

4.2.2. Precipitation

About 91% of respondents in the study area perceived the decreasing precipitation. The remaining 5.6%, 3% and 0.8% of respondent perceived increasing constant and unknown trend of precipitation respectively (table 7). There is no statistically significant variation in respondents' perception of precipitation across agro-ecologies of the study area. The extinction of some plant species, increasing the frequency of drought, shortening of crop growing time, degradation of soil and decreasing its productivity, rain come early and lately from normal, decreasing agriculture production and deterioration/decreasing of water amount are main local indicators that the respondents use to trace precipitation change for the last 20 years.

In addition, the result from FGD and KI confirmed that before many years ago they cultivated cereal crops twice per year (Meher and Belg season). However, currently they cultivate crops once per year in a Meher season since the rainfall in Belg season do not maintain right time. As the participant mentioned, the rains of Meher season start in August and end in the beginning of

September. Due to this problem crops that need a long growing period commonly become dry before producing seeds. Participants also confirmed that the some water bodies become dry up before the beginning of rainy season.

Table 7: Condition of rainfall for the last 20 years by agro-ecology

Kebele of respondent		Condition of rainfall for the last 20 years				Total	X^2
		Increasing	Decreasing	No change	I don't know		
Mezerazir	Count	3	25	1	0	29	4.287NS(df=6 p=0.638)
	%	10.3	86.2	3.4	.0	100.0	
Wogit	Count	0	32	1	0	33	
	%	.0	97.0	3.0	.0	100.0	
Giraramba	Count	4	64	2	1	71	
	%	5.6	90.1	2.8	1.4	100.0	
Total	Count	7	121	4	1	133	
	%	5.3	91.0	3.0	.8	100.0	

Source: Field Survey, 2012

The recorded rainfall data from 1991 to 2010 showed inter annual variability, with the increasing trend in total amount rainfall for the last 20 years. There is seasonal variation in kiremt and belg season . Thus, a high proportion of farmers' perception of reduction in rainfall over the last 20-year period influnced with seasonal rainfall variability.

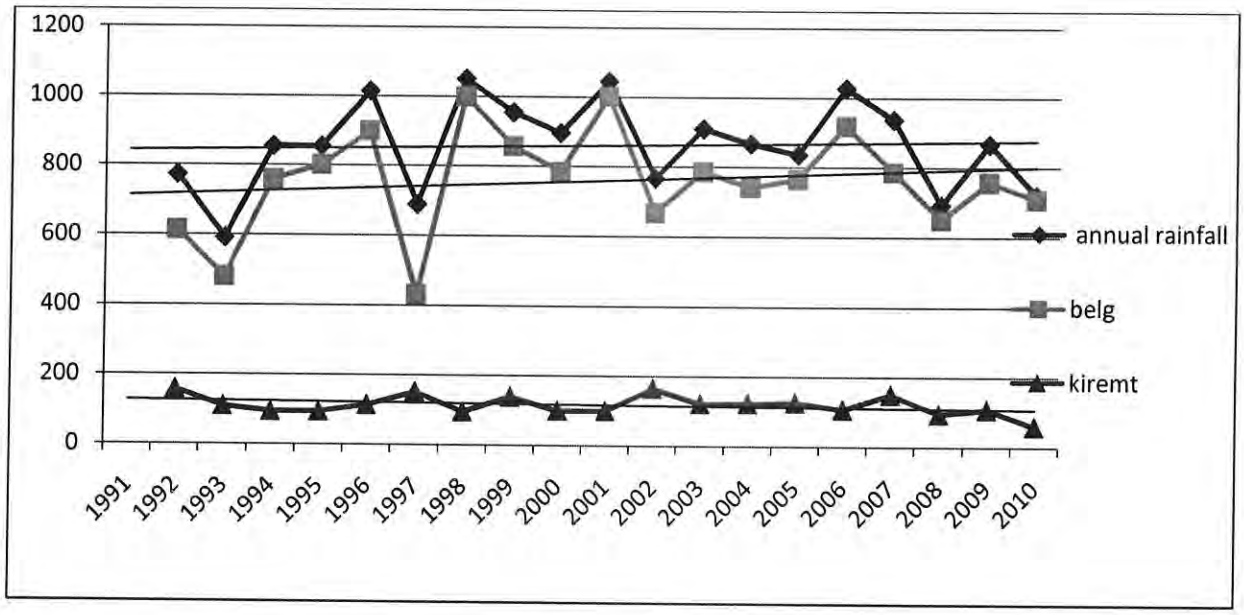

Figure 4: precipitation analysis from 1991-2010

Source: Own Computation, 2012(raw data obtained from NMSA)

Perception difference in terms of respondents' age, sex and education status

Table 8 shows the temperature change perception difference in age, sex and education status of respondents. Thus a higher proportion of respondents with the age category greater than 15-30 claimed the increase in temperature. On the other hand the relatively higher percentage of farmers with age category 15-30 years confirmed constant and unknown change in temperature. Similarly a higher proportion of respondents with primary and secondary education status confirmed the increase in temperature. While relatively more respondents with no formal education confirmed the unknown temperature change. Furthermore a higher proportion (88.4%) of male household heads perceived the increase in temperature. While a relatively more percentage of female household head perceived constant and unknown change in temperature. There is statistically significant difference in perception of temperature with age, sex and education status at 1%, 5%, and 10% confidence level respectively. Thus the educated as well as

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old farmers are more likely to perceive the current change. In addition male household heads are more likely to perceive the change in temperature.

Table 8: Perception of temperature by farmers' age, education and sex

Variables	Condition of temperature for the last 20 years						Total	X^2
	Increasing		no change		I don't know			
Respondent age	No	%age	No	%age	No	%age		
15-30	25	67.6	7	18.9	5	13.5	37	13.566*(df=4, p=0.009)
31-65	72	90	5	6.2	3	3.8	80	
>65	16	100	0	0	0	0	16	
Total	113	85	11	8.3	9	6.8	133	
Education status of respondent								
Illiterate	9	60	2	13	4	26.7	15	11.302***(df=6,p=0.079)
Read and write	42	84	3	6	3	6	50	
primary school	44	88	5	10	3	6	50	
Secondary school	18	100	0	0	0	0	18	
Total	113	85	10	7.5	10	7.5	133	
Sex of the respondent								
Male	99	88.4	7	6.2	6	5.4	112	6.568**(df=2, p=0.037)
Female	14	66.7	4	19	3	14.3	21	
Total	113	85	11	8.3	9	6.8	133	

(*, **, ***, significant at 1%, 5%, and 10% respectively) Source: Field survey, 2012

Regarding rainfall change, a higher proportion (90.7%) of respondents with the age category greater than 15-30 perceived the decrease in precipitation. On the other hand a relatively more farmers with age category 15-30 years perceived constant and unknown change in rainfall. There is a statistically significant difference in perception of rainfall with the respondent's age categories at 5% significance level. The older the farmer the more he/she perceive the current change. Similarly majority (98.5%) of respondents with primary and secondary education status perceived the decrease in precipitation while relatively more respondents with no formal education perceive constant change. Furthermore, a higher proportion of male household heads

perceived the deceased in rainfall. While relatively more (19.1%) of female household head perceived constant and unknown change in precipitation. There is also a statistically significant difference in precipitation perception with education status and sex of respondent at10% and 1% of probability respectively. Thus the male household head and educated farmers have better perception ability to change as they get more information and knowledge.

Table 9: Perception of rainfall by age, education status and sex of household head

Variables	Condition of precipitation for the last 20 years								Total	X^2
	Increasing		Decreasing		no change		I don't know			
Respondent age	No	%age	No	%age	No	%age	No	%age		
15-30	0	0	32	86.5	4	10.8	1	2.7	37	16.831*
31-65	5	6.2	75	93.8	0	0	0	0	80	*(df=6
>65	2	12.5	14	87.5	0	0	0	0	16	p=0.01)
Total	7	5.3	12	91	4	3	1	0.8	133	
Education status of respondent										
Illiterate	3	20	11	73.3	1	6.7	0	0	15	15.143*
Read and write	3	6	43	86	3	6	1	2	50	**(df=9
Primary school	1	2	49	98	0	0	0	0	50	,p=0.08
Secondary school	0	0	18	100	0	0	0	0	18	7)
Total	7	5.3	12	91	4	3	1	0.8	133	
Sex of the respondent										
Male	6	5.4	105	93.8	1	0.9	0	0	112	16.491*
Female	1	4.8	16	76.2	3	14.3	1	4.8	21	(df=3,p
Total	7	5.3	121	91	4	3	1	0.8	133	=0.001)

(*, **, *** significant at 1%, 5%, 10% level respectively) Source: Field Survey, 2012

4.3 Adaptive Capacity of Farmers to Climate Change and Variability

4.3.1 Key Livelihood Assets

4.3.1.1 Human Capital

Human capital refers to the level of education and productive skills of the people. It is vital to every society and enhances human capabilities. A good level of education will increase available livelihood options and enhance adaptive capacity (Smith and Skinner, 2002). Thus this study includes literacy level, number of dependant, radio ownership and skill training to assess human capital.

Literacy level

As mentioned in the previous section almost half of the respondents in the study area have education status of illiterate and capable of read and write. Communities with educated populations capable of 'productive' activity may have a better chance of acting on climate risk management strategies, coping with severe weather events and seeking out potential benefits from altered conditions (Ellen & Katia, 2006). However this study indicates the education level of respondents in the study area is low which limit the adaptation option of farmers.

Number of dependant

The average number of dependant (< 14 age and > 65 age) within a family is found to be 2.7 which are almost half of the average family size (5.64). Households with a high degree of dependency, whether through children, the elderly, or the infirm, are likely to be more vulnerable to climate change as they are already in the precarious position of having a relatively small number of economically active adults. This is because economically active adults will have more burdens to fulfill the needs of the dependant. As well they spend much of their resources in unproductive activity to take care of the dependants and they cannot invest their labor resource

where ever there is a demand (Balgis et al., 2005). Thus the study shows, a significant average number of dependants (almost half of average family size) are found per each household. This implies farmers in the study area are more vulnerable to climate change or have limited adaptive capacity as they spend much of their resources in unproductive activity to take care of the dependants.

Table 10: Average number of dependant per household

Kebele(agro ecology)	Mean	Std. Deviation
Mezerazir (kola)	2.6897	1.49053
Wogit (weynadega)	2.4242	1.47966
Giraramba(dega)	2.6479	1.41521
Total	2.7	1.4618

Source: Field Survey, 2012

Skill training

All sample respondents were asked to indicate the type of skill training that they participate in last five years. On average 21.2%, 42.5%, 34.2% and 8.7% of sample respondents were participated in agricultural management, health, how to generate income and climate change training for the last five years respectively (figure 5). According to Smit et al., 2001 "lack of informed, skilled and trained personnel reduces adaptive capacity," while "greater access to information increases likelihood of timely and appropriate adaptation." The survey result indicates significant numbers of respondents were not participating in the different skill training program. Thus there is a lack of skill training program in the study area which reduces the adaptive capacity of farmers to climate change and variability impact.

