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Farmers' Perception and Adaptation to Climate Change and Variability:

The Case of Dodota Woreda, Arsi Zone, Oromia Region, Ethiopia

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This is to certify that the thesis prepared by Anbesu Bikila, entitled: Farmers' Perception and Adaptation to Climate Change and Variability: The Case of DodotaWoreda, Arsi Zone, Oromia Region, Ethiopia and submitted in the partial fulfillment of the requirements for the Master of Social Science in Geography under Climate Change and its Adaptation stream

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Acronyms/Abbreviation

CEEPA==Center for Environmental Economic Policy in Africa

EACC==Economic Adaptation to Climate Change

GCM==General Circulation Model

GDP==Growth Domestic Production

FAO==Food and Agriculture Organization

ICPAC=IGAD Climate Prediction and Application Center

INCE==Initial National Communication of Ethiopia

IPCC==Intergovernmental Panel on Climate Change

IPCC TAR===Intergovernmental Panel on Climate Change: Third Assessment Report

ICPAC==IGAD Climate Prediction and Application Center

MDG==Millennium Development Goals

ENMA==Ethiopia National Meteorological Agency

Abstract

The fact that climate has been changing in the past and it continues to change in the future that implies the need to understand how farmers perceive climate change and adapt in order to guide strategies for adaptation in the future. This study assesses the farmers' perception on climate change impact and adaptation in Dodota woreda. It is based on data generated from 4 kebeles and 160 sample farmers which 81 households are from kola and 79 from woyna dega agro-ecological zones.

As data shows, there is an increment of temperature of the woreda understudy showing that there is an increment of 2.0^{o}C in the past three decades. Similarly, according to data gathered from Ethiopia National Meteorological Service Agency, there is declining of rainfall in the past three decades keeping that the existence of high variability. The maximum rainfall was observed in 1977 (annual rainfall of 1220.3mm), while the lowest annual rainfall was recorded in 1984 (511.9mm). As observed from focus group discussions and key informant interview the frequency of drought has increased from decade to decade, i.e. in the beginning there was drought in every ten years, next every five years at the end every two years.

The study applied logit model in order to analyze factors affecting farmers' perception on climate change and adaptation. The results revealed that respondents' age, educational status, sex, family size, access to extension services, wealth (farm size, number of farming oxen, cattle, ruminant animals and pack animals), farming experience and exposures to mass media have positively/negatively and significantly effect on farmers perception on climate change and adaptation. In addition, it indicates that the female-headed households are more likely perceive climate change and take up adaptation methods as they have more affected by climate change.

Moreover, farmers living in the lowland areas have perceived climate change as compared to midland and highlands. This is due to the fact that lowland areas are already hotter and a marginal change in temperature could be perceived easily. As observed from the study, farmers live in kola agro-ecological zone are more perceived than farmers in woyina dega. Moreover, access to credit has negative and significant effect on climate change perception and adaptation.

CHAPTER ONE: INTRODUCTION

1.1. Background of the Study

The fact that climate has been changing in the past and will continues to change in the future implies the need to understand how farmers perceive climate change and adapt in order to guide strategies for adaptation in the future. Some studies indicate that farmers do perceive on climate change and adapt to reduce its negative impacts (David et al., 2007). Also studies further show the perception or awareness of climate change and taking adaptive measures (Maddison, 2006; Hassan and Nhemachena, 2008) are influenced by different socio-economic and environmental factors.

Climate change, being a key governance issue in recent years, appears to have predominantly focused on the development of global climate change regime agreements, the UNFCCC and the Kyoto Protocol.

An important global challenge for the 21st century is adaptation to climate change. It is very likely that human contribution to changes in climate is due to emission of greenhouse gasses (IPCC, 2007). This human induced climate change is strongly reflected in the definition given by the United Nations Framework Convention on Climate Change (UNFCCC). It refers to a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods (UNFCCC, 1992). A broader and more adopted definition is formulated by the Intergovernmental Panel on Climate Change (IPCC) what refers to it as "a change in state of the climate that can be identified by changes in the mean and/or variability of its properties and that persists for an extended period, typically decades or longer" (IPCC, 2007).

Climate variability and change present complex challenges to people's livelihoods in Africa. Against an anticipated increase in the frequencies of extreme events such as floods and droughts under climate change, agriculture will suffer greatly (IPCC, 2007). Climate change will have far-reaching consequences for agriculture that will disproportionately affect poor and marginalized groups who depend on agriculture for their livelihoods and have a lower capacity to adapt (World Bank, 2007).

Climate change is real and its first effects are already being felt. Climate change will compound existing poverty and is expected to have serious environmental, economic, and social impacts of Ethiopia particularly rural farmers, whose livelihood depend on the use of natural resources, are likely to bear the brunt of adverse impacts. The extent to which these impacts are felt depends in large part on the extent of adaptation in response to climate change, (Glwadys, 2009).

Hence, development of planned adaptation strategies to deal with these risks is regarded as a necessary complement for mitigation actions (Burton, 1996; Smith et al., 1996). Adaptation to climate change requires that farmers using traditional techniques of agricultural production first notice that the climate has altered. Farmers need to identify potentially useful adaptation strategy/methods and implement them. This paper evaluates the perception of the farmers toward climate change and adaptation strategies from the context of vulnerability and adaptation capacity in Dodota woreda.

1.2. Statement of the Problem

A recent mapping on vulnerability and poverty in Africa put Ethiopia as one of the most vulnerable countries to climate change with and the least capacity to respond (Yosuf et al (2008). 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 thwarting efforts to build up assets and increase income. As some survey data show, between 1999 and 2004 more than half of all households in the country experienced at least one major drought shock. These shocks are a major cause of transient poverty: had households been able to smooth consumption, then poverty in 2004 would have been at least 14% lower, a figure that translates into 11 million fewer people below the poverty line. Food shortage and famine associated with rainfall variability cause a situation of high dependency on international food aid. Ethiopia is one of the biggest food aid receipt countries in Africa that accounts to 20-30% of all food aid to sub- Saharan Africa (Bezu and Holden, 2008).

The impact of climate change is increasing from decade to decade and adaptations to climate change differ from one locally. Farmers' Perception and Adaptation to Climate Change and Variability is new area of research in the selected study area. This study attempts to analyze the knowledge of farmers about climate change and adaptation and to cop up the impacts of climate change. Current knowledge of farmers about climate change and adaptation is insufficient for reliable prediction of climate change and adaptations; it also is insufficient for rigorous evaluation of planned adaptation options, measures, and policies of governments.

1.3 Objectives of the Study

The objective of this research paper is to assess farmers' perception to climate change and adaptation and to identify the best mechanisms of adaptation in the selected woreda.

1.4. Specific Objectives of the study

The specific objectives of this study are:

- To assess and establish the extent of climate variability, in terms of temperature and precipitation,
- To assess farmers' perception on climate change and their adaptation strategies,
- To examine the constraints of adapting to climate change,
- To assess the impact of climate change on farmers livelihood and
- To identify best practices for adaptation measures that farmers are using currently to overcome the expected potential impacts of climate change,

Based on other studies and findings of the impact of climate change in other areas of the country in general and in the region in particular, some relevant questions could be forwarded about farmers' perception toward climate change and method of mitigation to the problem.

- Is there climate variability or change in the area of understudy?
- Are there changes in temperature and precipitation in the area?
- Haw do the farmers perceive climate change?
- What are the constraints faced by farmers to adapt to climate change?
- What is the impact of climate change on farmers' livelihood?
- In the long term what kind of approaches could be recommended to maintain the adaptive mechanism of farmers to the impact of climate change?

1.5. Significance of the Study

Taken as a whole, this study assesses the potential impact of climate change on farmers' socio-economic and the options for adaptations, in order to provide a meaningful insight and contribute to efforts aimed at ensuring sustainable development of farmers. Therefore, the study conducted on the basis of samples in Dodota woreda, can be superimposed to all districts in the adjacent woredas of the Rift Valley of Ethiopia in general and Oromia in particular, and extend these to other woredas of similar agro-ecological environment that are under the impact of climate change and play decisive roles on farmers livelihood and adaptation strategies.

1.6. Limitation of the Paper

The study depends only on one meteorological station, which is located in the lower woyna dega agro-ecological zone. This implies that the representative meteorological station for kola area was not available and was generalized by data from woyna dega agro-ecological zone meteorological station. Moreover, the meteorological data received from ENMA were not complete. It has missing value for some months as well as years.

1.7. Organization of the Paper

The organization of paper includes the second chapter as review of some related literature, following the introduction aspects. Chapter three is devoted to research methodology, descriptive statistics, study area, and data sources and collection. Chapter four constitutes the core of the study to analyze quantitatively as well as qualitatively the data gathered through different tools concerning the perception and adaptations to climate change in Dodota woreda. Chapter five contains summery, conclusion and findings, and recommendation and policy issues.

CHAPTER TWO: LITERATURE REVIEW

2.1. Global Climate Change and Adaptation

2.1.1. Global Implication of Climate Change

There is increasing evidence that the climate of the world is changing already. It is probable that it will continue to change, where humans contribute to these changes. What turns this into a problem is that these changes affect the functioning of ecosystems and societies. Climate change is expected to cause serious difficulties for agriculture, especially in developing countries. According to the Intergovernmental Panel on Climate Change's (IPCC, 2007d), climate change can reduce rain-fed agricultural yields by as much as 50 percent. Global losses in gross domestic product (GDP) range from 1 to 5 percent for a 4°C warming, and regional losses could be substantially higher. It is predicted that Africa is highly vulnerable to climate change since its economy largely relies on agriculture and uses low capital and inputs. Moreover, semiarid and arid regions are expected to be particularly affected, according to Mendelson, Nardhaus, and Shaw (1994). It is well-established that both natural and human systems are vulnerable to climate change. Because many human systems have a larger capacity to adapt than natural systems, the latter are especially vulnerable. Vulnerability depends on the type of change (e.g. temperature, rainfall, variability, occurrence of extremes), magnitude and rate of the change, exposure, and adaptive capacity. Future climatic changes will affect the level and extent of impacts. The main impact areas are public health, agriculture, food security, forests, water resources, coastal areas, biodiversity, human settlements, energy, industry and financial services (Mohan Munasinghe Rob Swart, 2005).

One may even think of a situation in which a country may consider itself fully able to cope with the climatic changes locally and thus may not be interested in participating in international negotiations on a co-ordinated climate-response strategy (Toth et al. 2001). Furthermore, many believe that there is no need specifically to study adaptation, because it would be likely to happen anyway, without any significant costs, e.g. through natural selection or market forces (Kates, 2000). There was a lot of initial optimism that mitigation would be quite possible, probably based on the positive experiences with the internationally co-ordinated abatement of ozone-depleting substances and acidification. However, climate change appeared to be a much harder problem to address. R.A. Pielke (1998) also notes that even if climate change could be mitigated successfully, adaptation would still be very relevant, since many current developments increase vulnerability to climatic events (development of marginal lands and lands at risk to extreme events, increased dependence on highly technical interdependent systems, increased water and food demands).

“Most analysts in the less-developed countries believe that the urgent need, in the face of both climate variation and prospective climate change, is to identify policies which reduce recurrent vulnerability and increase resilience. Prescriptions for reducing vulnerability span drought proofing the economy, stimulating economic diversification, adjusting land and water uses, providing social support for dependent populations, and providing financial instruments that spread the risk of adverse consequences for individual to society and over longer periods. For the near term, development strategies should ensure that livelihoods are resilient to a wide range of perturbations.” (Rayner and Malone, 1998).

2.1.2. Climate Change and Adaptation

Numerous reasons have been given for pursuing planned adaptations at this time. Public adaptation initiatives are regarded not as a substitute for reducing GHG emissions but as a necessary strategy to manage the impacts of climate change (Burton, 1996; Pielke, 1998). Adaptation can yield benefits regardless of the uncertainty and nature of climate change (Ali, 1999). According Burton, (1996), there are six reasons to adapt to climate change now (Burton, 1996).

1) Climate change cannot be totally avoided.

2) Anticipatory and precautionary adaptation is more effective and less costly than forced, last-minute, emergency adaptation or retrofitting.

3) Climate change may be more rapid and more pronounced than current estimates suggest. Unexpected events are possible.

4) Immediate benefits can be gained from better adaptation to climate variability and extreme atmospheric events.

5) Immediate benefits also can be gained by removing maladaptive policies and practices.

6) Climate change brings opportunities as well as threats. Future benefits can result from climate change.

Klein and Tol (1997) also identified five generic objectives of adaptation:

1) Increasing robustness of infrastructural designs and long-term investments—for example, by extending the range of temperature or precipitation a system can withstand without failure and changing the tolerance of loss or failure (e.g., by increasing economic reserves or by insurance),

2) Increasing the flexibility of vulnerable managed systems— for example, by allowing mid-term adjustments (including change of activities or location) and reducing economic lifetimes (including increasing depreciation),

3) Enhancing the adaptability of vulnerable natural systems— for example, by reducing other (non-climatic) stresses and removing barriers to migration (including establishing eco-corridors),

4) Reversing trends that increase vulnerability (also termed "maladaptation")—for example, by introducing setbacks for development in vulnerable areas such as floodplains and coastal zones,

5) Improving societal awareness and preparedness—for example, by informing the public of the risks and possible consequences of climate change and setting up early-warning systems.

2.1.3. Vulnerability and Adaptive Capacity

Considerable attention has been devoted to the characteristics of systems (communities or regions) that influence their propensity or ability to adapt (as part of impact and vulnerability assessment) and/or their priority for adaptation measures (as a basis for policy development). These characteristics have been called determinants of adaptation. Generic concepts such as sensitivity, vulnerability, susceptibility, coping range, critical levels, adaptive capacity, stability, robustness, resilience, and flexibility have been used to differentiate systems according to their likelihood, need, or ability for adaptation (Sprengers et al., 1994; De Ruig, 1997; Klein and Tol, 1997; Smithers and Smit, 1997; Adger and Kelly, 1999). These characteristics influence (promote, inhibit, stimulate, dampen, or exaggerate) the occurrence and nature of adaptations and thereby circumscribe the vulnerability of systems and their residual impacts. In some literatures, these characteristics are reflected in socially constructed or endogenous risks (Blaikie et al., 1994; Hewitt, 1997). Together (in whole or part), they represent the adaptive capacity of a system.