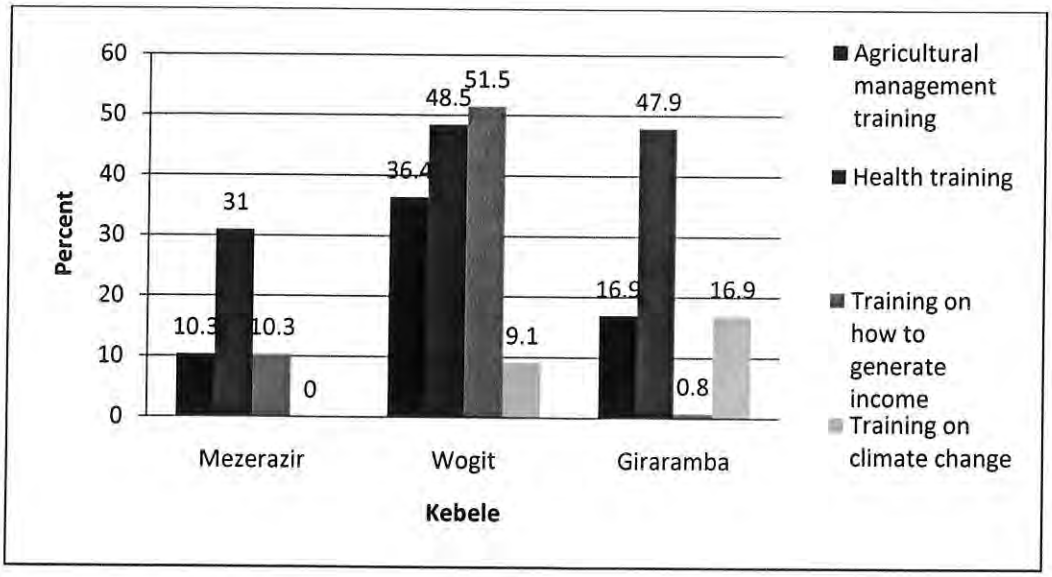

Figure 5: Participation of respondents in skill training for the last five years

Source: Field Survey, 2012

Radio Ownership

Out of total sample respondents about 28.6% of households have radios (table 11). Farm household requires information related to climate change and variability, market and other information which essential to their day to day life. When farmers get timely, the believable and indispensable information they can adjust according to changes in climate or market related change (Angelica and Richard, 2010). For this reason ownership of electronic device such as radio is necessary. However the survey result indicates a significant number of households do not have a radio which limits their access to information regarding agriculture and climate change. Therefore this limits the adaptation measure of farmers to climate change and variability. Since, if farmers do not have access to sufficient information regarding climate and other important issue, they can not take a necessary adjustment to changes. Therefore they become vulnerable to climate change impact and have low capacity to adapt.

Table 11: Radio ownership

Radio ownership		Respondents' kebele			Total	X^2
		Mezerazir	Wogit	Giraramba		
Yes	Count	5	6	27	38	6.681**(df=2,p=0
	%	17.2	18.2	38.0	28.6	.035)
No	Count	24	27	44	95	
	%	82.8	81.8	62.0	71.4	
Total	Count	29	33	71	133	
	%	100.0	100.0	100.0	100.0	

Source: Field Survey, 2012(** Significant at 5% Level)

4.3.1.2 Social Capital

All respondents in the sample kebeles were asked to state the level of relationship among family members within their family. Accordingly out of the total sampled respondents 67.7%, 15.8%, 15% and 1.5% of households perceive the level of relationship among family members were strong, very much strong, weak, and very much weak respectively. Social capital is related to adaptive capacity through its various forms and functions. Bonding enables strong ties between close associates or friends, bridging connects individuals of greater social distances. In terms of climate and weather related events with damaging impacts, communities with strong social resources are in a good position to handle climate related challenges. Therefore this survey indicates the existence of strong bonding among family in the study area which helps to handle climate related challenges and enhance adaptive capacity of farmers.

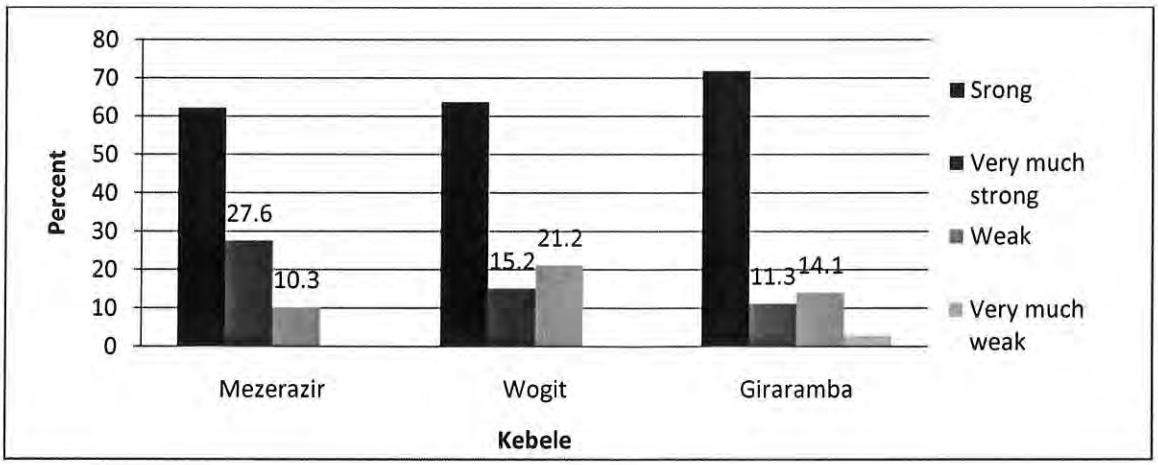

Figure 6: Level of relationship among family members within the family

Source: Field Survey, 2012

In addition all sample respondents were asked whether there is the tradition of working cooperative to perform agricultural activities. Accordingly about 85.7% of respondents reported the existence of working cooperative to perform agricultural activities (table, 12). There is no statistically significant difference in tradition of working cooperative at 5 % level of significance across three kebeles. This higher percentage indicates the existence of a strong network across all kebeles which help to handle climate related hazards and thereby enhance adaptive capacity of farmers in the study area.

Table 12: Tradition of working cooperative

Is there tradition of working cooperative to perform agricultural activities.		respondents' kebele			Total	X^2
		Mezerazir	Wogit	Giraramba		
Yes	Count	27	30	57	114	3.732 NS
	%	93.1	90.9	80.3	85.7	(df=2 p=0.155
No	Count	2	3	14	19	
	%	6.9	9.1	19.7	14.3	
Total	Count	29	33	71	133	
	%	100.0	100.0	100.0	100.0	

Source: Field Survey, 2012

Furthermore the respondents were asked whether there is informal social institution in their locality or not. Accordingly about 80.5% of respondent stated that the existence of informal institution like ekub, edir and mahaber in their locality. The majority (74.8%) of the respondents were members of informal institution. This indicates the existence of informal institutional support which contributes to enhance adaptive capacity of farmers to climate change and variability impact. The result from FGD and KI confirmed the existence of a good informal social institution in the study area. According to the participant edir is the main social institution which offers good social support within the community.

Table 13: Informal social institution

Kebele of respondent		Are there informal institutions (ekub, edir and mahaber) in your locality?			If yes are you a member?		
		Yes	No	Total	Yes	no	Total
Mezerazir	Count	20	9	29	11	9	20
	%	68.9	13.8	100.0	55	45	100
Wogit	Count	27	6	33	19	8	27
	%	81.8	18.2	100.0	70.3	29.7	100
Giraramba	Count	60	11	71	50	10	60
	%	84.5	15.5	100.0	83.3	17.7	100
Total	Count	107	26	133	80	27	107
	%	80.5	19.5	100.0	74.8	25.2	100
X^2		3.457NS(df=2,p 0.071)			NS5.101(df=2,0.125)		

Source: Field Survey, 2012(NS Not Significant at 5%Level).

4.3.1.3 Natural capital

Natural capital consists of land, water, and biological resource such as forest (Scoones, 1998). For this study, natural capital is the reflection of land holding size, soil fertility, slope of land, forest and water resource.

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Farm Land Holding Size

Out of total respondents 19.5%, 69%, 6.0%, 3.8%, and 1.5% of farmers land holding size falls under the categories of < 0.51, 0.51-1, 1.01-1.5, 1.51-2, and 2.01-2.5 hectares respectively (table 14). Obviously, for rural residents of most developing countries, land is the primary means of production used to generate a livelihood for a family. It is also the main asset that farmers have to accumulate wealth and, equally importantly, is what they can transfer in the form of wealth to future generations. Accordingly, the size of the land that they own affect a household's income, and their incentive to work and to invest (Hoben, 2000). This study indicates the majority (69%) of respondents' farm land holding size in the study area range from 0.51 to 1 hectare which is too small to diversify livelihood options.

Table 14: Distribution of farmers, by farm land size

Agro- ecology		Farm land size in hectare					Total
		< 0.51	0.51-1	1.01-1.5	1.51-2	2.01-2.5	
Mezerazir (kola)	Count	5	16	3	3	2	29
	%	17.2	55.2	10.3	10.3	6.9	100.0
Wogit (wogit)	Count	5	26	1	1	0	33
	%	15.2	78.8	3.0	3.0	.0	100.0
Giraramba (Dega)	Count	16	50	4	1	0	71
	%	22.5	70.4	5.6	1.4	.0	100.0
Total	Count	26	92	8	5	2	133
	%	19.5	69.2	6.0	3.8	1.5	100.0

Source: Filed Survey, 2012

Table 15 Mean, standard deviation, maximum and minimum farm land holding size

Agro-ecology	Minimum	Maximum	Mean	Std. Deviation
Mezerazir (kola)	.250	2.500	.99138	.508775
Wogit (weynadega)	.250	1.750	.76894	.283190
Giraramba (Dega)	.375	2.000	.78750	.269485
Total	0.25	2.500	0.849	0.354

Source: Field Survey, 2012 (* significant at 1% level)

The average farm land holding per sample household in Mezerazir, Wogit and Giraramba Kebele 0.99, 0.77, and 0.79 hectares respectively. The maximum land holding size is 2.5 hectares while the minimum land holding size is 0.25 hectares (table 15). The average farm land holding size of all sampled households in the study area was found to be 0.849 hectares. This small farm land holding size limits the adaptive capacity of farmers to climate change and variability impact in the study area.

In order to assess the changes that occurred in the farmers' land holding size, the respondent was asked to indicate the change since they start farming. Accordingly 24.1%, 70.7% and 5.3% of respondents were reported an increase, decrease and no change respectively (table 16). Thus the majority (70.7%) of farmers land holding size was decreased and this holds true for all agro-ecologies. The reported reasons for the decline of holding size are land degradation and distribution of land among family. The respondents also reported deforestation and plowing of the hilly and mountainous area were the reasons for the increasing of land holding size. The result from KII and FDG confirmed that the land holding size of farmers in the study area becomes highly fragmented due to increasing distribution of their actual land among family members when they get married. Therefore, the decreasing trends of land holding size in the study area limit the adaptive capacity of farmers to climate change and variability.

Table 16: Changes that had happened to the size of farmers' land holdings since they start farming

Respondent kebele (Agro-ecology)		Size of farm land			Total
		Increased	Decreased	no change	
Mezerazir(kola)	Count	10	18	1	29
	%	34.5	62.1	3.4	100.0
Wogit(weynadega)	Count	10	21	2	33
	%	30.3	63.6	6.1	100.0
Giraramba(dega)	Count	12	55	4	71
	%	16.9	77.5	5.6	100.0
Total	Count	32	94	7	133
	%	24.1	70.7	5.3	100.0

Source: Field Survey, 2012

Soil Fertility

All sample respondents were asked to identify the general fertility status of their farm plots. Out of total respondents 5.3%, 60.9%, and 33.8% of households were indicating the status of soil fertility as fertile, somehow fertile and not fertile respectively(figure 7). In order to see whether there is a difference in land fertility across agro-ecology Chi square test was calculated. The Chi square result 8.252 (df =4, p=0. 083) indicate statistically significant differences at the 10 % level of significance. This indicates only a small percentage (5.3%) of household heads in Giraramba and wogit kebele have fertile land but in Mezerazir kebele none of the respondents have fertile land. This may be due to the topography of the land that susceptible to erosion. On the other hand, a significant number (94.7%) of households' soil fertility falls under somehow fertile and not fertile. The poor status of soil fertility affects productivity and hence limits farmers' adaptive capacity to climate change and variability.

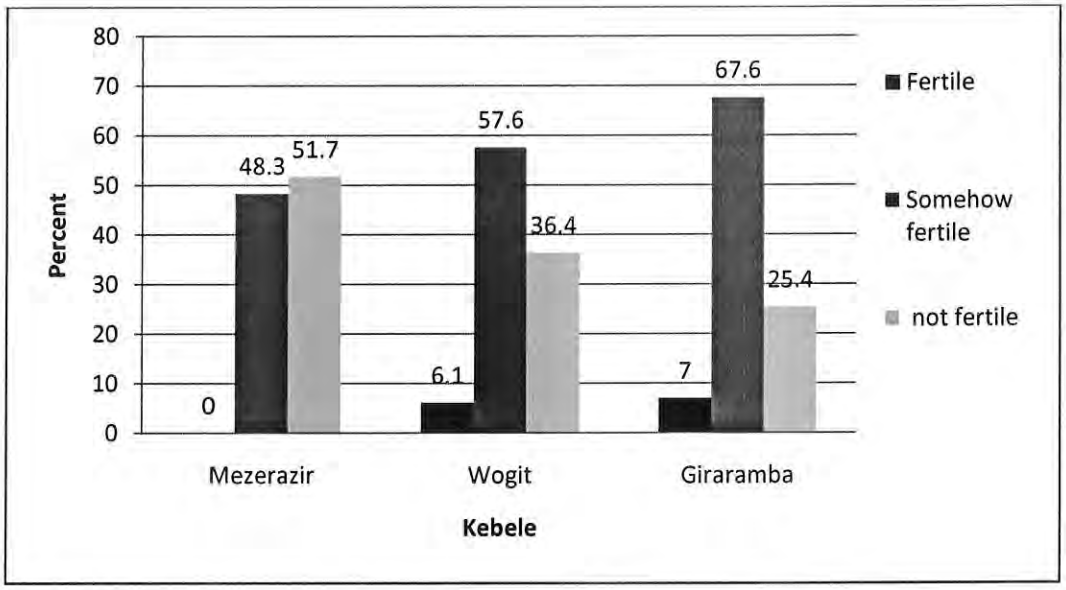

Figure 7: The status of soil fertility

Source: Field Survey, 2012

Slope of Land

The sampled respondents were asked to state the slope of their cultivated land. Accordingly on average 28.2%, 19.5%, 36.2% and 16.1% of respondents reported that the slope of their farm land is plain, hill, highly sloppy, and mountainous respectively (figure 8). In order to see whether there is a difference in the slope of household cultivated land Chi square test was calculated. The result of Chi square 10.536 (df=6, p=0. 104) indicates there is no a statistically significant difference at the 10 % level of confidence. Thus the majority (71.8%) of respondents' cultivated land slope falls under the categories of hilly, highly sloppy, and mountainous. Consequently households whose land slope is hilly, highly sloppy and mountainous can be easily susceptible to risk of climate change. Moreover it is not suitable for intensified agricultural activities like irrigation which is one of main adaptation strategy to climate change and variability. This will negatively affect the adaptive capacity of farmers in the study area.

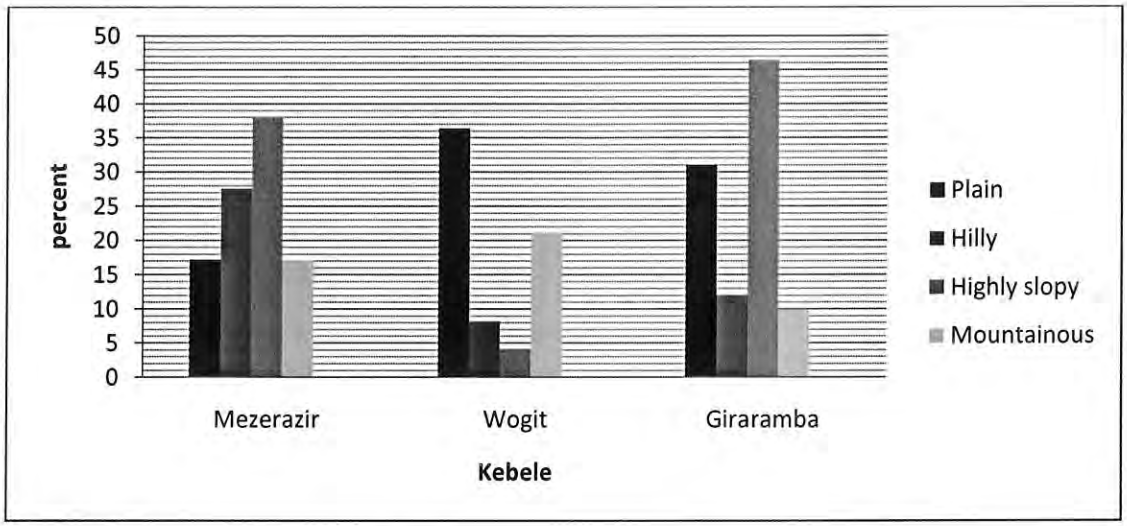

Figure 8: Slope of farm land

Source: Field Survey, 2012

Forest availability

In order to assess the availability of forest resources in the study area the respondents were asked whether there is the forest resource at their locality or not. Accordingly out of total sample respondent 33.1% of households have forest resource in their locality (table 17). This indicates a great deal of respondents in the study area do not have access to forest resource. This significantly affects farmers' adaptive capacity that they do not get benefit from forest resource. There is no a statistically significant difference in availability of forest resource across three kebele at 5% significance level.

Table 17: Forest resource availability

kebele of respondents		Availability of the forest resource in the locality		Total	X^2
		Yes	No		
Mezerazir	Count	14	15	29	5.101NS(df=2,p=0. 078)
	%	48.3	51.7	100.0	
Wogit	Count	12	21	33	
	%	36.4	63.6	100.0	
Giraramba	Count	18	53	71	
	%	25.4	74.6	100.0	
Total	Count	44	89	133	
	%	33.1	66.9	100.0	

Source: Field Survey, 2012

Water

In order to assess potable water availability and accessibility in the study area the respondent was asked to state their source of water. Accordingly 42.2%, 96.6% and 10.3% of respondents in Mezerazir kebele have river, spring, and pipeline water source respectively. Similarly 39.4%, 78.8 % and 69.7% of respondents in wogit kebele have river, spring and pipeline water source respectively. While in Giraramba 57.7% of respondents have a river water source, 71 .8 % have spring water source and 31% have pipeline water. This indicates the majority of respondent in Mezerazir kebele and Giraramba kebele have river and string water source. The respondents state that they use this water source for human and animal drinking purpose. In wogit kebele almost half of the respondents have a pipeline drinking water source. In general lack of potable drinking water source in Mezerazir and Giraramba kebeles affect the health of farmers and in turn reduce their adaptive capacity to climate change and variability.

Table 18: Water source

Kebele of respondent	Water source		
	River	Spring	Pipeline
Mezerazir	42.2%	96.6%	10.3%
Wogit	39.4%	78.8%	69.7%
Giraramba	57.7%	71.8	31.0%

Source: Field Survey, 2012

4.3.1.4 Financial Capital

Financial capital consists of stocks of money or other savings in liquid form. In this sense it does not include financial assets only but should also include easily disposable assets such as livestock, which in other senses may be considered as natural capital. It includes income level variability over time, and distributed within society of financial savings, access to credit, and debt levels (Harris et al, 2010). Smit et al. (2001) highlight that greater economic resources increase adaptive capacity, while a lack of financial resources limits adaptation options. This study includes livestock ownership, credit service, and farm land size to assess farmers financial capital.

Livestock ownership and farm land size

Livestock was considered to offer readily available cash in times of crop failure due to climate related problems in the study communities. Ox, cow, sheep, goat, mule and donkey are the major types of livestock in the study area (table 19). The average number of oxen per household was found to be 1.444 with standard deviation 0.668. The minimum and maximum ox owned being 0 and 3 respectively. The minimum and maximum number of cows per household is 0 and 2 respectively while the average ownership is 0.774 with a standard deviation of 0.531. The average number of sheep per household was found to be 6.684 with a standard deviation of 5.303, while the minimum and maximum number of sheep owned is 0 and 25 respectively. And

the average number of goats per sample household was 2.459 with standard deviation 3.412 whereas the minimum and maximum number of goat ownership is 0 and 20 respectively. The average number of mules per sample household was found to be 0.158 with standard deviation 0.366. And the minimum and maximum number of mules owned is 0 and 1respectively. The average number of donkey per sample respondent was found to be 0.849 with standard deviation 0.571 while the minimum and maximum number of donkeys owned is 0 and 3 respectively.

Table 19: Minimum, Maximum Mean and Standard Deviation of Livestock Owned

Livestock type	Kebele	Min	Max	Mean	Std. Dev
Ox	Mezerazir	.00	3.00	1.6552	.61388
	Wogit	.00	2.00	1.3636	.69903
	Giraramba	.00	3.00	1.3944	.66502
	Total	.00	3.00	1.444	.668
Cow	Mezerazir	.00	2.00	1.0690	0.52989
	Wogit	.00	1.00	.6364	.48850
	Giraramba	.00	2.00	.7183	.51222
	Total	.00	2.00	.774	.531
Sheep	Mezerazir	.00	2.00	1.3636	.69903
	Wogit	.00	25.00	10.6061	6.67523
	Giraramba	.00	16.00	6.4225	3.97730
	Total	.00	25.00	6.684	5.303
Goat	Mezerazir	.00	20.00	5.8621	2.94866
	Wogit	.00	10.00	2.3030	2.08394
	Giraramba	.00	7.00	1.1408	1.56110
	Total	.00	20.00	2.459	3.412
Mule	Mezerazir	.00	0.00	0.0000	.0.0000
	Wogit	.00	1.00	.1818	.39167
	Giraramba	.00	1.00	.2113	.41111
	Total	.00	1.00	.158	.366
Donkey	Mezerazir	.00	2.00	1.00	1.56110
	Wogit	.00	3.00	.8485	.71244
	Giraramba	.00	3.00	.7887	.50471
	Total	.00	3.00	.849	.571

Source: Field Survey, 2012 (* Significant at 1 % Level).