2.1.4. Determinants of Adaptive Capacity

Adaptation to climate change and risks takes place in a dynamic social, economic, technological, biophysical, and political context that varies over time, location, and sector. This complex mix of conditions determines the capacity of systems to adapt. Although scholars on adaptive capacity are extremely limited in the climate change field, there is considerable understanding of the conditions that influence the adaptability of societies to climate stimuli in the fields of hazards, resource management, and sustainable development. From this literature, it is possible to identify the main features of communities or regions that seem to determine their adaptive capacity: economic wealth, technology, information and skills, infrastructure, institutions, and equity (Mohan Munasinghe Rob Swart, 2005).

2.1.4.1. Economic Resources

Whether it is expressed as the economic assets, capital resources, financial means, wealth, or poverty, the economic condition of nations and groups clearly is a determinant of adaptive capacity (Burton et al., 1998; Kates, 2000). It is widely accepted that wealthy nations are better prepared to bear the costs of adaptation to climate change impacts and risks than poorer nations (Goklany, 1995; Burton, 1996). It is also recognized that poverty is directly related to vulnerability (Chan and Parker, 1996; Fankhauser and Tol, 1997; Rayner and Malone, 1998). Although poverty should not be considered synonymous with vulnerability, it is “a rough indicator of the ability to cope” (Dow, 1992).

2.1.4.2. Technology

Adaptive capacity is likely to vary, depending on availability and access to technology at various levels (i.e., from local to national) and in all sectors (Burton, 1996). Many of the adaptive strategies identified as possible in the management of climate change directly or indirectly involve technology (e.g., warning systems, protective structures, crop breeding and irrigation, settlement and relocation or redesign, flood control measures). Hence, a community’s current level of technology and its ability to develop technologies are important determinants of adaptive capacity. Moreover, openness to the development and utilization of new technologies for sustainable extraction, use, and development of natural resources is key to strengthening adaptive capacity (Goklany, 1995).

2.1.4.3. Information and Skills

“Successful adaptation requires recognition of the necessity to adapt, knowledge about available options, the capacity to assess them, and the ability to implement the most suitable ones” (Fankhauser and Tol, 1997). In the context of climate variability and change, this idea may be better understood through the example of the insurance industry: As information on weather hazards becomes more available and understood, it is possible to study, discuss, and implement adaptation measures (Downing, 1996). Building adaptive capacity requires a strong, unifying vision; scientific understanding of the problems; an openness to face challenges; pragmatism in developing solutions; community involvement; and commitment at the highest political level (Holmes, 1996). In general, countries with higher levels of stores of human knowledge are considered to have greater adaptive capacity than developing nations and those in transition (Smith and Lenhart, 1996). Magalhães (1996) includes illiteracy along with poverty as a key determinant of low adaptive capacity in northeast Brazil.

2.1.4.4. Infrastructure

Adaptive capacity is likely to vary with social infrastructure (Toman and Bierbaum, 1996). Some researchers regard the adaptive capacity of a system as a function of availability of and access to resources by decision makers, as well as vulnerable subsectors of a population (Kelly and Adger, 1999).

2.1.4.5. Institutions

O'Riordan and Jordan (1999) describe the role of institutions "as a means for holding society together, giving it sense and purpose and enabling it to adapt." In general, countries with well developed social institutions are considered to have greater adaptive capacity than those with less effective institutional arrangements—commonly, developing nations and those in transition (Smith and Lenhart, 1996).

2.1.4.6. Equity

It is frequently argued that adaptive capacity will be greater if social institutions and arrangements governing the allocation of power and access to resources within a community, nation, or the globe assure that access to resources is equitably distributed (Ribot et al., 1996; Mustafa, 1998; Adger, 1999; Handmer etal., 1999; Kelly and Adger, 1999; Rayner and Malone, 1999; Toth, 1999).

Some people regard the adaptive capacity of a system as a function not only of the availability of resources but of access to those resources by decision makers and vulnerable population (Kelly and Adger, 1999). Differentiations in demographic variables such as age, gender, ethnicity, educational attainment, and health often are cited in some literatures as being related to the ability to cope with risk (Chan and Parker, 1996; Burton et al., 1998).

Strengthening adaptive capacity is a key option, especially in the case of the most vulnerable and disadvantaged groups. Adaptive capacity itself will depend on the availability and distribution of: (a) economic, natural, social, and human resources; (b) institutional structure and access to decision-making processes; (c) information public awareness and perceptions, available technology and policy options, and (d) ability to spread risk.

2.1.5. Impacts and adaptation by sectors and systems

Natural and human systems are exposed to variations in climate. These include changes in average range and variability of temperature and precipitation as well as the frequency and severity of weather events.

2.1.5.1. Impacts of climate change on hydrology and water resources

Water stress is becoming an apparent problem in many parts of the world. The amount of water available per person is decreasing, whereas the ratio of volume of water withdrawn to volume of water potentially available is increasing (Arnell 1999; 2000). This water stress is caused by many socioeconomic and natural changes unrelated to climate change, but is likely to be exacerbated by climate change. Approximately one-third (1.7 billion) of the population of the world presently live in countries that are water-stressed, i.e. using more than 20 per cent of their renewable water supply. This number is expected to increase to 5 billion by the year 2025 (Arnell 1999; 2000).

2.1.5.2. Impacts on agriculture

The impact of climate change on agriculture is expected to result in small changes in global income, with positive changes in more developed regions and smaller or negative changes in developing regions (Antle 1996). Increases in mean annual temperature of 2.5◦C would increase world food prices due to the inadequate supply of food to meet demand (Antle 1996).

2.1.6. Vulnerability, impacts, and adaptation by geographic region

From the regional point of view, developing countries lying within the tropical areas are the most sensitive and vulnerable to climate change impacts. Many ecosystems in poorer countries are already under stress, and climate change impacts will further exacerbate the situation. Social and economic systems are also more vulnerable, because income levels are lower (including limited funds, human resources, and skills), and political, institutional, and technological support systems are weaker than in the industrialized world. An important implication is that adaptive capacity must be strengthened significantly, especially in the poorest and most vulnerable regions and countries (Mohan Munasinghe R.S., 2005).

2.1.6.1. Adaptive Capacity of Regions

Adaptation options—including traditional coping strategies—often are available in developing countries and countries in transition; in practice, however, those countries' capacity to effect timely response actions may be beyond their infrastructure and economic means (IPCC, 1997). For those countries, the main barriers are financial/market (uncertain pricing, availability of capital, lack of credit), institutional/legal (weak institutional structure, institutional instability), social/cultural (rigidity in land-use practices, social conflicts), technological (existence, access) and informational/educational (lack of information, trained personnel) (Smith, 1996; Mizina et al., 1999).

2.1.7. Enhancing Adaptive Capacity

The adaptive capacity of a system or nation is likely to be greater when the following requirements are met:

1) The nation has a stable and prosperous economy. Regardless of biophysical vulnerability to the impacts of climate change, developed and wealthy nations are better prepared to bear the costs of adaptation than developing countries (Goklany, 1995; Burton, 1996).

2) There is a high degree of access to technology at various levels (i.e., from local to national) and in all sectors (Burton, 1996). Moreover, openness to development and utilization of new technologies for sustainable extraction, use, and development of natural resources is key to strengthening adaptive capacity (Goklany, 1995).

3) The roles and responsibilities for implementation of adaptation strategies are well delineated by central governments and are clearly understood at national, regional, and local levels (Burton, 1996).

4) Systems are in place for the dissemination of climate change and adaptation information, nationally and regionally, and there are forums for the discussion and innovation of adaptation strategies at various levels (Gupta and Hisschemöller, 1997).

5) Social institutions and arrangements governing the allocation of power and access to resources within a nation, region, or community assure that access to resources is equitably distributed because the presence of power differentials can contribute to reduced adaptive capacity (Mustafa, 1998; Handmer et al., 1999; Kelly and Adger, 1999).

6) Existing systems with high adaptive capacity are not compromised. For example, in the case of traditional or indigenous societies, pursuit of western/European-style development trajectories may reduce adaptive capacity by introducing greater technology dependence and higher density settlement and by devaluing traditional ecological knowledge and cultural values.

2.1.8. Adaptive Capacity and Sustainable Development

Ability to adapt clearly depends on the state of development (Berke, 1995; Munasinghe, 1998). As Ribot et al. (1996) illustrate, underdevelopment fundamentally constrains adaptive capacity, especially because of a lack of resources to hedge against extreme but expected events. The events are not surprises: "It is not that the risk is unknown, not that the methods for coping do not exist rather inability to cope is due to lack of—or systematic alienation from—resources needed to guard against these events" (Ribot et al., 1996).

Africa is highly vulnerable to climate change, particularly in relation to water resources (Reibsame et al. 1995), food production (WRI 1998), human health (WHO 1998) and desertification (UNEP 1997). The diversity of African climates, high rainfall variability, and a sparse observational network, make predictions of future climate change difficult.

The overall capacity for Africa to adapt to climate change is generally very low due to the diversity of constraints facing many nations, notably the pervasively poor economic situation. Current technologies and approaches, especially in agriculture and water, are inadequate to meet projected demands under increased climate variability. Uncertainty of future conditions means that there is low confidence in projected costs of climate change. Individual states need to begin developing methodologies for estimating such costs based on their specific circumstances.

Scenarios performed for desert areas show great variation across Africa for the period 2071–2100 relative to the period 1961–1990 (IPCC 3rd Synthesis Report 2001). Other regional predictions for changes in temperature and rainfall suggest the following likely effects over the next 30 years (2010–2039): i) a decrease in rainfall of 10–25 percent over the northern parts of Africa; and ii) an increase in rainfall of 10–35 percent in the western part of the continent during normally dry months. On the other hand, East Africa has displayed a stable rainfall regime. For instance, the drier areas of eastern and South Eastern Ethiopia are shown to exhibit a change in mean precipitation of 0–0.25 mm/ day However some studies have indicated that, these general trends may include hidden variations within the regions, and some countries, for example in southern Africa, may be drier in general terms, while some countries of the region may become wetter than the average. On the other hand, the broad study of Africa (Elasha et al. 2006) reports that the extreme events results of the Global Circulation models suggest that, in general terms, the climate in Africa will become more variable with climate change. The exact nature of the changes in temperature, precipitation, and extreme events are not known and are still debated, but there is general consensus that extreme events will increase and may get worse (Elasha et al. 2006).

One major impact concerns water availability. Demand for water is also increasing, leading to worries regarding future access to water. By 2025, it is projected that around 480 million of people in Africa will face either water scarcity or stress with a subsequent potential increase of water conflicts (almost all of the 50 river basins in Africa are transboundary). Along with other Horn and Northern African countries, Ethiopia is one of the countries marked to face fresh water scarcity by 2025 (Elasha et al. 2006).

Socio-economic scenarios have also been prepared until the year 2030. Five socio-economic sectors—agriculture (crops and livestock), forestry, water resources, wildlife and human health—have been considered in our vulnerability and adaptation assessment. Africa's vulnerability to climate change is acknowledged in the IPCC TAR, areas of particular concern to Africa being: water resources, agriculture and food security, human health, ecosystems and biodiversity, forestry, coastal zones and attaining the Millennium Development Goals (MDGs) (Elasha, et al., 2006).

Africa is already vulnerable to a number of climate sensitive diseases (Guernier et al. 2004). For example, Rift valley fever, which afflicts people and livestock, is closely related to heavy rainfall events, which are predicted to increase with climate change. An outbreak in 1997 associated with an El Niño event killed up to 80 percent of the livestock in Somalia and northern Kenya (EACC, 2010).

2.2. Climate Change and Adaptation in Ethiopia

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

In Ethiopia, projections show that without adaptation, GDP is likely to fall between 2 and 10 percent by 2045, relative to the baseline growth. Climate projections show that both severe flooding and droughts will become more frequent. Agriculture, which accounts for 47 percent of Ethiopian GDP, is sensitive to these variations. Climate change will make growth rates more variable, particularly affecting the poor. The impact also varies across regions. In particular, the cereal-based highland zone will experience losses in yields, (EACC Synthesis Report 2010).

According to FAO (2008), of all the climatic factors, the daily and inter-annual variations in precipitation are most crucial for rain-fed and runoff for irrigated production. In both rain-fed and irrigated systems, the spatial and temporal variation of precipitation is the key. The day-to-day variability of rainfall associated with weather is the major risk factor for most forms of agriculture. Soil moisture deficits, crop damages and crop diseases are all driven by rainfall and associated humidity. The variability in rainfall intensity and duration makes the performance of agricultural systems in relation to long-term climate trends very difficult to anticipate.

Ethiopia is historically prone to extreme weather events. Rainfall in Ethiopia is highly erratic, and most rain falls intensively, often as convective storms, with very high rainfall intensity and extreme spatial and temporal variability. Since the early 1980s, the country has suffered seven major droughts, five of which led to famines in addition to dozens of local droughts (Diao and Pratt 2007). Survey data show that between 1999 and 2004 more than half of all households in the country experienced at least one major drought shock (UNDP, 2007). Major floods occurred in different parts of the country in 1988, 1993, 1994, 1995, 1996, and 2006 (ICPAC, 2007).

Impact and vulnerability assessments in priority sectors were undertaken as part of the process of developing the Initial National Communications of Ethiopia to the UNFCCC. The NAPA, (2007 p. 31) document provided analysis of rainfall variability and trend. Baseline climate was developed using historical data of temperature and precipitation from 1971–2000 for selected stations. The analysis provides the year-to-year variation of rainfall over the country expressed in terms of normalized rainfall anomaly averaged for 42 stations. The data shows that the country has experienced both dry and wet years over the last 55 years. The trend analysis of annual rainfall shows that rainfall remained more or less constant when averaged over the whole country. Similarly, temperature variability and trend was analyzed (NAPA 2007, p. 33).

The year-to-year variation of annual minimum temperatures, expressed in terms of temperature differences from the mean and averaged over 40 stations, is provided. The result shows that the country has experienced both warm and cool years over the last 55 years. However, the recent years are the warmest, compared to the early years. The data reveals that there has been a warming trend in the annual minimum temperature over the past 55 years. Temperature has been increasing by about 0.37^{0}C every ten years. Another study made of Africa as a whole (Elasha et al. 2006) that analyzed the historical and current climatic conditions based on observed changes, reports that based on historical records a warming of approximately 0.7°C over most of the continent during the 20th century is reported in the IPCC, (2001). Observational records show that this warming occurred at the rate of about 0.05°C per decade, with a slightly larger warming in the June– November seasons than in December–May.

Scenarios performed for desert areas show great variation across Africa for the period 2071–2100 relative to the period 1961–1990 (IPCC, 2001). Other regional predictions for changes in temperature and rainfall suggest the following likely effects over the next 30 years (2010–2039): i) a decrease in rainfall of 10–25 percent over the northern parts of Africa; and ii) an increase in rainfall of 10–35 percent in the western part of the continent during normally dry months. On the other hand, East Africa has displayed a stable rainfall regime. For instance, the drier areas of eastern and South Eastern Ethiopia are shown to exhibit a change in mean precipitation of 0–0.25 mm/day However some studies have indicated that, these general trends may include hidden variations within the regions, and some countries, for example in southern Africa, may be drier in general terms, while some countries of the region may become wetter than the average.

Drought and famine, flood, malaria, land degradation, livestock disease, insect pests, and earthquakes have been the main sources of risk and vulnerability in most parts of Ethiopia. Recurrent droughts, famines, and— recently—floods are the main problems that affect millions of people in the country. Climate hazards, mainly droughts, have caused instability in national economic performance and have hampered poverty reduction efforts (EACC, 2010).

While the causes of most disasters are climate-related, the deterioration of the natural environment due to unchecked human activities and poverty has further exacerbated the situation (ENMA, 2007 p. 27). For example the impacts of past droughts—such as those in 1972/73, 1984, and 2002/03—are still fresh in the memories of many Ethiopians. Other extreme events, like the floods in 2006, caused substantial loss of human life and property in many parts of the country. These challenges are likely to be exacerbated by anthropogenic climate change.

Cholera, associated with both floods and droughts, may increase with climate change. Increased temperatures could increase the levels of cholera bacteria in tropical seas and lakes. Changes in rainfall will affect the transmission potential and the presence (or absence) of vector- and water-borne pathogens (IPCC, 2001). Studies show that increased flooding could facilitate the breeding of malaria carriers in formerly arid areas. Small geographical changes in the distribution of malaria may expose large numbers of people to infection, e.g. densely populated East African highlands (Elasha, et al. 2006). Historical and current distribution of malaria assessed by Elasha et al. (2006 p. 24) shows that by 1870 malaria was prevalent in the western half of Ethiopia but by the year 2000 had expanded to all of the eastern half.

The recent IPCC Fourth Assessment Report indicates that climate change will have significant impact on crop production and water management systems in the coming decades. In addition, there is the potential for earlier negative surprises linked to increased frequency of extreme events (Tubiello, et al., 2007). The strong trends in climate change that are already evident, the likelihood of further changes and the increasing magnitude of potential climate impacts particularly in the mid-latitudes and tropical regions (but globally also) gives additional urgency to address agricultural adaptation more coherently (IPCC, 2007).

It is generally acknowledged that communities deal with extreme weather events such as floods and droughts over varying periods of time. In this context, adaptation to both long term mean and inter-annual variability in climate is often seen as a complex phenomena and process (Smit et al., 2004). Adaptation is widely defined as the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects which moderates harm or exploits beneficial opportunities (IPCC, 2001).

In Ethiopia, it is assumed that the temperature has been increasing annually at the rate of 0.2°C over the past five decades. Moreover, it has led to a decline in biodiversity, shortage of food and increases in human and livestock health problems, rural-urban migration and dependency on external support. Factors compounding the impact of climate change in Ethiopia are rapid population growth, land degradation, widespread poverty, dependency on rainfed agriculture, lack of awareness by policy and decision-makers about climate change and lack of appropriate policies and legislation (ENMA, 2007).

2.2.1. Projected Climate Change over Ethiopia

Climate projections for Ethiopia have been generated using the software MAGICC/SCENGEN the Assessment of Greenhouse-gas Induced Climate Change)/ (Regional and global Climate SCENario GENerator) coupled model (Version 4.1) for three periods centered on the years 2030, 2050 and 2080. For the IPCC mid-range (A1B) emission scenario, the mean annual temperature will increase in the range of 0.9 -1.1° C by 2030, in the range of 1.7 - 2.1^{0} C by 2050 and in the range of 2.7-3.4° C by 2080 over Ethiopia (the following maps) compared to the 1961-1990 normal. A small increase in annual precipitation is also expected over the country.

The effects of climate change are severe in developing countries like Ethiopia where agriculture is the dominant economy. Thirty five years data analyzed from 22 meteorological stations indicate that temperature is rising by 0.37^{0}c in the central rift valley and by 0.48^{0}c in the adjacent highland every 12 years along with insignificant rise of rainfall in intensity (NAPA, 2007).

2.2.2. Historical Climate Related Hazards in Ethiopia

Climate related hazards in Ethiopia include drought, floods, heavy rains, strong winds, frost, heat waves (high temperatures), etc. Though the historical social and economic impacts of all of these hazards are not systematically well documented, the impacts of the most important ones; namely droughts and floods are discussed (NAPA, 2007).

Ethiopia is highly vulnerable to drought. Drought is the single most important climate related natural hazard impacting the country from time to time. Drought occurs anywhere in the world but its damage is not as severe as in Africa in general and in Ethiopia in particular. Recurrent drought events in the past have resulted in huge loss of life and property as well as migration of people (NAPA, 2007).

Droughts and floods are the most frequent climate related hazards facing Ethiopia. Ethiopia is known to be highly vulnerable to drought, which is the single most important climate-related natural hazard impacting the country from time to time. Major droughts in Ethiopia in recent times were in the late 1950s (in northern parts), in 1972/73 (northeastern in Tigray and Wollo), in 1984/85 (in major parts of the country), 1994 (in the low land pastoral areas), in 2000 (in the southern lowland pastoral areas), in 2002/3 (in major parts of the country), and in 2007/8 (in many areas in the highland and lowlands). Droughts have been chronic events in some areas of the country for many years, as evidenced by harvest failures, especially in areas where food aid and recent productive safety net programs have been implemented over the years. Drought and, subsequently, famine, have had serious impacts on human life and property in the country (EACC, 2010).

The other climate-related hazard that affects Ethiopia is flood. Major floods caused loss of life and property in different parts of the country in 1988, 1993, 1994, 1995, 1996, and 2006. Flash and seasonal river floods have affected areas in the Afar Region along the Awash River, in the Somali Region along the Wabi Shebele River and in the Gambela Region along the Baro-Akobo River, in the Southern Nations, Nationalities and Peoples Region along the Oomo-Gibe River, and Bahir-Dar Zuria and Fogera areas along the Abbay River in the Amhara Region (Endalkachew et. al., 2004 quoted in NAPA p. 37). For instance, recently in the 2006 main rainy season (June–September), flood caused disasters in many locations. More than 250 people died, about 250 people were unaccounted for and more than 10,000 people became homeless due to the flood that occurred in Dire-Dawa town located in eastern Ethiopia. More than 364 people died, and more than 6000 people were displaced due to flooding of about 14 villages in South Omo zone in place called Dasenech located in Kuraz woreda. More than 16,000 people were displaced in Southwest Shoa, at 50 km west of Addis Ababa due to heavy flood disaster inflected by the overflow of the Awash River. Similar situations also occurred in Afar, Western Tigray, in Gambella and the low lying areas of Lake Tana in Amhara region.

The Ethiopia country study looked at what these costs imply for individual countries. Ethiopia is heavily dependent on rainfed agriculture. Historically the country has been prone to extreme weather variability. Rainfall is erratic and since the early 1980s, the country has suffered seven major droughts, five of which have led to famines. Its geographic location and topography make it highly vulnerable to the impacts of climate change.

2.2.3. Causes of Vulnerability to Climate Conditions in Ethiopia

Causes for vulnerability of Ethiopia to climate variability and change include very high dependence on rainfed agriculture which is very sensitive to climate variability and change, under-development of water resources, low health service coverage, high population growth rate, low economic development level, low adaptive capacity, inadequate road infrastructure in drought prone areas, weak institutions, lack of awareness, etc (NAPA, 2007).

Vulnerability assessment based on existing information and rapid assessments carried out under NAPA has indicated that the most vulnerable sectors to climate variability and change are Agriculture, Water and Human health. In terms of livelihood approach smallholder rain-fed farmers pastoralists are found to be the most vulnerable. The arid, semiarid and the dry sub-humid parts of the country are affected most by drought (NAPA, 2007).

Baseline climate was developed using historical data of temperature and precipitation from 1971–2000 for selected stations. The analysis provides the year-to-year variation of rainfall over the country expressed in terms of normalized rainfall anomaly averaged for 42 stations. The data shows that the country has experienced both dry and wet years over the last 55 years. The trend analysis of annual rainfall shows that rainfall remained more or less constant when averaged over the whole country. Similarly, temperature variability and trend was analyzed (NAPA 2007, p. 33).

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2.2.4. Coping Mechanisms to Climate Variability

Traditional and contemporary coping mechanisms to climate variability and extremes in Ethiopia include changes in cropping and planting practices, reduction of consumption levels, collection of wild foods, use of inter-household transfers and loans, increased petty commodity production, temporary and permanent migration in search of employment, grain storage, sale of assets such as livestock and agricultural tools, mortgaging of land, credit from merchants and money lenders, use of early warning system, food appeal/aid (Deressa et al. 2008).

In countries like Ethiopia, more than 85% of the people depend mainly on agriculture for their livelihoods, rendering them very vulnerable to climate variability and change. Accordingly, in recent times, a significant number of people in Ethiopia are being affected chronically by drought and/or flooding, leading to deaths and loss of assets and to an appeal for international support (Yahannes and Kifle, 2009).

2.3. Climate Change Impact on Oromia Region

In Oromia region, most agriculture is rainfed and small scale farming which provides livelihoods for 85 percent of the population, which accounts for about 51% of crop production in Ethiopia, so that the extreme variability in climate severely affects the economy of the region and the country in general. Some studies indicate that increasing temperature and rainfall variability have been prevailed in the region since the last five decades and posed significant impacts on the livelihoods of the people. Particularly, crop production which is considered the sources of the country's agricultural surplus and it is also the major sources of food supply for the country's major urban centers and deficit areas; will be heavily affected by these changes (Mahammed Hassena et al, 2007).

As the study conducted by Oxfam International (2010) in Adami Tullu – Jido kombolcha woreda, Oromia National Regional State indicated the total number of days of rainfall has been decreased. However, when the rain comes, it does with great intensity leading to flooding without recharging ground water resources. It is devastating for agricultural production, beating down crops and sluicing away soil and silts up lakes and riverbeds. It has negatively impacted crop production and food security, livestock, forestry, energy, water, and health.

Though the frequency and extent of feeling the impact varies, the frequently experienced climatic shocks are prolonged drought and delay in the onset of rain, erratic and low precipitation, and heavy and unseasonal rainfalls (Senbeta Abate, 2009). These climatic events occurred in different parts of the region in different times.

Agriculture is overwhelmingly dependent on the timely onset, amount, duration, and distribution of rainfall. Over 90% of the food supply of the region comes from rainfed subsistent agriculture and rainfall failure means loss of major livelihood source that always accentuate food deficit (Adgolign, 2006). Large part of Oromia has suitable climate and rainfall for agricultural production. However, as rainfall varies across areas, many areas are suffering from recurrent drought and famine particularly the rift valley, east and south-east part of the region. The average rainfall in Southern and Eastern Oromia (Borana, Bale, East and West Hararghe) and Rift Valley areas are generally considered inadequate for crop production and the area is often vulnerable to recurrent drought. In addition, much of the high lands areas of the region are suffering from deforestation, over grazing and subsequent erosion due to expansion of farm lands to sloppy areas, over grazing by huge livestock herds. This has been exacerbated by increased dependency on forest resource for fuel (firewood and charcoal) and construction by local people, private business owners and forest-dependent poor households (Adgolign, 2006).

Temperature variability has been observed in different parts of Oromia in the past few decades. For instance, the analysis of temperature data collected from NMSA for three stations of the region, particularly Shashamene (1970 – 2007) midland, Kofele (1965-2007) represents the highland area and Langano (1981-2006) represents the lowland, has shown increasing trends of temperature over two decades. Due to these gradual increases in temperature from time to time, the researches states, now days crops and insects of lowlands are becoming popular to highlands where previously never seen (Senbeta Abate, 2009).

CHAPTER THREE: RESEARCH METHODOLOGY

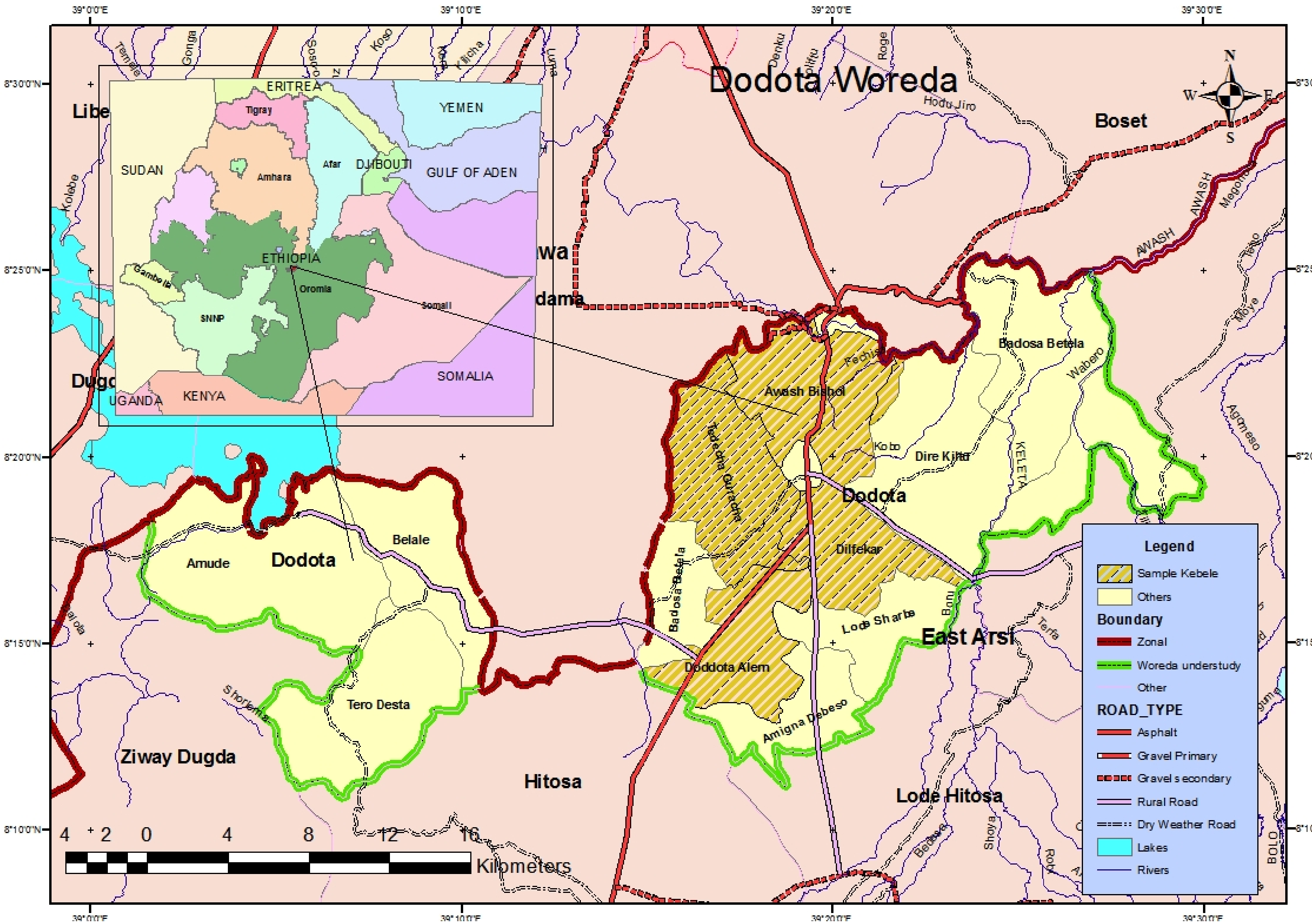
3.1. Study Area

3.1.1. Location

Dodota is one of the 26 woredas of Arsi zone. Before 1997, the woreda was called as Dodota-Sire. However, to ensure good administration, the woreda was sub-divided into Sire and Dodota. Now-a-days, Dodota woreda has 15 kebeles, of which 12 are rural kebeles, while three are urban kebeles. Dera town is the capital city of the woreda, which is located at 125km from Addis Ababa and 50 km from zonal capital, i.e. Asela town. The woreda understudy is truncated into two. It is due to the kinship distribution of the settlers.