To know the aggregate life weight of livestock owned per household, all types of livestock converted into TLU. Accordingly out of total sampled respondents, 2.3%, 3.0%, 10.5%, 20.3% and 59.4% of respondents TLU fall under the TLU categories of 0.01-1, 1.01-2, 2.01-3, 3.01-4, and >4 respectively (table 20). There is no a statistically significant difference in TLU across three kebele at 5% significance level. According to Asfaw and Jabbar, 2008 the average herd size of Ethiopia is 4.46. However the average herd size of the study area is found to be 4.11 which are below the average herd size of Ethiopia.

Table 20: Distribution of respondent by livestock ownership

Kebele of respondent		TLU category						Total	X^2
		0	0.01-1	1.01-2	2.01-3	3.01-4	> 4		
Mezerazir	Count	0	0	1	1	7	20	29	13.613(df=10 p=191)
	%	.0	.0	3.4	3.4	24.1	69.0	100.0	
Wogit	Count	3	0	1	4	2	23	33	
	%	9.1	.0	3.0	12.1	6.1	69.7	100.0	
Giraramba	Count	3	3	2	9	18	36	71	
	%	4.2	4.2	2.8	12.7	25.4	50.7	100.0	
Total	Count	6	3	4	14	27	79	133	
	%	4.5	2.3	3.0%	10.5	20.3	59.4	100.0	

Source: Field Survey, 2012

Farmers' farm land size determines wealth accumulation. If farmers have large farm land size, they can increase crop and livestock productivity. However as table 15 indicate, the farm land size of farmers in the study area is very small that contributed for mouth to hand productivity and low adaptive capacity at the time of climate stress.

Credit service

Out of total surveyed respondents 54.1% use credit service for the purpose of purchasing food (2.7%), animal fattening (85.1%), trading (2.7%) and to purchase agricultural input (50.2%) and the remaining 45.9% of respondents do not use credit service (table 21). The reason for being non credit user is complicated precondition to get credit service (54.7%), lack of interest (28.3%)

and lack of credit access in their locality (17 %). There is no statistically significant difference in using a credit service at 10% significance level. Formal financial services from banks and microfinance industry (microcredit, micro insurance and micro savings) improve adaptive capacity, and reduce the vulnerability of the poor to climate induced extreme events (Hari et al, 2010). The survey result indicates a significant number of respondents use credit service for the purpose of animal fattening and purchasing of agricultural input which contributed to increase the adaptive capacity of farmers to climate related hazard.

Table 21: Credit service

kebele of respondents		using credit service		Total	X^2
		Yes	no		
Mezerazir	Count	21	8	29	5.842NS(df=2,0.054)
	%	72.4	27.6	100.0	
Wogit	Count	14	19	33	
	%	42.4	57.6	100.0	
Giraramba	Count	37	34	71	
	%	52.1	47.9	100.0	
Total	Count	72	61	133	
	%	54.1	45.9	100.0	

Source: Field Survey, 2012

4.2.1.5 Physical Capital

Physical assets such as road networks and the availability of markets and health facilities may enhance the adaptive capacity of a household (Zhang et al., 2007). Physical capital allows people to develop livelihood strategies that improve their resilience. A society, family, group or person with limited or no physical capital, is at risk of non-productiveness which is likely to affect their livelihood. This study included two main indicators of physical capital, such as availability of technologies (improved seed, fertilizer, pesticide, insecticide) and accessibility to infrastructure and institution such as microfinance, markets, health center, veterinary service, telephone and electricity.

Agricultural Technology

On average 39.1%, 43.9%, 16.9% and 21.2% of respondents utilize agricultural input such as chemical fertilizer, quality seed, pesticide and insecticide respectively (figure 9). There is no statistically significant difference in utilization of agricultural input at 5% level across agro-ecology. Utilization of agricultural technologies like chemical fertilizer, quality seed, pesticide, and insecticide increases farmers' agricultural productivity. Thereby enhance adaptive capacity of farmers to climate change challenge. However as the survey result shows agricultural technology utilization of farmers in the study area is low. The result from FGD and KI confirmed that the limited access of agricultural technologies in the study area especially insecticide and quality seed. According to the participant the limited access of agricultural technologies besides high price limit their utilization.

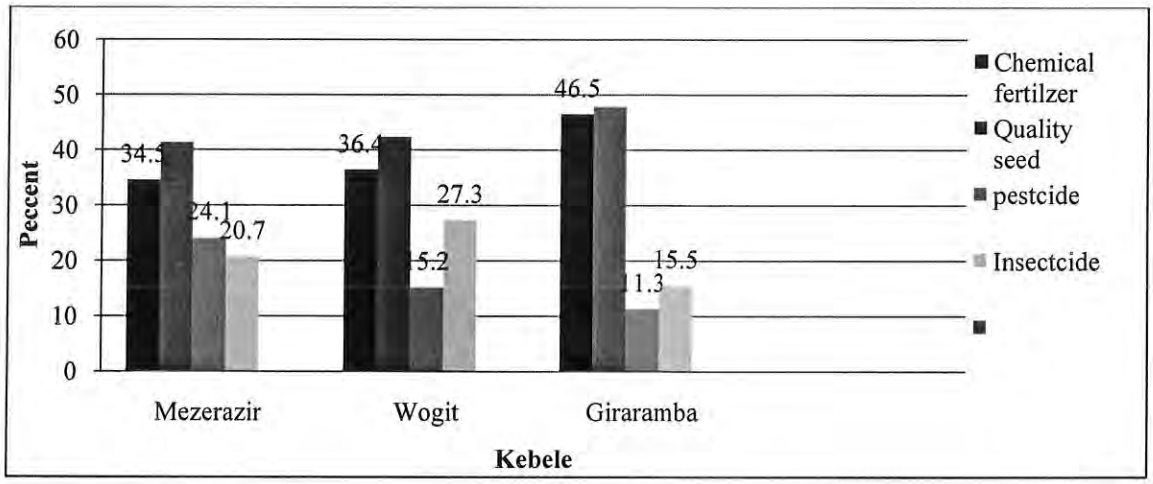

Figure 9: Utilization of Agricultural Input

Source: Felid Survey, 2012

Infrastructure and Institution

According to Temesgen (2010) those people who have access to infrastructure and institution (market, health service, veterinary service etc.) within 1-4 km is less vulnerable to climate

related challenge. Thus this study assesses farmers' access to infrastructure and institution in terms of distance they traveled.

Access to market

Out of total sample respondents in the study area 22.6% and 77.4% of households are found at a distance of ≤4 km and ≥5 km from the nearest market respectively (table 22). It is hypothesized that as distance to market increase, the adaptations to climate change decrease. The proximity to market is an important determinant of adaptation most likely because the market serves as a means of exchange information and goods with other farmers (Maddison, 2006). However this study indicates high proportion of respondents (77.4%) has traveled a long distance to reach the nearest market.

Table 22: Access to market

Respondents' kebele		Distance traveled to the nearest market		Total	X^2
		≤4km	≥5km		
Mezerazir	Count	0	29	29	21.474*(df=2,p =0.000)
	%	.0	100.0	100.0	
Wogit	Count	16	17	33	
	%	48.5	51.5	100.0	
Giraramba	Count	14	57	71	
	%	19.7	80.3	100.0	
Total	Count	30	103	133	
	%	22.6	77.4	100.0	

Source: own field survey, 2012(*significant at 1% level)

The result from Chi square test indicates a significance difference in the availability of market across three kebeles. Thus in Mezerazir kebele 0% and 100% of respondents are found at a distance of ≤ 4 km and ≥5 km respectively. Whereas 48.5% and 51.5% of respondents in wogit kebele are found at a distance of ≤ 4 km and ≥5 km respectively. Similarly in Giraramba kebele 17.3% and 82.7% of respondents are found at a distance of ≤ 4 km and ≥5 km from the nearest

market respectively. Therefore farmers in wogit kebele have relatively better availability of market than Mezerazir and Giraramba kebele by the relative distance from the nearest market.

Access to health center

Out of total respondents 56.4% and 43.6% of household are found at a distance of ≤ 4 km and ≥ 5 km from the nearest health center, respectively (table 23). Access to health care infrastructure is positively correlated with higher adaptive capacity because it provides alternatives to recover from health problems resulting from climate impacts, such as cholera, dengue fever and respiratory illnesses (Temesgen, 2010). The survey result shows a good percentage (56.4%) of respondents have good access to health service. However the result from Chi square test shows significant difference in access to health center service across three kebeles at 1% significance level. Thus only 20.7% of respondents in Mezerazir kebele located at a distance of $\leq$ 4km from the nearest health center. While in wogit and Giraramba kebele 48.5% and 74.6% of sample households found at a distance of ≤ 4 km from the nearest health center. Therefore, farmers in Giraramba kebele have best access to health center service and in wogit kebele have better access to health center service. While the majority of respondents in Mezerazir kebele has poor access to the health center services as they travel long distance to reach the nearest health center.

Table 23: Access to health service

Respondents kebele		Distance traveled to the nearest health center		Total	X^2
		≤4 km	≥5 km		
Mezerazir	Count	6	23	29	25.493*(df= 2,p=0.000)
	%	20.7	79.3	100.0	
Wogit	Count	16	17	33	
	%	48.5	51.5	100.0	
Giraramba	Count	53	18	71	
	%	74.6	25.4	100.0	
Total	Count	75	58	133	
	%	56.4	43.6	100.0	

Source: Field Survey, 2012 (* Significant at 1% Level)

Access to veterinary

Veterinary station is an important infrastructure for rural community as they participate in livestock production and their diseased livestock get medical service. For this study access to veterinary service assessed in terms of distance traveled to reach the nearest veterinary service station. Table 24 shows, 51.9% and 48.1% of total sampled respondents' residence located at a distance of ≤ 4 km and ≥ 5 km from the nearest veterinary station. This indicates almost half of respondents in the study area have good access to veterinary services. On the other hand the result from Chi square test indicates a significant difference in availability of veterinary station across three kebele at 1% significance level. Thus in Mezerazir kebele 0% and 100 % of respondents located at a distance of ≤ 4 km and ≥ 5 km from the nearest veterinary station respectively. While 48.5% and 51.5% of households in Wogit kebele placed at a distance of ≤ 4 km and ≥ 5 km from the nearest veterinary service station respectively. Similarly 74.6% and 25.4% of respondents are found at a distance of ≤ 4 km and ≥ 5 km from the nearest veterinary station in Giraramba kebele respectively. This indicates farmers in Giraramba kebele have best access to the veterinary service station. While in Mezerazir kebele none of the respondents get

veterinary service station at a distance of ≤ 4 km and this significantly limit the adaptive capacity of farmers who live in this remote kebele as their diseased livestock do not get medical treatment.

Table 24: Access to veterinary service

Kebele of respondents		distance to the nearest veterinary service		Total	X^2
		≤ 4 km	≥ 5 km		
Mezerazir	Count	0	29	29	46.161*(df=2,p =0.000)
	%	.0	100.0	100.0	
Wogit	Count	16	17	33	
	%	48.5	51.5	100.0	
Giraramba	Count	53	18	71	
	%	74.6	25.4	100.0	
Total	Count	69	64	133	
	%	51.9	48.1	100.0	

Source: Field Survey, 2012(*significant at 1% level)

Access to Telephone Service

Table 25 shows out of total sampled respondents only 22.8% of respondents have access to telephone service. This indicates farmers in the study area have poor access to telephone service due to lack of telecommunication service and low economic status of farmers to purchase mobile phone. There is no statistically significant difference in access to telephone service at 5% significance level. Result from KI and FGD confirmed that local and regional governments give less attention to infrastructural development like telecommunication service in the study area.

Table 25: Access to telephone service

Respondents' kebele		Access to telephone service		Total	X^2
		Yes	No		
Mezerazir	Count	5	24	29	1.132NS(df=2,p=0.568)
	%	17.2	82.8	100.0	
Wogit	Count	6	27	33	
	%	18.2	81.8	100.0	
Giraramba	Count	18	53	71	
	%	25.4	74.6	100.0	
Total	Count	29	104	133	
	%	21.8	78.2	100.0	

Source: Field Survey, 2012

Access to credit and saving intuitions

The respondents were asked whether there is a microfinance institution in their locality or not. Thus out of total respondent 41.3% of household head reported that they have access to microfinance institutions. Availability of credit and savings institution in a given locality of farm community plays an important role in supporting farmers' adaptation to climate change. Farmers can get financial resource in the form of loans in order to diversify the range of livelihood strategies (Hari et al, 2010). The survey result shows more than half of the respondents do not have access to microfinance institutions in their locality. This indicates poor access of microfinance institution that farmers cannot build strong adaptation options by diversifying their livelihood strategy. The reported microfinance institution includes ACSI and farmer association saving and credit institution. The result from FGD and KI confirmed that farmers in Mezerazir and Giraramba kebele travel so far distance in order to get the main microfinance institution (ACSI) which found at woreda town. On the other hand farmers in wogit kebele have better access to formal microfinance institution (ACSI) since the kebele is located near by the woreda town

Table 26: Access to microfinance institution

Kebele of respondents		Availability of credit and saving institution in the locality		Total
		Yes	No	
Mezerazir	Count	11	18	29
	%	37.9	62.1	100.0
Wogit	Count	23	10	33
	%	69.7	18.2	100.0
Giraramba	Count	21	50	71
	%	29.5	70.5	100.0
Total	Count	55	19	133
	%	41.3	58.7	100.0

Source: Field Survey, 2012

Access to Electric Power

Farmers' access to electric power play an important role to diversify their livelihood strategy. However none of the farmers in the study area have access to electric power. This indicates farmers in the study have limited capacity to diversify livelihood strategy and hence limit their adaptive capacity to the climate change problem.

4.2.2 Adaptive capacity Index

Adaptive capacity analysis was conducted using access to and control over natural, human, social, physical, and financial resources. Access to and control over the resources necessary for adaptation varies within communities in the different agro-ecologies. Adaptive capacity index calculated by using the minimum and maximum value across three agro-ecologies (see appendix 1). Accordingly farmers in all kebeles (agro-ecologies) have high adaptive capacity in terms of social capital (0.716 Mezerazir kebele, 0.739 Wogit kebele and 0.694 Giraramba kebele). The existence of good tradition of working cooperation and social informal institution contributed to high adaptive capacity index in social capital. However farmers in Mezerazir kebele have low adaptive capacity (0.311) in terms of human capital while farmers in Wogit kebele (0.536) and

Giraramba (0.449) kebele have moderate adaptive capacity. Low literacy level, high number of dependant, lack of sufficient skill training and radio ownership are the major contributing factor for low and moderate adaptive capacity index in terms of human capital. Furthermore farmers in all kebeles have moderate adaptive capacity in terms of financial capital (Mezerazir kebele 0.537, wogit kebele 0.397, and Giraramba kebele 0.423). While farmers in all kebeles have low adaptive capacity in terms of natural capital (Mezerazir kebele 0.25, wogit kebele 0.273 and Giraramba kebele 0.202). The major contributing factors for this low adaptive capacity are land degradation and fragmentation, poor soil fertility, and unsuitable topography of land. Similarly farmers in all kebeles have low adaptive capacity in terms of physical capital (Mezerazir kebele 0.148, Wogit kebele 0.37, and Giraramba kebele (0.300). Low level of infrastructural and institutional development such as road, telephone service, electricity, market and veterinary service and low level of agricultural technology utilization such as pesticide, insecticide are the major contributing factors for low adaptive capacity in terms of physical capital.

The overall adaptive capacity index in Mezerazir kebele is 0.298 which indicate low adaptive capacity. While the overall adaptive capacity index in Wogit and Giraramba kebele are (0.42), and 0.381 respectively which indicate moderate adaptive capacity (figure 10).

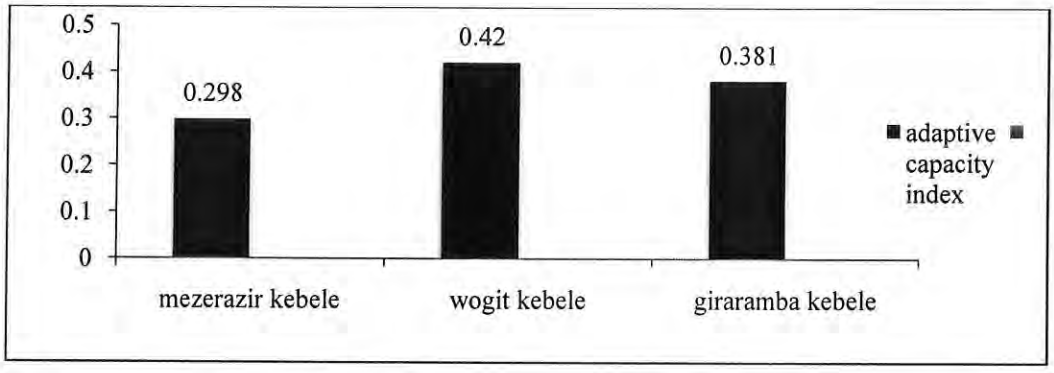

Figure 10: Adaptive capacity induces

Source: Field Survey, 2012

4.4. Adaptation Strategy.

In order to assess climate related risk in the study area, the respondents were asked whether they face any hazard related to climate change since 1970. Accordingly about 85.7% of respondents in the study area face climate related hazards since 1970s. The remaining 14.3% of respondents reported that they do not face climate related hazard. Drought, soil degradation, infectious animal and human diseases, unexpected rain and crop failure are the main climate related hazards in the study area as reported by respondents.

However all respondents employ different adaptation measures to cope the current and future climate change impact. Farmers in all kebeles shared common adaptation strategies to maintain soil fertility and moisture content, conserve forest resources, manage livestock and feed resource, and manage and conserve crop production

1. **Means to Maintain Soil Fertility and Moisture Content**

Farmers in the study area perform different adaptation activities to maintain the soil fertility and moisture content of their farm plot. About 93.5%, 35.7%, 15.1% and 82.7% of respondents in the study area practiced stone bund, soil bund, crop rotation, and preparing and use of compost respectively so as to maintain soil fertility and its moisture content (figure 11). Stone bound and crop rotation are the most common adaptation strategy across three kebeles. Smith's research (2009) indicated that the application of animal manure helps to reduce the use of fertilizers, improve soil structure, and increase water-holding capacity. However they would be less likely to report preparing and use of compost as a main adaptation strategy. Because they use the animal dung as a main source of energy for cooking food. The reported constraints that hinder the implementation of those adaptation strategies across three kebeles include shortage of land, labour, and knowledge.

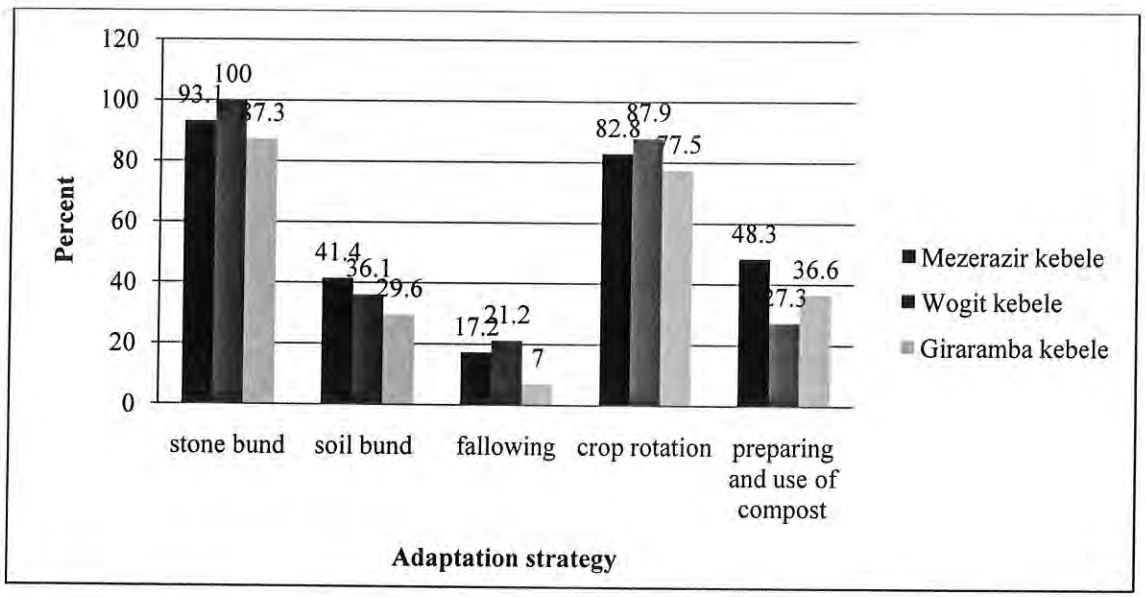

Figure: Adaptation strategies to maintain soil fertility and moisture content

Source: Field Survey, 2012

2. Forest Resource Conservation

Table 27 indicates the adaptation strategy of farmers to conserve forest resources. Thus 34.5%, 21.2% and 29.3% of respondents in Mezerazir, Wogit and Giraramba kebeles practice forest conservation and protection activity. Conserving forest resource play important role in improving the livelihood of rural people. However the survey result shows only a few percentages of farmers conserve and protect forest resource. This strongly limits the adaptive capacity of farmers to climate related impact. Furthermore Mezerazir kebele (75.9%), wogit kebele (39.4%), Giraramba kebele (70.4%) of respondents perform planting trees around farm land as an adaptation strategy which is the best method to conserve forest resources and in turn protect soil erosion. There is statistically significant difference in planting trees across three kebeles. Accordingly it is major adaptation strategy in Mezerazir and Giraramba kebele. The reported constraints to implement forest conservation adaptation strategy include lack of seedling and early drying of plant.