The woreda has a total area of 512km^2 and located between 8^o 11'- 8^{o}26' north latitude and 39^{o}2' - 39^{o}29' east longitude. Relatively, Dodota woreda covers northwestern part of Arsi zone and bordering by Lode Hetosa, Hetosa, Ziway Dugda and Sire woredas of Arsi zone in the east and East Shewa Zone in the west. It is located completely within the Ethiopian Rift Valley.

Fig.1. Location Map of Dodota Woreda



3.1.2. Soil

Molic andosol and leptosols are the major soil in the woreda understudy. Lithosols are soils of limited depth with continuous hard rock within 10cm of the surface and have low agricultural value though cultivated in areas of high population pressure. Andosols, one major soil unit could form the other soil group having of over 60% vitric, volcanic ash or other vitric pyroclastic materials in silt, sand and gravel fraction. They occur on young, vitric pyroclastic materials with the largest extent in the rift valley (FAO, 1988).

3.1.3. Drainage and Water Resources

Physically, the woreda is located in sub-humid area and has few seasonal streams. There are two major permanent rivers Keleta flowing in the northern part and Awash in the parts of the woreda understudy. Larger part of the woreda is plain, which is conducive for irrigation purpose. The two rivers are not accessible for irrigation at farmer level. They need large capital to use them for irrigation. On the other hand, seasonal streams are dissecting woreda's plain area and form large and deep galleys.

3.1.4. Climate

The climate of Arsi zone in general and Dodota woreda in particular is mainly controlled by the seasonal migration of the Inter-Tropical Convergence Zone (ITCZ), which follows the position of the sun relative to the earth and the associated atmospheric circulation. There are different ways of classifying the climatic systems of the Zone in general and the woreda in particular. The most commonly used classification systems are the traditional and the agro-ecological zones. According to the traditional classification system, which mainly relies on altitude and temperature, the woreda has two climatic zones, i.e., woyna dega and kola. Altitudinally, the woreda understudy lies between 1343 and 2271 meter above sea level.

3.1.5. Vegetation Coverage

The settlement distribution is related to the past history. The dwellers of this woreda were pushed down from the highland areas of Arsi zone by the feudal landlords of the time. The farmland of the farmers was taken by landlords. At that time, the current woreda (Dodota) was under dense forest. Currently, the forest is cleared by the settlers and almost all area is brought under crop cultivation. Therefore, the vegetation coverage of woreda is limited to inaccessible area. Some patch of land is under very scattered wood (acacia) and there is no known forest in the woreda (DWAO, 2010).

3.1.6. Population

Based on 2007 National Housing and Population Census, the projected total population of 2012 of the woreda was 75,143 of which 37,812 (50.3%) was male population and 37,331(49.7%) was female population. On the other hand, about 69% of the total population of the woreda understudy resides in rural area while about 31% of the total population of the woreda lives in urban area. Moreover, population between the ages 15 and 64 years, which is considered economically active population, constitutes for about 62.5% of the total population, while the inactive age or economically dependent population (<15 and >64 years age) forms 37.5%. The sex ratio of the woreda is 101.3, meaning that more than 101 males per 100 females, indicating excess of males over females in the woreda.

3.2. Research Design

The study was designed as cross-sectional survey of households in Dodota woreda with purposive sampling of kebeles and simple random sampling techniques method for the selection of households. Dodota woreda was selected purposively, because it is under the impact of climate change since. The woreda is food shortage area and it is under food aid. It is a sub-humid woreda where rainfall variability is high. Dodota woreda is sub-divided into kola and woyna dega agro-ecological zones, which is attractive for such study.

The woreda has 12 rural kebeles where some kebeles are in kola and some are in woyna dega agro-ecological zones. Taking agro-ecological condition and accessibility into account two kebeles were selected from kola and two from woyna dega zones. Accordingly, Tedecha Guracha and Awash Beshola kebeles are from kola agro-ecological zone whereas, Dodota Alem and Dilfeker kebeles are from woyna dega zone. All kebeles are accessed by transportation network and are under food aid that is due to climate change.

3.3. Data Sources and Analysis

3.3.1. Data Source

Quantitative and Qualitative data were gathered from primary and secondary sources. Household survey was applied by using administrated questionnaires to 160 sample households (81 from ‘kola’ ‘kebeles’ and 79 from ‘woyna dega kebeles’) proportionate to their numbers of households. This method was applied in order to assess and find out the family size, access to information and perception of households on climate change as well as farmers adaptation to climate change.

The selected respondents were interviewed personally with the help of a well structured questionnaire. To have a better understanding of the condition of climate of the woreda and farmers' perception toward climate change and adaptation, key informant interviews were made with two experts of Dodota woreda agriculture and rural development office and two experts of Dodota woreda Safety Net Agent. Key informants were asked general knowledge of climatic change and its impact on the society of the rural population of the woreda understudy. Focus Group Discussion (FGD) was made to generate information on the perception of the farmers on climate change, its related impact and existing coping strategies or level of adaptation of farmers. Four FGDs, each consisting 10 participants, approximately two aged persons, two middle aged persons, two young persons and four women of different age group, drawn from different 'gots', were held for climate change identification and characterization, identification and prioritization of coping mechanisms.

The relevant secondary data were collected from different sources such as published books, journals, reports prepared by different national as well as international institutions. Different websites were visited for the purposes of literature as well as for general analysis of the document.

3.3.2. Method of Analysis

The collected data, both qualitative and quantitative were statistically processed, summarized and analyzed to interpret the result. Descriptive statistics and tabular presentation including graphs and maps were used to characterize farmer's perceptions on climate changes as well as various adaptation measures being used by farmers. Moreover, Statistical Package for Social Sciences (SPSS) version 20 was used for the analysis of quantitative data.

The study has applied logit model (logit regression analysis) to examine the characteristics that best explain the variation in the measures of attitudes of the farmers' perception and adaptation level to climate change and factors that influence such decisions. Kurukulasuriya and Mendelsohn (2006) employed the multinomial logit model to see if crop choice by farmers is climate sensitive. Similarly, Seo and Mendelsohn (2006) used the multinomial logit model to analyze how livestock species choice is climate sensitive.

Madison (2006) argued that adaptation to climate change is a two-step process which involves perceiving that climate is changing in the first step and then responding to changes through adaptation in the second step. To analyze these two steps this study applied logit binary model. The advantage of this is that it permits the analysis of decisions across more than two categories, allowing the determination of choice probabilities for different categories (Madalla, 1983) and it is also computationally simple (Tse, 1987).

The parameter estimates of the logit model provide only the direction of the effect of the independent variables on the dependent (response) variable, but estimates do not represent either the actual magnitude of change nor probabilities (Deressa, 2010). In this study, independent variables are age, sex, education, family size, occupation, access to extension, access to credit, size of farm land, access to market, farming experience and access to weather information; while the dependent variables are feeling to climate change, rainfall change, drought, increase of drought frequency, feeling of temperature increase etc. Independent factors positively affect the perception of farmers on climate change and adaptation.

For statistical analysis, the logit model was employed due to the nature of the decision variable; whether farmers perceived climate change and have adapted or otherwise. For such a dichotomous outcome, the logit model is the most appropriate analysis tool. The logistic model considers the relationship between a binary dependent variable and a set of independent variables that mentioned above, whether binary or continuous. The logistic model for 'k' independent variables (X_1, X_2, X_3…….. X_k),

The logistic regression model is given by

$$P(X) = \alpha + \sum_{i=1}^{ki} \beta i X i \qquad \text{--------}1$$

(Exp) (βi) indicates the odds ratio for a person having characteristics i versus not having i, while βi is the regression coefficient, and α is a constant.

Thus the estimated regression coefficient associated with 1 or 0 coded dichotomous predictor is the natural log of the perception of farmers and demographic data associated with climate change.

The logistic model also can be written

$$\ln\left(\frac{P(Y \mid X)}{1 - P(Y \mid X)}\right) = \ln\left(\frac{P}{1-P}\right) = \beta_o + \beta_1 X \qquad \text{-----------}2$$

This implies that the odds for success can be expressed as

$$\frac{P}{1-P} = e^{\beta_o + \beta_1 X} \quad \text{---3}$$

This relationship is the key to interpreting the coefficients in a logistic regression model (logit model).

Models relationship between set of variables X_i dichotomous (yes/no)

$$P(\text{"}Success\text{"} | X) = \frac{e^{\beta_o + \beta_1 X}}{1 + e^{\beta_o + \beta_1 X}} \quad \text{-------------------4}$$

(Kurukulasurya, P & Mendelson, R, 2006)

CHAPTER FOUR: RESULT and DISCUTION

4.1. Climate Data Analysis

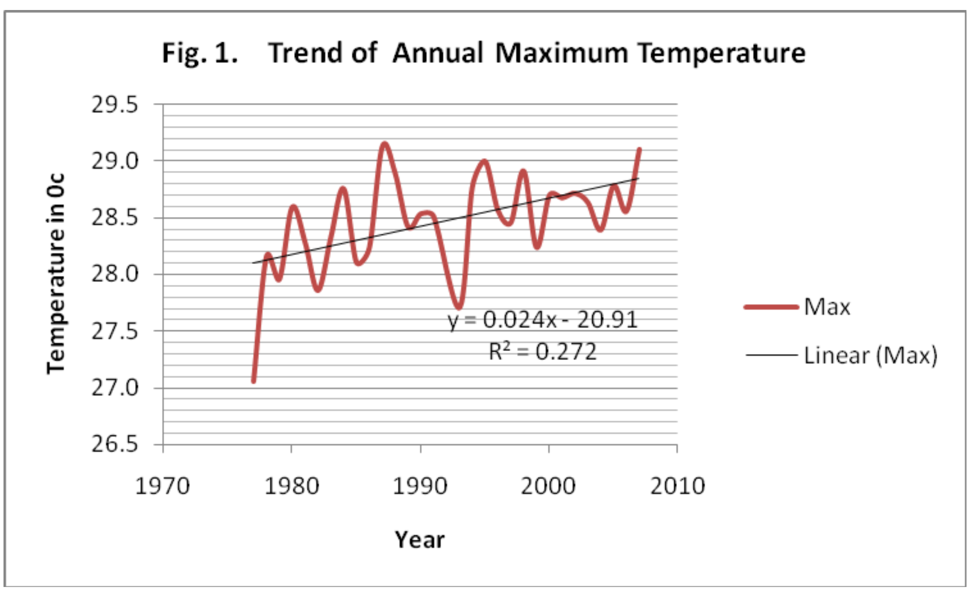
Climate is determined by temperature, precipitation, wind and cloud. Climate change is likely affected by the intensity, frequency, duration and amount of precipitation, as well as daily, monthly and annual temperature. Temperature and precipitation are major elements of weather. Daily temperature and precipitation are recorded at meteorological station. The Awash Melkasa meteorological station is the C type station, which records only temperature and precipitation and is located in Dodota woreda, at an altitude of 1850m above sea level. The station is mostly representing lower woyna dega agro-ecological zone. Recording system of the station is poor. From 31 years records, some years have missed of two to six or more months of records. Years that have such restrictions of records have been fulfilled based on calculation. 31 years data of average maximum and minimum monthly temperature and daily and average monthly rainfall have been treated.

4.1.1. Temperature

Temperature is one of the elements that determine weather condition as well as climate of an area. It is recorded as maximum and minimum daily, monthly and annual temperatures. Monthly maximum and minimum and annual temperatures are presented in Annex 2. According to data presented in the annex 2, the warmest month of the woreda is May, while the coldest month is August. The warmest year was 1995, while the coldest year was 1977. Highest annual range is manifested in 1999, while the lowest range is recorded in 1977. As shown in annex.1 the warmest season is spring while the coldest month is kiremt (summer). Generally, temperature is slightly increasing from year to year and from 1977 to 1984 maximum temperature is below mean temperature, while from 1997 to 2003 the average maximum temperature is above the mean. Temperature of the study area has increased by 2.1^0C in the past 31 years with an annual increment of 0.07^0C.

According to the IPCC mid-range (AIB) emission scenario, the mean annual temperature of central rift valley will increase up to 1^0C by the year 2030, 1.8^0C by the year 2050 and 2.9^0C by the year 2080, where the woreda understudy is found.

The average temperature of the woreda understudy ranges between 19.1^0C and 21.7^0C, while the average maximum temperature ranges between 27.1^0C and 29.1^0C (annex.1). Accordingly, the annual minimum temperature ranges between 10^0C and 14.7^0C in the past three decades. The annual range of temperature ranges between 13.2^0C and 18.2^0C showing that the existence of high variability of temperature of the woreda. The following figures show the trend of temperature in the past three decades.



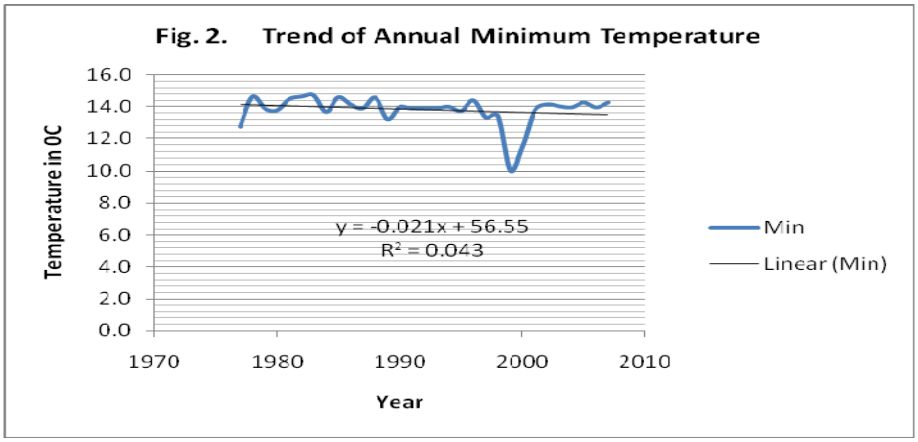


Fig. 2. Trend of Annual Minimum Temperature
Temperature in 0C
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
1970
1980
1990
2000
2010
Year
y = -0.021x + 56.55
R² = 0.043
Min
Linear (Min)

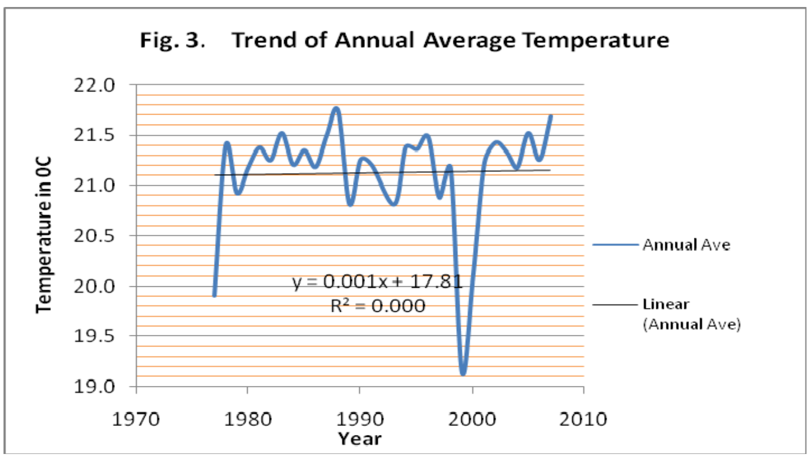


Fig. 3. Trend of Annual Average Temperature
Temperature in 0C
22.0
21.5
21.0
20.5
20.0
19.5
19.0
1970
1980
1990
2000
2010
Year
y = 0.001x + 17.81
R² = 0.000
Annual Ave
Linear (Annual Ave)

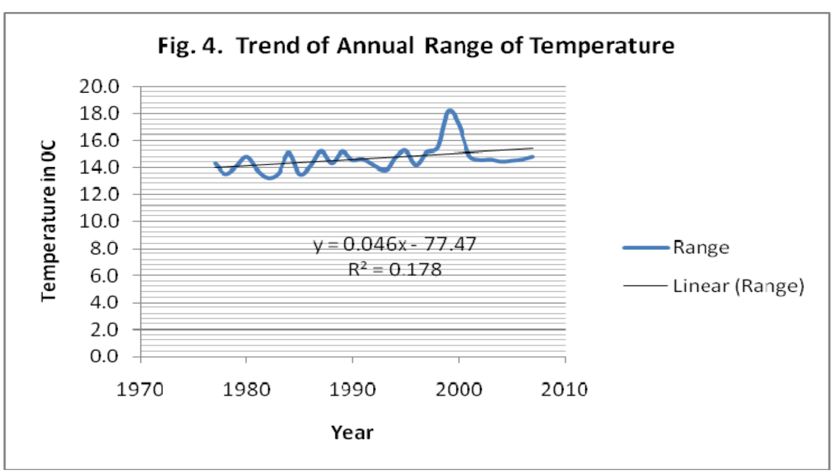
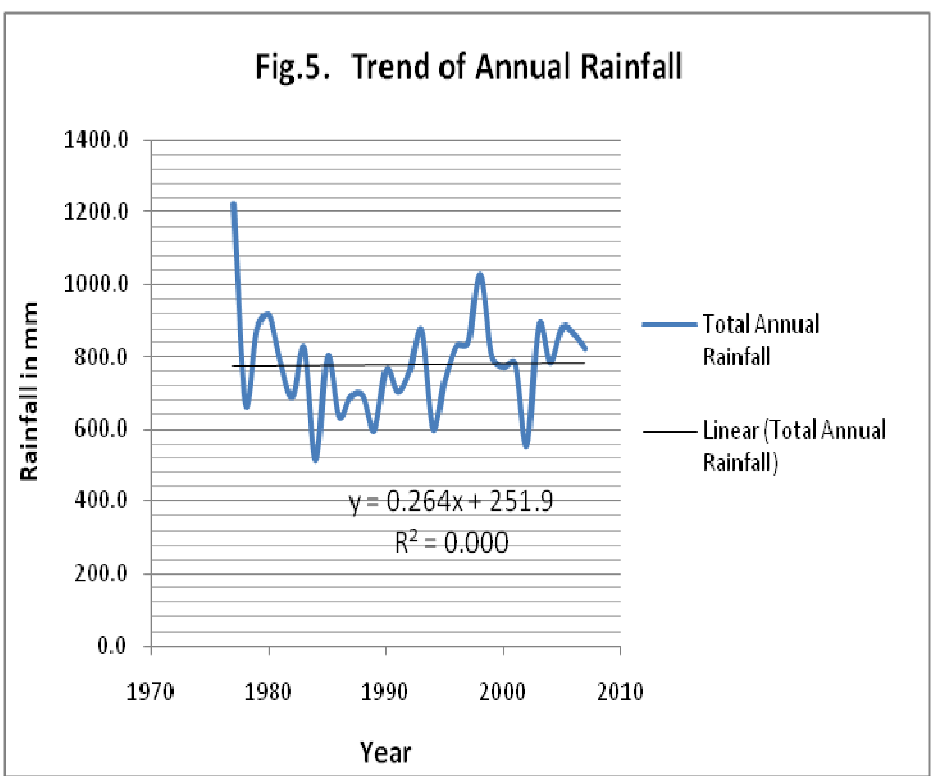


Fig. 4. Trend of Annual Range of Temperature
Temperature in 0C
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
1970
1980
1990
2000
2010
Year
y = 0.046x - 77.47
R² = 0.178
Range
Linear (Range)

4.1.2. Rainfall

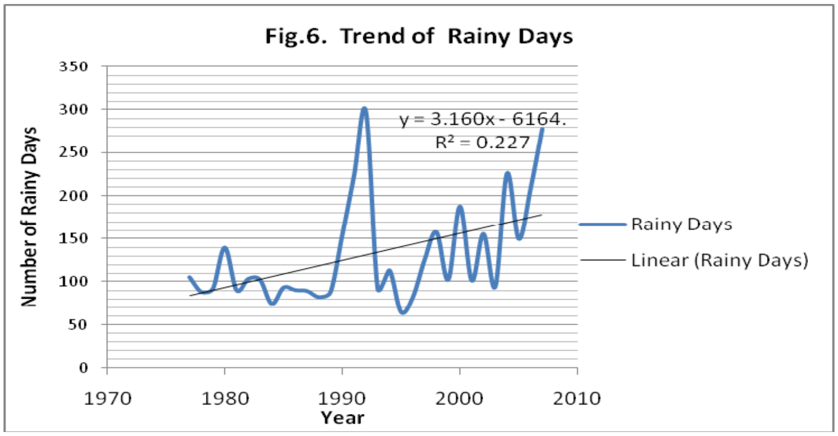
Based on the data obtained from ENMA, the study tries to analyze monthly, seasonal and inter annual average rainfall of 31 years. Inter decennial trend is also treated in the study. As observed from the data, there is a decline in rainfall amount in the past three decades that is from 1220.3mm in 1977 to 821.9mm in 2007 with a decline rate of -1.27% annually. The lowest rainfall is observed in 1984 (511.9mm), while the highest rainfall is recorded in 1977 (1220.3mm). If we take the average annual rainfall of 31 years, which is 778.6mm as a normal annual rainfall, about 12 years (38.7%) were under normal condition of rainfall. The chronic rainfall shortage was observed in 1984, 1989 and 1994. The major drought years were 1984 and 1994, however, there were a number of years with lowest precipitation for crop cultivation.



4.1.2.1. Number of Rainy-days: The number of rainy days indicates that days that have at least 0.2mm and above of rainfall. As data presented in annex 3, the high number of rainy days is observed in 1992 (298 rainy days), while the lowest number of rainy days were recorded in 1995 (65 rainy days). In general, the number of rainy days shows an increasing trend, however, there is high variability. The highest peak number of rainy days was observed in 1992, while the lowest peak is in 1995. As shown in fig.6, the increment trend of rainy days is smooth in the mentioned decades. In general, rainy days show an increasing trend (fig.6). However, the cycle of drought year is becoming shorter and shorter.

Table.1. Rainfall amount by months and year

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1977	95.2	2.0	62.9	145.9	75.1	211.1	87.5	140.0	86.4	261.2	53.0	-	1,220.3
1978	2.5	143.3	4.3	48.7	12	51.1	75.5	176.6	70.3	47.6	0	34.8	666.7
1979	50.4	13.0	60.4	14.1	120.1	127.8	226.1	142.5	83.9	21.6	0.0	14.8	874.7
1980	49.4	0.0	6.7	67.6	25.5	95.3	157.2	193.7	107.9	189.7	19.3	0.0	912.3
1981	0.0	62.9	123.0	49.4	1.2	2.8	248.5	149.8	135.8	9.7	0.2	0.0	783.3
1982	5.4	20.2	10.3	39.3	51.5	28.4	124.2	226.9	42.4	67.8	61.3	9.0	686.7
1983	33.8	37.9	56	44.9	184.8	22.3	174.3	135.2	124	10.3	0	1.3	824.8
1984	0	0	14	0.2	81.2	42.2	153.8	109.9	96.7	0	0	13.9	511.9
1985	6.2	0	13.4	41.8	80.1	26.1	278	261.4	79.1	0.6	0.7	4.9	792.3
1986	0	55.7	67.6	53.4	25.6	103.4	147	87.7	76.6	10.2	0	2.6	629.8
1987	0	13.1	87.7	44.2	148.2	3.3	102.4	227.5	60	0.6	0	0	687
1988	35.4	12.2	2.4	28	26.2	59.3	188.7	186.2	132.1	14	0	4.5	689
1989	0	15.7	34	60.8	1.2	83.5	147.4	169.9	66.2	10.7	0	0	589.4
1990	19.6	102.3	57.7	80.7	12.2	3.3	127.1	220.2	89.3	49.5	0	0	761.9
1991	14.5	37.3	41.5	41.7	59.3	50.7	165	175.8	89.5	34.4	5.8	7	722.5
1992	19.9	35.0	42.9	48.6	60.4	61.4	159.8	173.4	89.3	49.5	9.0	7.2	756.4
1993	40.2	46	0	161.8	95.4	55.9	249.6	125.6	57.3	34.3	0	7.3	873.4
1994	0.0	0.0	35.4	29.9	28.5	99.8	165.1	93.1	87.5	20.4	18.2	22.6	600.5
1995	0.0	29.3	73.0	115.1	9.9	54.3	158.8	194.1	83.0	2.2	0.0	13.5	733.2
1996	26.5	0	151.8	56.4	63.6	94.8	124.9	166.6	139.8	0	4.7	0	829.1
1997	14.1	0	46.1	57	3.2	112.1	230.6	153.6	65.6	140	8.3	7.9	838.5
1998	19.0	30.2	47.3	57.1	40.2	19.2	256.9	325.6	98.6	132.0	0.0	0.0	1026.1
1999	7.6	0	20.2	0	2.8	125	248.4	173.8	62.8	145.6	7.9	7.5	801.6
2000	0	0	8.5	39.7	52.6	67.1	262.8	180	88	55	8	7.5	769.2
2001	0	6.8	96.7	27	137.6	67.1	221.4	159.4	50.8	1.4	0	10.7	778.9
2002	17	26.9	53	53.5	45.4	20.2	71.5	156.9	40.6	52.9	7.6	7.7	553.2
2003	16.6	24.2	128.1	70.8	4	47.9	197.3	183.8	158.8	0	1.3	53.1	885.9
2004	17.6	27.8	51.8	55.6	55.7	67.2	182.5	136.7	103.4	64.3	19.4	0	782
2005	18.2	26.8	49.9	99.3	90.6	107.3	112.4	229.5	131.1	3.8	9.4	0	878.3
2006	17.1	44.5	59.4	55.2	55	60.9	173.9	174.2	138.5	49.8	0	34.3	862.8
2007	48.5	40.7	50.2	55.2	55	66.1	173.9	174.2	91.2	49.8	7.6	9.3	821.7
STDEV	21.3	31.7	37.8	35.3	46.3	44.5	57.1	48.2	30.4	62.6	14.5	12.2	139.9
Min	-	-	-	-	1.2	2.8	71.5	87.7	40.6	-	-	-	511.9
Max.	95.2	143.3	151.8	161.8	184.8	211.1	278.0	325.6	158.8	261.2	61.3	53.1	1,220.3
Average	18.5	27.5	50.2	56.2	65	65.7	174	174.3	91.2	49.3	7.8	9.1	778.8



4.1.2.2. Number of Wet Days: The number of wet days shows that days that have 1mm and above of rainfall. According to data obtained from ENMSA, number of wet days varies from 60 to 206, showing that the highest number of wet days is recorded in 2007, while the lowest number of wet days is observed in 1995 (fig.7). The variability of number of wet days is almost similar to the number of rainy days. In general, both indices shows the variability of rains across the area under study, i.e., around Awash Melkasa town in particular and Dodota woreda in general where the meteorological station is located.