Table 27: Means to conserve forest resources

Respondents Kebele	Forest conservation & protection	Planting trees around farm land
Mezerazir	34.5%	75.9%
Wogit	21.2%	39.4%
Giraramba	23.9%	70.4%
X^2	df=2,p=0.44	Df=2,p=0.003

Source: Field Survey, 2012

3. Crop production management and conservation

Out of all sampled respondents about 91.4%, 15%, 36.8% and 9.0% of households use an adaptation strategy such as conservation of water and protect soil erosion, irrigation, use of fast growing crop species, and water harvesting respectively to manage and conserve crop production. Irrigation, use of fast growing crop species, and water harvesting are the most important adaptation option to climate change and variability impact. However these adaptation strategies were not the key adaptation strategy in the study area. The reported constraint to implement those adaptation strategies include lack of finance, shortage of water and unsuitable topography of land to use irrigation, the difficulty to get fast growing and drought tolerant crop species.

Table 28: Adaptation measure to manage and conserve crop production

Adaptation measure	Kebele of respondent			Total
	Mezerazir	Wogit	Giraramba	
Conservation of water and protect soil erosion	96.6%	87%	88.7%	91.4%
Irrigation	24.1%	9.1%	14.1%	15.0%
Use of fast growing crop species	37.9%	27.3%	40.8%	36.8%
Water harvesting	17.2%	18.2%	1.4%	9.0%

Source: Field Survey, 2012

4. Livestock and feed resource management

About 28.7% and 54.3% of respondents expand the size of fodder growing land and reducing the number of herds respectively (table 29). Reducing the number of herds is the main adaptation strategy across three kebele while expanding the size of fodder growing land is the least one. Shortage of land is the main problem to expand the size of fodder growing land as reported by the respondent.

Table 29: Livestock and feed resource management

Respondent Kebele	Expand the size of fodder growing land	Reducing the number of herds
Mezerazir	20.7%	48.3%
Wogit	30.3%	54.5%
Giraramba	35.2%	60.0%
Total	28.7%	54.3%

Source: Field Survey, 2012

The condition of households' productivity after undertaking adaptation strategies

Effective implementation of the adaptation options to climate change is important to improve productivity and build strong adaptive capacity to climate related challenge. Thus the respondents were asked whether the implemented strategies which explained above improve their productivity or not (table 30). Accordingly out of all sampled households only 27.1% of respondents reported that increased productivity while using those adaptation strategies. But 18.3% and 56.3% of respondents were reported that decrease and no change trend in productivity even though they use multiple adaptation strategy respectively. There is no statistically significant difference in contribution of adaptation strategy on productivity across three kebele at 5% significance level.

Table 30 Contribution of adaptation strategy on productivity

Kebele of respondent		Contribution of adaption strategies on productivity			Total	X^2
		Increased	Decreased	no change		
Mezerazir	Count	8	4	17	29	0.558(df= 4,p= 0.968)
	%	27.6	13.8	58.6	100.0	
Wogit	Count	10	5	18	33	
	%	30.3	15.2	54.5	100.0	
Giraramba	Count	18	13	40	71	
	%	25.4	18.3	56.3	100.0	
Total	Count	36	22	75	133	
	%	27.1	16.5	56.4	100.0	

Source: Field Survey 2012

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The analysis result of the farmers' perceptions of climate change indicates most of the farmers in the study area were aware that temperature is increasing and the level of rainfall is declining. Farmers perceived the changes in climate using local indicators. Similarly the statistical analysis of temperature data from 1991 to 2010 shows a trend of increasing temperature Over the 20 years examined, rainfall is characterized by inter annual variability with slight increase. Indeed the perception of farmers is in line with the analysis of long term temperature data and farmers' perception of a reduction in rainfall is influenced by seasonal shift. The result from chi square test shows the perception difference with age, education and sex of the respondent.

Discrepancies in adaptive capacity within and between communities are a product of access and possession of key livelihood assets such as human, social, natural physical and financial. The finding of this study shows farmers in the study area have limited access and possession of key livelihood assets except social capital.

The result of adaptive capacity index indicates farmers in kola agro-ecology have low adaptive capacity. While farmers in weinadega and Dega agro-ecologies have moderate adaptive capacity.

The key or major adaptation strategy of farmers in the study area includes, stone bund crop rotation, planting trees around farm land, reducing the number of herds, and conservation of water and protect soil erosion. Irrigation, use of fast growing crop species, preparing and use of compost and water harvesting are the most important adaptation option to climate change and

variability. However these adaptation strategies were not the key adaptation strategy in the study area. The identified constraints to implement the existing adaptation strategy include lack of knowledge, shortage of labor, lack of finance, shortage of water and unsuitable topography of land to use irrigation, the difficulty to get fast growing and drought tolerant crop species, shortage of plant seedling, early drying of plant, and shortage of land. The majority of the respondent confirmed that their current adaptation strategy does not bring positive outcome on their productivity.

5.2. Recommendation

The adaptive capacity of households in the study area must be increased to employ more adaptation measure by improving their access and possession of key livelihood assets. Therefore to improve the adaptive capacity of farmers in the study area the following recommendation forwarded to the concerned bodies.

- The government policies and strategies should empower farmers in the study area with information, technological skills or skill training and education to improve human capital.
- The local government and communities should plan and implement effective natural resource management strategy, so as to improve the ongoing natural resource depletion in the study area. Through participatory and community based forest management, sustainable soil and water conservation activity, control soil erosion and improve soil fertility.
- The government policies should encourage informal social network with financial or materially that can improve mutual support, group discussion and better information flow, thus enhancing the ability of farmers to deal with climate change challenge.
- The government should formulate rural development policies that improve the poor access to infrastructure and institution at accessible distance. Particularly emphasis should be given

relative to the area which have low adaptive capacities (Mezerazir kebele) in terms of investment in technology, institution and infrastructure such as agricultural technologies (chemical fertilizer, pesticide, and insecticide and quality seed), health center, veterinary station, market, telecommunication, road, electric power, and micro finance institution

- The local government should ensure the provision of credit service to farmers in their locality. In addition the current complicated precondition to get credit service should be revised and encouraging farmers to use credit service so as to diversify their livelihood options. Since the land holding size of farmers in the study area is too small to support crop and livestock production, therefore the farmers should use credit service and engage in non-farm activities that are less likely to be adversely impacted by climate variability and change.
- The government policies and programs should strength the existing adaptation strategy practiced by farmers and supports adoption of adaptive technologies that have the potential to sustain the adaptation measures and improve productivity, such as drought tolerant and fast growing crop varieties, water harvesting, small scale irrigation and resource conservation and management activities. In addition the policies and programs should offer relevant information on the type of adaptation measure and provide financial resource to support the adaptation activities and to ease the limitation to adaptation.

REFERENCE

Adger, W. N. (1999) .Social Vulnerability to Climate Change and Extremes in Coastal Vietnam. *World Development, 27* (2), 249-269.

Adger, W.N., and Kelly, P.M. (1999). Social Vulnerability and the Architecture of Entitlements. *Mitigation and Adaptation Strategies for Global Change*. 4:253-266.

Adger, W.N., Brooks, N., Kelly, M., Bentham, G., Agnew, M., and Erisen, S. (2004). *New Indicators of Vulnerability and Adaptive Capacity.* Norwich: University of East Anglia.

Admassie Ayele (2008). *Stakeholder Perception on Climate Change and Adaptation Strategies in Ethiopia.* Paper Presented at the Workshop on Climate Change Adaptation in Ethiopia. Ethiopia: Nazareth.

Aklilu Amsalu and Alebachew Adem, (2009). *Assessment of Climate Change Induced Hazards, Impacts and Responses in Southern Lowland of Ethiopia. FSS Research Report*. No.4, Addis Ababa: Ethiopia. Forum for Social Studies.

Angelica, V.O. and Richard, H. (2010). *Linking ICTs and Climate Change Adaptation: A Conceptual Framework for Resilience and Adaptation.* UK: University of Manchester.

Anne, J. and Lennart, O. (2008).Adaptation and the Poor: Development, Resilience and Transition. Sweden :Lund University, *Climate Policy 8* (2008) 170–182

Armayas Admasu (2008). Urban Governance for Resource Mobilization. Unpublished MA Thesis, Addis Ababa, Ethiopia.

Asfaw,Negassa and Jabbar, M. (2008). *Livestock Ownership, Commercial Off-Taking Rates and Their Determinants in Ethiopia.* Research Report 9. ILRI(International Livestock Research Institute),Nairobi, Kenya.

Balgis, O.E Nagmeldin, G.E Hanafi A. Sumaya, Z. (2005). Sustainable Livelihood Approach for Assessing Community Resilience to Climate Change: Case Studies From Sudan, AIACC Working Paper NO 17: *Higher Council For Environment and Natural Resource.* Retrieved from http://www.aiaccproject.org/working_papers/Working%20Papers/AIACCWPNo017.pdf

Bezu, Sonia and Holden, S. (2008). Can Food-for-Work Encourage Agricultural Production? *Food Policy* 33 (6): 541-549.

Brooks, N. & Adger, W.N. (2005). Assessing and enhancing adaptive capacity. *In: Adaptation Policy Frameworks for Climate Change.* New York: Cambridge University Press. Pp. 167-180.

Cannon, T., et al. (1992). *Social Vulnerability, Sustainable Livelihoods and Disasters: Report to Humanitarian Assistance Department and Sustainable Livelihoods Support Office.* London: University of Greenwich, Natural Resources Institute. Retrieved from:http://web.uct.ac.za/depts/politics/courses/2010/POL5033F%20outline%202010.dc

Christoph, W. (2005). *Perception and Adaptation to Climate.* Sweden: Lund University.

Davies, S., and Hossain, N. (1997). Livelihood Adaptation, Public Action and Civil Society: A Review of the Literature. *IDS Working Paper* No. 57, Institute of Development Studies.

DAP(Department of social anthropology) (2005. *Topographic and Administrative Map of North Shewa Zone, Amahara Region and Ethiopia.* (Report No, 7491-Trondheim). Retrieved from http://www.svt..ntnu.no/Ethiopia.

Deressa, T., Hassan, R., Ringler, C., Alemu, T., & Yesuf, M. (2008). Analysis of the Determinants of Farmers' Choice of Adaptation Methods and Perceptions of Climate Change in the Nile Basin of Ethiopia. IFPRI Discussion Papers No. 798, *International Food Policy Research Institute.*

DFID (1999). *Sustainable Livelihoods Guidance Sheets.* London: Department for International Development (DFID).
Retrieved from:http://www.eldis.org/vfile/upload/1/document/0708/DOC14919.pdf

Easterling, W.E., Hurd, B.H., and Smith, J.B. (2004). *Coping with Global Climate Change: The Role of Adaptation in the United States.* USA: Arlington.

Ellen, W. & Katia, M. (2006). *Adaptive Capacity for Climate Change in Canadian Rural Communities.* Canada: University of Guelph.

Ellis, F. (2000). *Rural Livelihoods and Diversity in Developing Countries.* Oxford: Oxford University Press.

Federal Democratic Republic of Ethiopia (2007). *Climate Change National Adaptation Program of Action (Napa) of Ethiopia.* Ethiopia: Addis Ababa.

Fusil, H.M., and Klein R.J.T (2006). Climate Change and Vulnerability Assessment. *An Evaluation of Conceptual Thinking of Climate Change,* 75 (3): 301 -329.

Füssel, H. (2007). Adaptation Planning For Climate Change: Concepts, Assessment Approaches, and Key Lessons. *Sustainability Science 2* (2), 265-275.