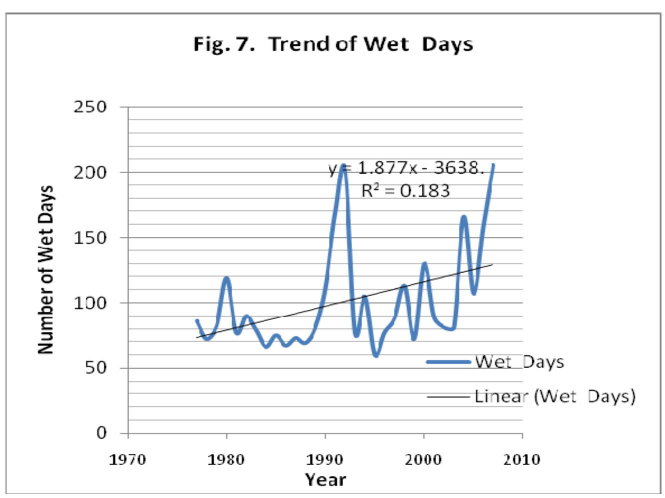


Table.2. Distribution of Rainy and Wet Days

Year	Wet Days	Rainy Days
1977	86	106
1978	72	89
1979	82	93
1980	119	140
1981	77	91
1982	90	104
1983	79	103
1984	66	75
1985	75	94
1986	67	91
1987	73	90
1988	69	83
1989	81	89
1990	112	155
1991	169	224
1992	202	298
1993	77	93
1994	105	114
1995	60	65
1996	77	83
1997	88	126
1998	113	158
1999	72	103
2000	130	188
2001	89	102
2002	81	156
2003	81	95
2004	166	226
2005	107	150
2006	159	208
2007	206	278
Min	60	65
Max	206	298
STDEV	39.8	60.2
Mean	101.0	131.3

4.1.2.3. Seasonal and Monthly Rainfall: Rainy months are Jun, July, August and September while November and December are the lowest rainy months. As shown in the following table, the wettest month is August, while the driest month is December. On the other hand, the wettest season is kiremt (summer), while the driest season is bega (winter). Relatively, belg (spring) is the second rainy season in the woreda understudy.

Table. 3. Seasonal Distribution of Rainfall Patterns

Year		Belg				Kiremt				Bega			Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1977	95.2	2.0	62.9	145.9	75.1	211.1	87.5	140.0	86.4	261.2	53.0	0.0	1220.3
1978	2.5	143.3	4.3	48.7	12.0	51.1	75.5	176.6	70.3	47.6	0.0	34.8	666.7
1979	50.4	13.0	60.4	14.1	120.1	127.8	226.1	142.5	83.9	21.6	0.0	14.8	874.7
1980	49.4	0.0	6.7	67.6	25.5	95.3	157.2	193.7	107.9	189.7	19.3	0.0	912.2
1981	0.0	62.9	123.0	49.4	1.2	2.8	248.5	149.8	135.8	9.7	0.2	0.0	783.3
1982	5.4	20.2	10.3	39.3	51.5	28.4	124.2	226.9	42.4	67.8	61.3	9.0	686.7
1983	33.8	37.9	56.0	44.9	184.8	22.3	174.3	135.2	124.0	10.3	0.0	1.3	824.8
1984	0.0	0.0	14.0	0.2	81.2	42.2	153.8	109.9	96.7	0.0	0.0	13.9	511.9
1985	6.2	0.0	13.4	41.8	80.1	26.1	278.0	261.4	79.1	0.6	0.7	13.6	801.0
1986	0.0	55.7	67.6	53.4	25.6	103.4	147.0	87.7	76.6	10.2	0.0	2.6	629.8
1987	0.0	13.1	87.7	44.2	148.2	3.3	102.4	227.5	60.0	0.6	0.0	0.0	687.0
1988	35.4	12.2	2.4	28.0	26.2	59.3	188.7	186.2	132.1	14.0	0.0	4.5	689.0
1989	0.0	15.7	34.0	60.8	1.2	83.5	147.4	169.8	66.2	10.7	0.0	6.0	595.3
1990	19.6	102.3	57.7	80.7	12.2	3.3	127.1	220.2	89.3	49.5	0.0	0.0	761.9
1991	0.0	46.2	42.9	10.3	60.4	61.4	159.8	173.4	89.3	49.5	0.0	7.2	700.4
1992	19.9	35.0	42.9	48.6	60.4	61.4	159.8	173.4	89.3	49.5	9.0	7.2	756.3
1993	40.2	46.0	0.0	161.8	95.4	55.9	249.6	125.6	57.3	34.3	0.0	7.2	873.3
1994	0.0	0.0	35.4	29.9	28.5	99.8	165.1	93.1	87.5	20.4	18.2	22.6	600.5
1995	0.0	29.3	73.0	115.1	9.9	54.3	158.8	194.1	83.0	2.2	0.0	13.5	733.2
1996	26.5	0.0	151.8	56.4	63.6	94.8	124.9	166.6	139.8	0.0	4.7	0.0	829.1
1997	14.1	0.0	46.1	57.1	3.2	112.1	230.6	153.6	65.6	140.0	8.3	7.9	838.6
1998	19.0	30.2	47.3	57.1	40.2	19.2	256.9	325.6	98.6	132.0	0.0	0.0	1026.0
1999	7.6	0.0	20.2	0.0	2.8	125.0	248.4	173.8	62.8	145.6	7.9	7.5	801.7
2000	0.0	0.0	8.5	39.7	52.6	67.1	262.8	180.0	88.0	55.1	7.9	7.5	769.3
2001	0.0	6.8	96.7	27.0	137.6	67.1	221.4	159.4	50.8	1.4	0.0	10.7	778.9
2002	17.0	26.9	53.0	53.5	45.4	20.2	71.5	156.9	40.6	52.9	7.6	7.7	553.2
2003	16.6	24.2	128.1	70.8	4.0	47.9	197.3	183.8	158.8	0.0	1.3	53.1	885.9

2004	17.6	27.8	51.8	55.6	55.7	67.2	182.5	136.7	103.4	64.3	19.4	0.0	782.0
2005	18.2	26.8	49.9	99.3	90.6	107.3	112.4	229.5	131.1	3.8	9.4	0.0	878.3
2006	17.1	44.5	59.4	55.2	55.0	60.9	173.8	174.2	138.5	49.8	0.0	34.3	862.7
2007	48.5	40.7	50.2	55.2	55.0	66.1	173.8	174.2	91.2	49.8	7.6	9.6	821.9
Ave	18.1	27.8	50.2	55.2	55.0	66.1	173.8	174.2	91.2	49.8	7.6	9.6	778.6
Max	95.2	143.3	151.8	161.8	184.8	211.1	278.0	325.6	158.8	261.2	61.3	53.1	1220.3
Min	0.0	0.0	0.0	0.0	1.2	2.8	71.5	87.7	40.6	0.0	0.0	0.0	511.9
StD	21.567	31.81	37.79	36.14	46.35	44.44	57.124	48.182	30.42	62.54	14.55	12.12	139.9972

4.1.2.4. Inter-annual Rainfall Variability

The recorded annual maximum rainfall in 31 years is 1220.3mm (1977), while the lowest rainfall was 511.9mm (1984) showing that the range of 805.5mm. It shows that there is high variability of rainfall across the years. On the other hand, the average/mean annual rainfall of 31 years is 778.6mm, while standard deviation is about 140.0 where this much rainfall amount is deviated from the mean. In general, there is high variability in rainfall distribution across the past three decades. The variability of rainfall is more pronounced and the amount shows gradual decreasing trend.

4.1.2.5. Inter Decennial Variability and Trend

The 1970s decades' rainfall was more pronounced than the remaining consecutive decades. Its trend shows that declining rainfall up to 1980s and then starts increasing slightly. The lowest rainfall was observed in 1980s, while the highest rainfall was recorded in 1970s (Table.4).

Table.4. Inter Decennial Variability and Trend

Rainfall/Year	1970s	1980s	1990s	2000s
Decennial Rainfall	969.2	692.3	810.6	822.0

4.1.2.6. Variation on Date of Onset and off-set of Rain: As indicated in Table.5, kiremt is the major rainy season, while belg is not as such an important rainy season particularly in Dodota woreda. The onset of rain for kiremt season varies from June first to June 22nd through the given years, i.e., about 3 years (1988, 1993 and 1995) the rain started early, while in 1990 it was started very late. On the other hand, the rain stopped earlier in 1998, while most of the years included in the study the rain stopped at the end of August. Rainy days in kiremt season varies from 32 rainy days to 54 rainy days. From the rainy days of kiremt (90 days) only 4 years from 31 years have 50% and above of rainy days, showing that the distribution of rainfall across days was not uniform which implies that the rain in area understudy is not adequate for crop cultivation.

Table. 5. Dates of onset and off-set of Rainy season (Kiremt) and durations (No. of days) of Belg and Kiremt

	Rainy season		Rainy days	
Year	Date of Onset/June	offset/August	Belg	Kiremt
1977	9	31	23	32
1978	7	28	12	40
1979	7	30	24	40
1981	11	30	31	42
1982	15	28	17	43
1983	3	31	25	40
1984	3	31	15	46
1985	17	30	24	44
1986	2	29	26	37
1987	7	27	36	29
1988	1	31	8	46
1989	2	29	20	50
1990	22	31	24	38
1993	1	30	16	34
1994	2	31	19	39
1995	1	31	16	34
1996	3	31	26	39
1997	2	30	9	44
1998	3	24	26	40
1999	1	31	9	39
2001	7	30	29	41
2003	5	30	16	54
2005	2	30	29	45
2006	10	27	21	44

4.1.2.7. Drought years

In the past 3 to 4 decades there were two major and serious drought years. The 1984 is the one that more pronounced in the history of droughts in Ethiopia. The next drought year was 1993/1994.

4.2. Demographic and Socio-economic Characteristics of the Study Community

As explained earlier 81 respondents were from ‘kola’ area while 79 were from ‘woyna dega‘ agro-ecological zone. As indicated in Table. 4, 72.5% (116) of the respondents were male and 27.5% (44) were female population. The majority of the respondents fall in the age category of 30-50 (57.5%) seconded by age category of above 50 years old (23.8%), as presented in Table.3. The young respondents constitute only about 18.7% of the total respondents. As indicate in Table.5, the educational status of respondents was from illiterate to 12 grades, i.e., about 33.8% of the respondents cannot read and write (illiterate), 2.5% only have the ability of read and write. As indicated in Table.5. 21.3%, 33.1%, 7.5%, and 1.8% of the respondents have educational status of 1-4, 5-8, 9-10 and 11-12 grades respectively.

Table.6. Distribution of Sample Households by age group and kebele

Family head by age category	Woyna dega		Kola		Total	%
	Dilfeker	Dodota Alem	Awash Beshola	Tedecha Guracha		
<30	14	10	1	5	30	18.7
30-50	13	28	23	28	92	57.5
>50	6	8	6	18	38	23.8
Total	33	46	30	51	160	100.0

Table.7. Distribution of Sample Households by sex and kebele

Family head by sex		Woyna dega		Kola		Total	%
		Dilfeker	Dodota Alem	Awash Beshola	Tedecha Guracha		
Sex of respondents	male	20	39	20	37	116	72.5
	female	13	7	10	14	44	27.5
Total		33	46	30	51	160	100

Table.8. Distribution of Sample Households by educational status

Educational status of respondents	Woyna dega		Kola		Total	%
	Dilfeker	Dodota Alem	Awash Beshola	Tedecha Guracha		
Read and Write	2	1	1	0	4	2.5
1-4	13	7	10	4	34	21.3
5-8	5	20	10	18	53	33.1
9-10	4	5	2	1	12	7.5
11-12	0	0	0	3	3	1.88
Illiterate	9	13	7	25	54	33.8
Total	33	46	30	51	160	100

As indicated in Table.6, about 31.8% of the respondents had 0.5 to 1ha of farmland, while about 14.9% have had below 0.5ha of farm land. In general, 46.7% of the respondents have less than 1ha of farmland. About 33%, 21%, 43% and 22% of the respondents do not have cattle, oxen, pack animal and small ruminants, respectively.

Table.9. Distribution of Sample Households by wealth Status and kebele

Kebele	Size of Farmland				Total	Cattle			Total	Oxen for Farming			Total	Pack Animal			Total	Goat and Sheep			Total
	<0.5	0.5-1	1-2	>2		0	1-5	>5		0	1-2	>2		0	1-2	>2		0	1-5	>5	
Dilfeker	9	8	8	8	33	11	22	0	33	11	21	1	33	28	5	0	33	12	19	2	33
Dodota Alem	2	11	5	22	40	4	35	7	46	4	35	7	46	10	33	3	46	10	23	13	46
Awash Beshola	9	2	10	9	30	9	11	10	30	10	18	2	30	20	8	2	30	5	8	17	30
Tedecha Guracha	3	28	20	0	51	29	22	0	51	9	36	6	51	11	37	3	51	8	32	11	51
Total	23	49	43	39	154	53	90	17	160	34	110	16	160	69	83	8	160	35	82	43	160
%	14.9	31.82	28	25	100	33	56	11	100	21	69	10	100	43	52	5	100	22	51	27	100

4.3. Factors Affecting Farmers' Perceptions to Climate Change

The results of analysis examining the factors influencing the farmers' perceptions of climate change are depicted in table 8. The results revealed that the age, educational status, sex, family size, access to extension services, wealth (farm size, number of farming oxen, cattle, ruminant animals and pack animals), farming experience and exposures to mass media have significant relationship with farmers' perception to climate change.

According to some studies, the influence of age on perception of climate change and adaptation to change of climate are of mixed nature. Some of them concluded that age had no influence on perception of climate change and adaptation, while others found that age is significantly and negatively related to perception of climate change. According to the result of this study, the age has positive and significant effect on the perception of farmers in the study area toward rainfall change, drought, and frequency of drought and crop failure due to shortage of rainfall. Thus, increasing the age of household head by one unit increases the probability of perceiving change in climate by 7%, whereas increasing farm income by one unit increases perception by 179.2%. For example, the perception of aged (>50yr old) farmers toward rainfall in their local area is higher than the farmers of others age of group. All sample farmers aged above 50 understand about the increment or decrement of rainfall and occurrences of drought in the past three decades. They also feel there is an increment of temperature in the past 31 years.

Higher level of education is believed to be associated with access to information on improved technologies and productivity consequences (Norris and Bati, 1987). Evidence from past sources indicates that there is a positive relationship between the education level of the household head and the adoption of improved technologies and adaptation to climate change (Maddison, 2006). As observed from the study, a unit increase in the education of the head of the household will have the impact of raising the probability of perceiving to climate change by 6.6%. Similarly, education has positive and significant impact on the analyzing of drought occurrences and frequency, and crop damage due to drought. Therefore, farmers with higher levels of education are more likely to better perceive to climate change.

We can see the influence of household size on use of adaptation methods from two sides. The first assumption is that households with large family members may be forced to divert part of the labor force to off-farm activities in an attempt to earn income in order to ease the consumption pressure imposed by a large family size (Yirga, 2007). The second assumption is that large family size is normally associated with a higher labor endowment, which would enable a household to accomplish various agricultural tasks (Dereessa, 2007). However, this study shows that there is negative relationship between family size and climate change and adaptation. According to the result indicated in Table.10, family size has positive (76.7%) and significant (0.036) impact on perceiving drought, drought frequency and encountering of crop failure, while has negative and insignificant impact on having awareness of climate change. As observed from focus group discussion and key informants, families that have large family members forced part of the labor force to off-farm activities. Specially, those who have young daughters have sent to Arab countries and get money. In general, household with large family size has positive and significant effect on the awareness of rainfall change, drought and drought frequency and damage of crop due to climate change. For example, as the family size increases by one unit the perception of farmers on the existence of drought will be increased by 76.7% (Table.8).

Male-headed households are often considered to be more likely to get information about new technologies and take risky businesses than female-headed households (Asfaw and Admassie, 2004). Moreover, Tenge et al. (2004) argued that female- headed households may have negative effects on the adoption of soil and water conservation measures because they have limited access to information, land and other resources due to traditional social barriers. The result of study by Nhemachena and Hassan (2007) indicated a contrary result to the above argument by showing that female-headed households are more likely to take up climate change adaptation methods.

This study support that the second argument which indicates the female-headed households are more likely to perceive climate change and take up adaptation methods as they are more affected by impact of climate change. As indicated in Table 7, sex has negative and significant impacts on the perception of climate change. Therefore, the negative implies the perception of female household toward climate change. Females in the study area are more affected by climate change as observed from focus group discussion. As a result of climate change, there is scarcity of water and firewood in the woreda. On the other hand, women have responsibilities of fetching water and firewood and women must travel long distances to get these two important things.

According to the result, non-farm income, farm size and livestock ownership represent wealth. The adoption of agricultural technologies requires sufficient financial well-being (Knowler and Bradshaw, 2007). On this line of the argument, other studies, which investigate the impact of income on adoption, revealed a positive correlation (Franzel, 1999). Farm size is associated with greater wealth and it is hypothesized to increase adaptation to climate change. Studies on adoption of agricultural technologies indicate that farm size has both negative and positive effect on the adoption showing that the effect of farm size on technology adoption is inconclusive (Bradshaw et al., 2004). According to this study, farm size has negative effect on climate perception as well as adaptation even in most cases it has insignificant impact on the farmers' perception of drought, increasing of temperature as well as drought frequency. It is due to that farmers with large farm land have an alternative of diversifying their livelihood.

Moreover, farmers living in lowland areas are perceived climate change as compared to midland and highlands. This is due to the fact that lowlands are already hotter and a marginal change in temperature could be perceived easily. As observed from the study, farmers living in kola have better perception than farmers of woyina dega.

Access to affordable credit increases financial resources of farmers and their ability to meet transaction costs associated with various adaptation options they might want to take (Nhemachena & Hassan, 2008). Access to credit have positive and a significant factor affecting climate change adaptation measures. However, as the result indicates, access to credit has negative and significant effect on climate change perception and adaptation. Here the farmers in the study area could not take risk and they are less risk taker.

According to Madison, (2006), perceived change in climate variables and access to climatic change information are also important pre-conditions to take up adaptation measures. According to the study of Nhemachena and Hassan (2007), farmers that perceive change in climatic conditions and farmers who have access to climate change information have higher chances of taking adaptive measures in response to observable changes. In the study area, credit is significantly and negatively related to perceive climate change and adaptation. Credit by its nature is expected to relax the financial constraint of farmers and makes the farmers to have a positive influence on climate change risk in order to adapt the existing condition. However, this is applied only as far as it is profitable and accepted by farmers.

Table.10. Analysis of Variables that affect Farmers perception on climate change

	Opinion on Climate Change		Rainfall Change		Occurrences of Drought		Feeling of Temperature		Drought increment		Encountering of Crop failure	
	B(S)	Exp(B)	B(S)	Exp(B)	B(S)	Exp(B)	B (S)	Exp(B)	B(S)	Exp(B)	B(S)	Exp(B)
Age	0.070(0.926)	1.073	1.281(0.057)	3.599	0.692(0.118)	1.997	-3.985(0.999)	.019	0.660(0.093)	1.935	0.283(0.501)	1.327
Sex	-1.188 (0.28)	.305	-0.676(0.420)	.509	-0.171(0.741)	.843	-71.658(0.986)	.000	-0.377(0.404)	.686	-0.407(0.397)	.665
Education	0.066(0.822)	1.068	-0.153(0.547)	.858	0.477(0.011)	1.611	-6.041(0.994)	.002	0.242(0.111)	1.274	0.237(0.144)	1.267
Family Size	-0.436(0.539)	.647	0.278(0.612)	1.320	0.767(0.036)	2.152	99.786(0.981)		0.563(0.073)	1.756	0.45(0.181)	1.568
Access to Extension	2.23(0.023)	9.301	-1.383(0.024)	.251	1.279(0.17)	3.594	1.424 (1.000)	4.155	0.187(0.644)	1.206	0.627(0.151)	1.871
Size of Farm land	-0.566(0.183)	.568	-1.01(0.007)	.364	-0.114(0.615)	.892	-20.505(0.984)	.000	-0.012(0.953)	.989	-0.123(0.562)	.884
Access to Information	-1.075(0.108)	.341	-2.426(0.001)	.088	-0.698(0.080)	.498	62.088(0.988)		-0.004(0.991)	.996	0.868(0.016)	2.381
Access to Credit	-1.447(0.058)	.235	-0.779(0.209)	.459	1.06(0.018)	2.886	-24.260(0.994)	.000	0.814(0.033)	2.256	1.821(0.000)	6.180
Farm Experience	1.096(0.212)	2.992	0.145(0.821)	1.156	0.755(0.138)	2.128	-4.496(0.998)	.011	-0.070(0.864)	.932	0.094(0.834)	1.099
Extra Income	1.792(0.021)	6.000	2.021(0.001)	7.544	-0.020(0.967)	.980	79.959(0.977)		-0.758(0.070)	.469	-0.578(0.189)	.561
Access to Market	-2.355(0.001)	.095	-2.187(0.001)	.112	0.671(0.240)	1.955	-150.429(0.977)	.000	-0.134(0.763)	.874	-0.627(0.182)	.534
Constant	5.266	193.682	8.629(0.004)	5593.300	-7.083(0.001)	.001	57.997(0.995)		-2.341(0.157)	.096	-4.648(0.013)	.010

Exp(β)=odds ratio
S------=significance

4.4. Descriptive Statistics

4.3.1. Farmers Perception

Change of climate was well perceived by farmers of the study area as most of them have been observing changes in temperature, precipitation and timings of rainfall and related frequent drought. Particularly, perceptions on temperature and precipitation change of farmers of the study area (Table.11). The result indicates that most respondents, about 85%, perceive that there is change in climate, while 15% of respondents perceived that there is no change in climate or they did not know about climate change. Similarly, 97.5% of respondents feel that temperature of Dodota was increasing in the last three decades, whereas 2.5% of them noticed that they were not aware of temperature change or they did not feel change in temperature.

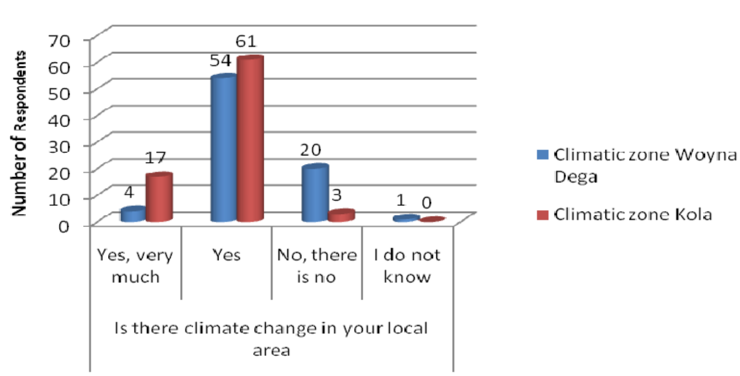
Furthermore, 69.4% of the respondents observed increase in rainfall amount in the last three decades in the area, while 29.4% have noticed a decrease in the amount of rainfall. Generally, about 98.8% of the respondents observed the change in rainfall in the past three decades, whether there is decrease or increase in rainfall. As observed from key informants and group discussion, there is a change not only in the total amount of rainfall but in the timing of the rains, with rain coming either earlier or later than expected and with rain withdraws before the normal time. About 71.3% of the respondents observed the late starting of rainfall from normal date and 91.3% of the respondents approved the early termination of rainy season from normal date.

Table. 11. Farmers' perception of climate change based on the past 31 years experiences

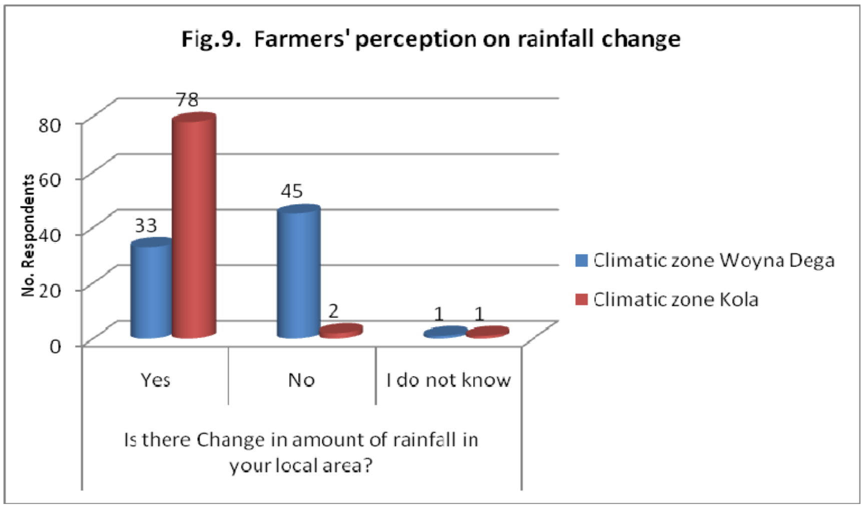
No.	Perception	Number of Respondents					Percentage			
		Respon-dents	Yes, very much	Yes	No, there is no	I do not know	Yes, Very much	Yes	No, there is no	I do not know
1	Do you think that there is climate change in your local area?	160	21	115	23	1	13.1	71.9	14.4	0.6
2	Is there change in amount of rainfall during main rain season?	160	0	111	47	2	0.00	69.38	29.38	1.25
3	Has the timing of the onset of rain in the main season shifted?	160	0	114	43	3	0.00	71.25	26.88	1.88
4	Has rain started late than normal?	160	0	150	1	9	0.00	93.75	0.63	5.63
5	Is rain of main season early withdrawn than normal?	160	0	157	0	3	0.00	98.13	0.00	1.88
6	Do you feel temperature of the area is changing?	160	17	139	1	3	10.63	86.88	0.63	1.88
7	Do you feel temperature is increasing?	160	87	69	1	3	54.38	43.13	0.63	1.88

Agro-ecologically, farmers of kola area (96.3%) are more aware on climate change than farmers of woyna dega (73.4%). This is mostly related to a unit change in climate results the hotter the area of kola because it is already environmentally fragile and hazard prone. In general, about 85% of the respondents in both climatic zones are aware of climate change, while 15% of respondents perceive either there is no or do not have the knowledge of climate change (fig.8).

Fig.8. Farmers' climate change perception



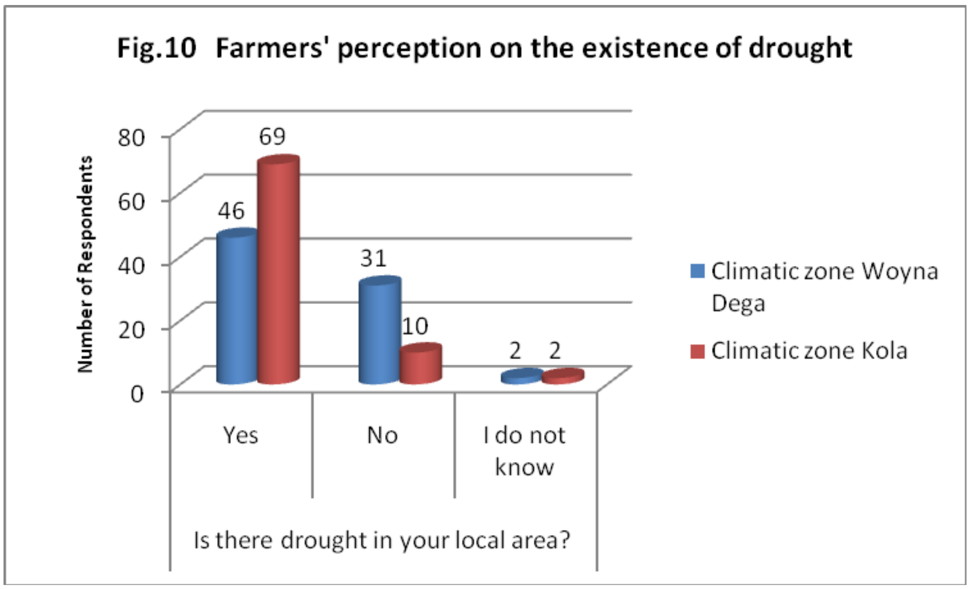
About 96.2% of the respondents in kola area recognized the change (the increase or decrease) of rainfall amount, while only 41.8% of respondents of woyna dega perceived rainfall change (Fig.9). This shows that climate change is more pronounced in areas already have climatic problem.