Gbetibouo, G. (2009). Understanding Farmers' Perceptions and Adaptations to Climate Change and Variability. The Case of the Limpopo Basin, South Africa: *IFPRI Discussion paper* 00849.

Hahn, M.B., Riederer, A.M. Stanly,S.O. (2009). The Livelihood Vulnerability Index: A pragmatic approach to assessing risks from climate variability and change. A case study in Mozambique. Global Environment. Retrieved from 10.1016/j.gloenvcha.2008.11.002

Hari,B.D, Gernot, B., Charity, G.O, and Hemanta, K.T (2010). *Capitalizing on Assets: Vulnerability and Adaptation to Climate Change.* Washington DC: World Bank.

Heredia, R.M (2011) Characterizing Adaptive Capacity to Climate Change in Developing Countries: A Case Study in Peru. Master of Science Thesis.

Hoben, A. (2000). *Ethiopian Rural Land Tenure Policy Revisited. Paper Presented at the Symposium for Reviewing Ethiopia's Economic Performance 1991-1999.* Ethiopia: Addis Ababa.

IPCC (2001). *Impacts, Adaptation, and Vulnerability.* Inter Governmental panel on climate change. Cambridge, UK: Cambridge University Press.

Lindsey, J., Ludi, E. and Levine, S. (2010). *Towards Characterization of Adaptive Capacity: A Framework for Analyzing Adaptive Capacity at the Local Level.* Available at http://www.odi.org.uk/sites/odi.org.uk/files/od-assets/publications-opinion-files/6353.pdf

Maddison, D. (2006). The Perception and Adaptation to Climate Change in Africa. *Discussion Paper No.10.Centre or Environmental Economics and Policy in Africa.* South Africa: Pretoria.

Mahmud Yesuf, Di Falco, S. Temesgen Deressa, Ringler, and Kohlin, G. (2008). The Impact of Climate Change and Adaptation on Food Production in Low-Income Countries., Evidence from the Nile Basin, Ethiopia.

Mendelsohn, R, 2000. Measuring the Effect of Climate Change on Developing Country Agriculture. Two Essays on Climate Change and Agriculture: A Developing Country Perspective. *FAO Economic and Social Development Paper* 145.

Mertz, O., Mbow, C., Reenberg, A., & Diouf, A. (2009). Fermers' Perceptions of Climate Change and Agricultural Adaptation Strategies in Rural Sahel. *Environmental Management, Vol.43* (2009), 804-816.

MOA (ministry of agriculture) (2000). *Agro -ecological Zonation of Ethiopia.* Ethiopia: Addis Ababa.

Nakuja, T., Sarpong, D.B., Kuwornu, J.K.M. and Ashante F.A. (2012). Water Storage for Dry Season Vegetable Farming as an Adaptation to Climate Change in the Upper East Region of Ghana. *African Journal of Agricultural Research Vol. 7* (2), pp. 298-306

Nhemachena, C., & Hassan, R. (2007). *Micro-level Analysis of Farmers' Adaptations to Climate Change Adaptations to Climate Change in Southern Africa, Environment and Production Technology Division.* Washington DC: International Food Policy Research Institute.

NMSA (National Meteorological Service Agency) (2001). *Initial National Communication of Ethiopia to the United Nation Frame Work on Climate Change*. Ethiopia: Addis Ababa.

Polsky, C. and Esterling, WE. (2001). Adaptation to Climate Variability and Change in the US Great Plain: A Multi Scale Analysis of Rechardian Climate Sensitivities. *Agriculture, Ecosystem, and Environment 85* (3): 133-144.

Santiago, O (2001). Vulnerability and Adaptation to Climate Change: Concepts, Issues, Assessment Methods. *Climate Change Knowledge Network Foundation Paper*. Retrived from http://www.iisd.org/cckn/pdf/va_foundation_final.pdf

Schneider, S., Sarukhan, J., Adejuwon, J., Azar, C., Baethgen, W., Hope, C., Moss, R., Leary, N., Richels, R. & Van Ypersele, J. (2001). *Overview of Impacts, Adaptation, and Vulnerability to Climate Change.* Cambridge, UK: Intergovernmental Panel on Climate Change.

Scones, I. (1998). *Sustainable Rural Livelihoods: A framework for Analysis.* Retrieved from http://200.17.236.243/pevs/Agroecologia/Sustainable%20Rural%20Livelihhods-Scoones.pdf

Simon, L., Eva, L. and Lindsey, J. (2011). *Rethinking Support for Adaptive Capacity to Climate Change* London: *Overseas Development Institute*

Sissay Mekbib, Adesola, O., Masia, J., Spirit, B., and Taddese Wondimu. (2012). *Assessment of the Impact and Adaptive Capacity of the Machobane Farming System to Climate Change.* African Technology policy studies network, Kenya.

Smit, B. & Skinner, M.W. (2002). Adaptation Options in Agriculture to Climate Change: a Typology. *Global Change 7* (1), 85-114

Smit, B. & Wandel, J. (2006). Adaptation, Adaptive Capacity and Vulnerability. *Global Environmental Change 16* (3), 282-292

Smit, B. and Pilifosova, O. (2003). *From Adaptation to Adaptive Capacity and Vulnerability Reduction.* London:Imperial College.

Sofoluwe, N., Tijani, A., & Baruwa, O. (2011). Farmers' Perception and Adaptations to Climate Change in Osun State, Nigeria. *African Journal of Agricultural Research, 6* (20), 4789-4794

Swanson, D.A., Hiley J.C., Venema, H.D. and Grosshans, R. (2007). Indicators of Adaptive Capacity to Climate Change for Agriculture in the Prairie Region of Canada: An Analysis Based on Statistics Canada's Census of Agriculture. Working Paper for the Prairie Climate Resilience Project, Winnipeg: International Institute for Sustainable Development.

Temesgen Tadese (2010). *Assessment of Vulnerability of Ethiopian Agriculture to Climate Change and Farmers adaptation strategy.* Published PhD Thesis, University of Pretoria.

UNDP (2007). *Human Development Reports.* Retrieved from http://hdr.undp.org.

World Bank, (2007). *Ethiopia Climate Fact Sheet: Site Resources*. Retrieved World bank. Org//Ethiopia Country_Note. Pdf

Yohannes Gebre-Eyesus (2003). *Ethiopia in View of the National Adaptation Program of Action.* Addis Ababa: Meteorological service Agency

Zhang, X., Rockmore, M. & Chamberlin, J. (2007). *A typology for Vulnerability and Agriculture in Sub-Saharan Africa.* International Food Policy Research Institute.

APPENDIXES

Appendix 1: Calculating adaptive capacity indices for sub and major component each kebele

Major component	Sub- component	Unit	Kebele			Minimum value for three kebele	Maximum value for three kebele	adaptive capacity index		
			Mezer-azir	Wogit	Girar-amba			Mezer-azir kebele	Wogit kebele	Girara-mba kebele
Social capital	percent of HHs who have tradition of cooperation to carry out farming activity	Percent	93.1	90.9	81.3	0	100	0.931	0.909	0.813
	percent of HHs being member of informal social institution	Percent	55.00	70.30	80.30	0	100	0.550	0.703	0.808
Social capital index								0.741	0.806	0.808
Human capital	dependency ratio	Mean ratio	0.45	0.4	0.44	0	1	0.550	0.600	0.660
	percent of HHs participate in agricultural training for the last five years	Percent	23	66.7	43.7	0	100	0.230	0.667	0.437
	percent of HHs participate in health training for the last five years	Percent	23	49.5	47.9	0	100	0.230	0.495	0.479
	percent of HHs participate in natural resource conservation training for the last five years	Percent	10.3	51.5	40.8	0	100	0.103	0.515	0.408
	percent of HHs participate in how to generate income training for the last five years	Percent	17.2	81.8	71.8	0	100	0.172	0.818	0.718
	percent of HHs participate in climate change training for the last five years	Percent	100	90.9	83.1	0	100	1.000	0.909	0.831
	percent of HHs complete primary school	Percent	31	39.4	38	0	100	0.310	0.394	0.380
	percent of HHs	Percent	3.4	24.2	12.7	0	100	0.034	0.242	0.127

	complete secondary school									
	percent of HHs with radio ownership	Percent	17.2	18.2	38	0	100	0.172	0.182	0.380
	percent of HHs who have fertile land	Percent	0	6.1	7.1	0	100	0.000	0.061	0.071
Human capital index								0.311	0.536	0.449
Natural capital	percent of HHs whose cultivated land slop is plain	Percent	17.2	36.4	31.4	0	100	0.172	0.364	0.314
	percent of HHs who have access to forest resource	Percent	48.3	36.4	25.4	0	100	0.483	0.364	0.254
	percent of HH with farm land size increase	Percent	34.5	30.3	16.9	0	100	0.345	0.303	0.169
Natural capital index								0.25	0.273	0.202
Financial	size of farm land	Hectare	0.99	0.77	0.79	0.25	2.5	0.330	0.231	0.239
	Mean TLU	TLU	4.59	4.40	3.80	0	8.25	0.557	0.533	0.460
	percent of HHS using credit services	Percent	72.4	42.4	52.1	0	100	0.724	0.424	0.521
Financial capital index								0.537	0.397	0.423
Physical Capital	percent of HHs with insect side utilization	Percent	20	27.3	15.5	0	100	0.200	0.273	0.155
	percent of HHs with pesticide utilization	Percent	24.1	15.2	15.2	0	100	0.241	0.152	0.152
	percent of HHs with fertilizer utilization	Percent	34.5	36.4	46.5	0	100	0.345	0.364	0.465
	percent of HHs with quality seed utilization	Percent	41.4	42.4	47.9	0	100	0.414	0.424	0.479
	percent of HHs with market access <=4 km	Percent	0.00	24.20	19.70	0	100	0.000	0.242	0.197
	percent of HHs with health center access <=4km	Percent	10.3	15.20	25.40	0	100	0.103	0.152	0.254
	percent of HH s with veterinary service access <=4 km	Percent	0	57.6	74.6	0	100	0.000	0.576	0.746
	percent of HHs with access to telephone service	Percent	17.2	18.2	25.4	0	100	0.172	0.182	0.254
	percent of HHS with access to road	Percent	0	0	29.6	0	100	0.000	0.000	0.296
	percent of HHs with access to	percent	68.9	81.8	83.1	0	100	0.689	0.818	0.831

	microfinance institution									
Physical capital index								0.148	o.237	0.300
Over all adaptive capacity index								0.298	0.420	0.381

Calculating social capital adaptive capacity index for kola agro ecologies

Step 1 (repeat for all subcomponent and kebele):

AI (SC11)1 = (observed - minimum) / (maximum - minimum)

= (93.1-0) / (100 - 0)

= 0.931

Step 2 (repeat for all components and kebele):

ACI (SC1) = $\sum$ (SC1, SC2,) / N

= (0.931 + 0.55) /2

= 0.741

Step 3 (repeat for all capitals across agro ecologies):

ACIm= $\sum\{(W_{SC}*SCm), (W_{HC}*HCm), (W_{NC}*NCm), (W_{FC}*FCm), (W_{PC}*PCm)\}/W_{SC}+W_{HC}+W_{NC}+W_{FC}+W_{PC}$

=(2*0.741) +(9*0.311)+(3*0.25)+(4*0.537)+(10*0.148)/2+9+3+4+10

=0.298

Where: SC1 is first subcomponent of first component of social Capital. N is the total numbers of subcomponents of one major component ACIm (adaptive capacity index for Mezerazir kebele) equals the weight average of five major capitals.

Appendix 2: TLU conversion factor

Animal category	TLU conversion factor
Ox	1
Cow	1
Sheep	0.13
Goat	0.13
Mule	0.7
Donkey	0.7

Source: Hans E. J. (1982).

Appendix 3: Survey Questionnaire

This questionnaire intended to gather information on Local Farmers' Adaptive Capacity to Climate Change in the case of Gishe Woreda. Therefore, I request you to respond genuinely to this questionnaire. I appreciate your cooperation in advance.

Name of data collector_____Date_____Code_____

kebele:_____

I. Socioeconomic Characteristics:

1. House Code_____

2. Sex 1= Male 2= Female

3. Age 1= 15-30 2= 31-65 3=>65

4. Marital Status 1=married 2= not married 3= divorce

5. Educational Status

1= illiterate 2= Capable of reading and writing 3= primary school 4= Secondary school 5= Higher education

6. Livelihood source 1= crop production 2= livestock 3= Mixed agri. 3= government civil servant 4= other, please specify_____

7. Responsibility in the community 1= member of the community 2= religious leader 3= coordinator of community development work 4= other, please specify_____.

8. Size of family

No	Age	Sex (in number)		
		Male	Female	Total
8.1	<14 year			
8.2	15-65 years			
8.3	> 65 year			
Total				

II. Questionnaire Regarding Perception (objective one)

9. How is the condition of the temperature of the day in the past 20 years?

1. Increasing 2. Decreasing 3. No change/constant 4. I don't know 5. Other, please specify_____

10. What are the local indicators that show the variability/change in temperature through time in your surrounding?

Human and animals diseases that has not been seen before

1. The emergence of new species of animals and plant in your local area
2. Changes of clothing style of the communities and shrinking of snow coverage
3. Degradation/deterioration of rivers through time
4. Change of animal and plants/crop type (for instance cultivation of teff and other crop types)
5. Other, please specify_____

11. How is the condition of rainfall for the last 20 years? And how do you comment?

1. Increasing 2. Decreasing 3. No change 4. Change in the seasons of rainfall 5. Increase the frequency of drought 6. I don't know 7. Other, please specify_____

12. What are the local indicators that show the variability/change in rainfall through time in your surrounding?

1. Existinction of some plant species
2. Increasing the frequency of drought and floods
3. Shorting crop growing time
4. Degradation of soil and decreasing its productivity
5. Rains come early and lately from normal
6. Decreasing agriculture production
7. Deterioration/decreasing of water amount
9. Other, please specify_____

III. **Questionnaire Regarding to Key Livelihood Asset (objective two)**

1. Social Capital

A) Social Profile

13. According to your opinion, how is the level of relationship among family members with in the family? 1. Very much weak 2. Weak 3. Good 4. Strong 5. Very much strong

14. Is there a tradition of cooperation to carry out farming activities? 1. Yes 2. No

15. Are there local (informal) institution in your locality? 1. Yes 2. No

15.1 If your answer is yes, please list the name of these organization_____

16. Which informal organization are you a member? _____

2. Human Capital

A) Labor profile

17. Is there enough man power for farming activities in your family? 1. Yes 2. No

B) Health profile

18. Is there any member of your family who stopped his/her education? 1. Yes 2. N0

18.1. If your answer is yes, what is the reason? _____

19. Is there any handicap/disabled person in your family? 1. Yes 2. No

19.1. If your answer is yes how many of them? _____

20. Is there any member of your family always sick? 1. Yes 2. No

20.1. If your answer is yes, how many of them? _____

20.2. What type of disease? _____

20.3. What do you suggest the reason for the occurrence of the diseases? _____

C) Skill/training profile

21. In the past 5 years from the training listed below in which training you participate/engaged?

Type of Training	Yes	No	What type of skill you get from the training
Agricultural management			
Health			
Natural resource conservation			
How to generate income			
Climate change			
Education			
Other, please specify			

D) **Information profile**

22 Do you have radio in your home?

23. Is there any information center/source in your locality? 1. Yes 2 No

24. Do you get important information related to agriculture and market from information center/source? 1. Yes 2. No

24.1 If your answer is yes please specify and list the information you got from the information center/source_____

Natural Capital

A) Land profile

26. Do you have your own farm land 1. Yes 2. No

27. If your answer for question 1 is yes, what is its size in hectare or (Timad)?

1. Cultivated land _____

2. Grass and woodland_____

4. Irrigated Land_____

28. Has your farm land size decreased or increased since you start farming?

1. Increased 2. Decreased 3. No change: please give your suggestion_____

29. What are the reasons for the increment of your cultivated land?

1. Deforestation 2. Farming of mountainous and hill lands 3. Redistribution of cultivated land

4. Other, please specify_____

30. What are the reasons for the decrement of you cultivated land?

1.Degradation of land and increase of rangeland 2. Distribution of cultivated land in the family

3. Redistribution of cultivated land 4. Other, please specify_____.

_____.

31. How is the status of your cultivated land fertility?

1. Not fertile 2. Somehow fertile 3. Fertile 4. Highly fertile

32. How is the slop of your cultivated land?

1. Plain 2. Hilly 3. Highly sloppy 4. Mountainous 5. Other, please specify_____

B) Water

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

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

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

C) Forest and energy profile

35. Is there any forest in your locality? 1. Yes 2. No

36. If your answer is yes who owns the forest? _____

37. Who is managing the forest? _____

38. What advantages you get from the forest?_____

4. Financial Capital

A) Wealth profile

39. How much land does your family have? Indicate in hectare ----------

40. Do you engage/participate in livestock breeding? 1. Yes 2. No

40.1.1. If your answer for question 53 is yes, what type of livestock you breed and what are their number?

Type of animal	Size in number
Ox	
Cow	
Sheep	
Goat	
Horse	
Mule	
Donkey	
Other	

41. Are you using credit service? 1. Yes 2. No

42. Who is the source of this credit service?_____

43.If your answer for question number 41, is yes, for what purpose you take credit? 1. For purchase of food items 2. For health treatment 3. For trading 4. For animal fattening 5. For education expense 6. For buying agriculture inputs 7. Other, please specify_____

1. If your answer for question number 411 is no, why not you use the credit service? 1. due to complicated preconditions 2. Not interested 3. Other, please specify_____

5. **Physical Capital**

A) Technology Profile

44. Do you have access to agricultural technologies?

a. Yes b. No

45. If your answer is yes to Q no 44, do you use agricultural service listed in table below

No.	Agricultural technology	Use	
		Yes	No
1	Insecticide		
2	Pesticide		

3	Fertilizer		
4	Quality seed		

B) Institution and Infrastructural Profile

1. Market:

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

47. If your answer is yes how long it takes to reach there (KM or Hour)?_____

2. Road

48. Is there any road connection to your neighbor and the nearby towns? 1. Yes there are roads that connect always 2. Yes there are but sometimes they break their services 3. No

49. Is the road functional in the rainy season also? 1. Yes 2. No

3. Health service:

50. Is there any health centre in your locality? 1. Yes 2. No

50.1. How much distance and time it takes to reach the nearby health centre? _____

4. Veterinary Service:

52. Is there any Veterinary Service station in your locality? 1. Yes 2. No

52.1. If your answer is yes how much distance and time it takes to reach the nearby veterinary station?

5. Telephone Service:

53. Is there any telephone service in you locality? 1. Yes 2. No

54. If your answer is yes, what type of telephone service you use frequently?

1. House telephone line 2. Tele centre 3. Wireless telephone 4. Other, please specify_____

6. Electric power service:

55. I there any electric power service in your locality? 1. Yes 2. No

56. If your answer is yes, what is your source of the electric power? 1. Hydro 2. Sun

3. Biofuel 4. Wind 5. Other, please specify _____

4. Questionnaires Concerning Adaptive Strategy (objective three)

57. Did you face any hazard related to climate change since 1970? 1. Yes 2. No

77.1. If the answer for question 57 is yes, what are the hazards and give according to their impact priority.

Types of hazards	Rank (As their level of impact)	Any solution to decrease the impact of the hazard	Remark
Drought			
Flooding			
Unexpected rain			
Cold (below 0)			
Strong wind			
Infectious human disease			
Infectious animal disease			
Degradation of soil			
Other, specify_____			

58. Is there any opportunity due to the presence of climate change/variability in your locality? Please explain by giving some examples_____

_____

89. What are the response measures taken and barriers to adapt and protect the problems caused due to climate change/variability in your locality?

Adaption strategies	Strategies you used	Hindrance to implement
1. Means to keep soil fertility and its moisture content		
• Stone bund		
• Soil bund		
• Fallowing		
• Crop rotation		
• Preparing and use of compost		
• Agro forestry		
2. Forest resource conservation		
• Forestations/plantation		
• Forest conservation & protection		
• Planting trees around the farm land		
3. Livestock and feed resource management		
• Manage the communal grazing land		
• Reduce the size of the herd		

• Expand the size of fodder growing land		
• Prepare and produce fodder		
4. Crop production management and conservation		
• Application of fertilizer		
• Conservation of water and protect soil erosion		
• Irrigation		
• Fast growing crop species		
• Water harvesting		

59. Explain the problems that hinder the implementation of the above listed adaptation strategies and give you suggestion to protect the problems._____

60. How do you explain the advantages of the above listed adaptation strategies to increase productivity while you used these adaptation strategies?

1. Increase 2. Decrease 3. Highly decreased 4. No change

Appendix 4: Focus Group Discussion Checklist

Address----------

Date of discussion----------

Time----------

1. How do you perceive the change in temperature at your village? What indicators do you use?
2. How do you perceive the change in precipitation at your locality? What indicator do you use?
3. What climate hazards have you seen in your locality?
4. What climate related impact do you observe in your locality?
5. Do you observe any shift in crop calendar?
6. What adaptation strategies are currently used by the community to deal with the climate change hazard? Are they working or effective?
7. How do you see the general level of education, health, and skill of the society?
8. Do you have adequate access to different technology (fertilizer, pesticide, quality seed etc?)
9. Do you have adequate access to different infrastructure like road, market, school etc.?
10. How do you see the general condition of natural resource of your village?

Appendix 5: Checklist to guide Key informant interview

For Agriculture and Rural Development Office officials, Development Agents, and kebele administrator

Name----------Position/profession----------kebele----------

1. What is the agro-ecology of your kebele?
2. Is there any form of climate change in your kebele or district?
3. What change do you observe in temperature and rain fall?
4. What climate related impact do you observe in your kebele or woreda?
5. Do you think that there is a shift in cropping calendar? How?
6. What adaptation strategies are currently used by the community to deal with the climate change hazard?
7. Do you think farmers in this kebele/woreda have better livelihood strategies that combine the livelihood asset they have?
8. How do you state the livelihood asset base (human, financial, physical, social and natural capital) of farmers?

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Declaration

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

Declared by:

Name: Tayyu Adamu

Signature:

Date: 3/7/2013