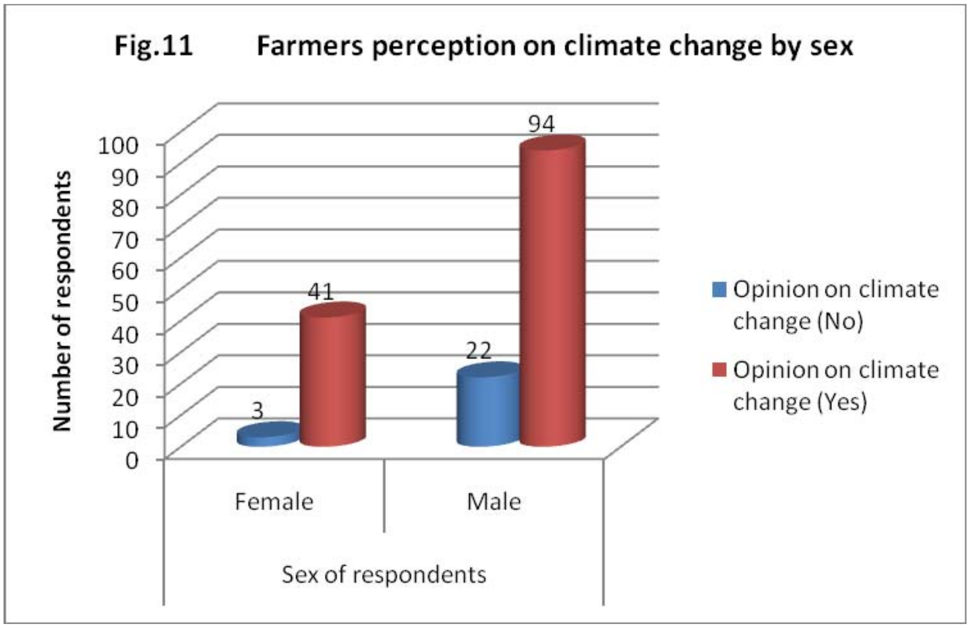
From the sample households, about 81.2% are well recognized the existence of drought in kola region, while 58.2% of sample farmers of woyna dega are perceived drought existence (fig.10). On the other hand, the increment of the frequency of drought is more perceived by kola sample respondents (88.9%) than woyna dega sample respondents (59.5%). From this one can conclude that climate change is not the problem of the woyna dega area of the woreda understudy.

Table. 12. Farmers' perception on the existence of drought by climatic zones

		Climatic zone		Total	%
		Woyna Dega	Kola		
Is there drought in your local area?	Yes	46	69	115	71.9
	No	31	10	41	25.6
	I do not know	2	2	4	2.5
Total		79	81	160	100.0
%		58.2	85.2	71.9	



From the total female sampled population 93.2% are aware of climate change, while 81% of the sample male population is recognized climate change. As the finding indicates female population is more sensed climate change than male population of the study area.



4.3.2. Climate Change Impact

About 84.4% of the respondents have well observed about the increasing of drought frequency. As indicated in Table. 13, about 71.9% of the respondents recognized the occurrences of drought and about 88.1% confirmed that the amount of precipitation in the study area was not sufficient for crop cultivation. As the respondents indicated that, frost, heavy rain and hail were not the problems of the woreda understudy.

Problems of livestock and human health, crop failures and their frequencies and extreme temperature events are visible for the majority of the sample households. About 67.5% of households have encountered at least one time complete crop failure in the last three decades. An increase in the problem of livestock and human health related to climate change are perceived by 41.9% and 59.4% by sample households, respectively. Malaria infestation area expanded from the kola area to woyna dega area where it was uncommon before. It was only common in kola area, but now it covers almost the lower woyna dega area (up to 2200masl). Due to climate change there was shortage of food and uncommon child diseases like diarrhea and malnourished have emerged as the most common problems of the society of the study area.

Table.13. Climate Impacts on Farmers in the past three Decades

No.	Impacts	Respondents	Yes, very much	Yes	No, there is no	I do not know	Percentage			
							Yes, very much	Yes	No, there is no	I do not know
1	Is there drought?	160	0	115	41	4	0.00	71.9	25.6	2.5
2	Is there an increment of drought frequency or occurrences of drought?	160	99	20	37	4	61.9	12.5	23.1	2.5
3	Is the amount of precipitation sufficient for full cropping during drought period?	160	0	9	141	10	0.00	5.63	88.13	6.25
4	Did you encounter complete crop failure?	160	4	104	49	3	2.50	65.00	30.63	1.88
5	Increase problem of frost?	160	0	28	125	7	0.00	17.50	78.13	4.38
6	Increase problem of heavy rain and hail?	160	0	55	50	55	0.00	34.38	31.25	34.38
7	Is there an increase of livestock health problem due to climate change?	160		67	91	2	0.00	41.88	56.88	1.25
8	Is there an increase of human health problem due to climate change?	160	0	95	58	7		59.38	36.25	4.38

Based on the meteorological data of three decades (1977-2007), which was collected from ENMA, there is a significant increment of temperature of the woreda understudy. It shows that there is an increment of $2.0^{o}C$ in the past three decades with an annual increment of $0.07^{0}C$.

Similarly, according to data gathered from ENMA, there is declining in rainfall amount in the past three decades keeping that the existence of high variability. The maximum rainfall was observed in 1977 (mean annual rainfall 1220.3mm), while the lowest mean annual rainfall was recorded in 1984 (511.9mm). In the past 31 years, the average annual rainfall was 778.6mm with standard deviation of 140mm. Relatively, the wettest years were 1977 and 1998, while the driest years were 1989 and 2002. In general, the rainfall of 14 years was below the average annual rainfall indicating that in these years there was scarcity of rainfall for proper crop cultivation.

As observed from focus group discussion and key informant discussion the frequency of drought increase from decade to decade, i.e. in the beginning there was drought for every ten years, next every five years at the end every two years there was drought that affect crop cultivation. Due to this, farmers do not have confidence on rainfall and there is lag of agricultural inputs such as fertilizer and improved seeds use. Woreda agricultural development office data indicates, only 25% of the farmers applied these inputs. This shows that the woreda is the lowest in using these new technologies in Arsi zone (OFEDDW, 2012).

Therefore, farmers perception analyses to climate change indicates that most of the farmers in the study area are aware of the fact that temperature is increasing, while on the level of precipitation, it is both way.

4.3.3. Adaptation

The climate change research community has identified different adaptation methods. The adaptation methods most commonly cited in literature include: use of new crop varieties and livestock species that are more suited to climate change, irrigation, crop diversification, mixed crop livestock farming systems, changing planting dates, diversifying from farm to non-farm activities, increased use of water and soil conservation techniques, changed use of capital and labor and shading and sheltering /

tree planting (Bradshaw et al., 2004; Kurukulasuriya and Mendelsohn, 2006; Maddison, 2006; Nhemachena and Hassan, 2007).

This study focused on the adaptation strategies of farmers to cope with the climate change impact that are faced in their local area. The study focused on diversification of crop variety, using different type of crop cultivation, applying short season growing crops and drought tolerance varieties, changing planting dates and applying other types of adapting mechanisms such as cattle fattening and using small scale irrigation. As indicated in Table.14, about 96.2% of the respondent households across all kebeles have accessed to using different improved crop varieties and applied short maturing crop variety to cop up the occurrence of climate change. 71.3% of the respondent was using diversification of crop cultivars. About 83.1% of the respondents changed their planting date to go with the changed climate condition and 81.9% of them applied this changed planting date to most of crops. The most common improved varieties of crops are short maturing teff type, haricot beans and maize in ‘kola’ area while in ‘woyna dega’ area wheat and barley varieties are practiced by farmers.

Table.14. Farmers climatic adaptation mechanism by climatic zone

Climatic zones	Using different crop cultivars			Using different type of crop varieties			Applying short season crop variety		
	NO	yes	Total	no	yes	Total	no	yes	Total
Woyna Dega	44	35	79	2	77	79	4	75	79
%	56	44	100	3	97	100	5	95	100
Kola	2	79	81	4	77	81	7	73	80
%	2	98	100	5	95	100	9	91	100
Total	46	114	160	6	154	160	11	148	159
%	28.7	71.3	100.0	3.8	96.2	100.0	6.9	93.1	100.0

Irrigation development is one way of enhancing food production and carrying capacity of farm land and reducing dependency of rainfed agriculture. As indicated in Table.15, about 41.9% of the respondents were practicing small scale irrigation to overcome food shortage that they faced due to climate change. In the woreda understudy, irrigation at large needs huge capital because rivers (Awash and Keleta) which have large capacity are located at inaccessible distances. At farmer level to use these rivers for irrigation is impossible due to shortage of capital and also technology. Horticulture and cattle fattening are common activities in the sample areas because these sample areas are nearer to major cities and does not have market problem.

Table.15. Diversities of Adapting Mechanisms

Sex of the Respondent	Diversities of adaptation mechanisms								Total
	Early Short maturing crop	Shifting cropping pattern	Using small scale irrigation	Petty-trade	Cattle fattening	daily laborer	small ruminant fattening	Horti culture	
Male	2	4	51	1	20	0	1	37	116
Female	2	1	16	1	16	2	1	5	44
Total	4	5	67	2	36	2	2	42	160

Since the woreda understudy is most likely affected by climate change, farmers are engaged in different activities such as petty-trade, daily labor, small ruminant fattening, developing nursery, renting horse and donkey and even sending their young daughters to Arab countries as a means of getting money and improving their life. As observed from focus group discussion, young people are migrated to large cities to have job opportunities and help their families. This is also has negative impact on adaptation to climate change, thus the energetic population migrated to nearer cities like Adama and Bishoftu, even to Addis Ababa. So the population remaining behind is more or less aged population that does not have capacity to cope up climate change hazards and mostly become dependent on food aid. As observed from focus group discussion, almost all farmers of the study area are under safety net.

Regarding climatic zone, using different crop varieties are more common in 'woyna dega' area, while in 'kola' using crop diversification are more practiced by farmers (Table.12). As indicated in table 16, using of early maturing crop variety were low in woyna dega area (44%) as comparing with in kola area (98% of the respondents).

Table.16. Number of Farmers' climatic adaptation mechanism by climatic zone

Climatic zones	Crop diversification		Total	Use of improved crop varieties		Total	Using of early maturing crop variety		Total
	NO	yes		no	yes		no	yes	
Woyna Dega	44	35	79	2	77	79	4	75	79
Kola	2	79	81	4	77	81	8	73	80
Total	46	114	160	6	154	160	12	148	160

Both female and male household headed respondents were using of improved crop varieties and early maturing crop variety. Furthermore, as indicated in Table 17, 88.6% of sampled female population was crop diversification, while only 64.7% male population of the respondents was using this method to cope up climate change.

Table.17. Farmers climate change adaptation mechanisms by sex

Sex of respondents	Crop diversification			Use of improved crop varieties			Using of early maturing crop variety		
	NO	yes	Total	no	yes	Total	no	yes	Total
Female	5	39	44	2	42	44	3	41	44
%	11.4	88.6	100	4.5	95.5	100.0	6.8	93.2	100.0
Male	41	75	116	4	112	116	8	107	115
%	35.3	64.7	100.0	3.4	96.6	100.0	7.0	93.0	100.0
Total	46	114	160	6	154	160	11	148	159

As indicated in Table.18, there are factors that affect adaptation to climate change. Age, educational status, sex, occupation, access to extension, family size, wealth (farm land size, livestock), access to credit, access to information, farm experience, access to market and extra income are positively or negatively and significantly affect farmers adaption to climate change. Age has been observed positively and significantly affects the decision to take up climate change adaptation measures in the study area. It increases the probability of using crop diversification; use of improved crop varieties and using of early maturing crop variety. Women are more familiar than male population in using adaptation methods such as crop diversification; use of improved crop varieties and using of early maturing crop variety. Educational status has positive and significant impact on and using of early maturing crop variety, while negative and significant impact on using crop diversification. For example, as the educational status of the farmer increases by one unit the using improved crop varieties increases by 93.9%. Similarly, access to extension has positive and significant effect on applying crop varieties and short maturing crop varieties. This means as the farmers accessed to extension services by one unit, the using of these two technologies by farmers will be increased by 206.7% and 246.9% respectively. Farm experience also has positive and significant effect on the using of Crop diversification, improved crop varieties and early maturing crop variety. On the other hand, access to credit has negative impact on using these methods of adaptation. This due to those farmers are less risk taker. According to this study, family size has negative and insignificant impacts on the using of these methods of adaptation by farmers of the study area, because as family size increases farmers have other options, i.e., off-farm activities.

Table.18. Analytical Result of Adaptation Mechanisms

Factors	Crop diversification		Use of improved crop varieties		Using of early maturing crop variety	
	B(S)	Exp(B)	B(S)	Exp(B)	B(S)	Exp(B)
Age	0.042(0.94)	1.043	0.955(2.586)	2.586	0.160(1.174)	1.174
Sex	-2.278(.031)	.103	-1.102(0.523))	.332	-0.235(0.825)	.791
Education	-0.303(0.306)	.739	0.939(0.137)	2.558	0.212(1.236)	1.236
Family Size	-0.005(0.994)	.995	-0.250(0.847)	.779	0.262(0.755)	1.299
Access Extension	-1.701(0.020)	.182	2.067(0.312)	7.898	2.469(0.138)	11.814
Size of Farm land	-0.488(.195)	.614	0.162(0.843)	1.176	0.858(0.152)	2.357
Source of Information	-1.218(0.164)	.296	-1.343(0.330)	.261	-0.285(0.770)	.752
Access to Credit	-0.708(0.348)	.492	-0.170(0.902)	.843	-0.678(0.511)	.508
Farm Experience	1.377(0.144)	3.965	2.158(.122)	8.651	1.062(0.216)	2.892
Extra Income	0.052(0.947)	1.053	-1.994(0.282)	.136	0.263(0.792)	1.300
Access to Market	-2.657(0.005)	.070	-1.144(0.447)	.318	-0.425(0.693)	.654
Oxen	0.336(0.747)	1.399	2.888(0.137)	17.958	2.776(0.033)	16.058
Cattle	-0.284(0.782)	.753	0.885(0.580)	2.423	-0.409(0.724)	.664
Ruminant	-0.258(0.695)	.773	-2.338(0.099)	.096	-0.711(0.260)	.491
Constant	4.687(0.376)	108.553	12.109(0.133)	181513.929	-1.025(0.829)	.359

Exp(B)====odd ratios

S==========significant

CHAPTER FIVE: SUMMERY, CONCLUSION and RECOMMENDATION

5.1. Summery

The Dodota woreda has 15 kebeles of which 12 are rural kebeles. It has an area of 512km^2 and located between 8^o 11'- 8^{o}26' north latitude and 39^{o}2' - 39^{o}29' east longitude. A total population of 75143 were resided in the woreda (49.7% were female population and 50.3% were male population). 69% of the total population was rural population. Relatively, the woreda understudy has high density of population (147 persons per km^2).

According to data of ENMA, the average temperature of the woreda ranged between 19.1^{0}C and 21.7^0 C, while the maximum and minimum annual temperature ranged between 27.1^0 C and 29.1^0 C; 10^0 C and 14.7^{0}C respectively. In general, in the past three decades, temperature of the study area has increased by 2.0^0 C with annual increment of 0.07^{0}C. On the other hand, rainfall of the woreda shows a declined trend. It decreased almost by -1.3% annually. On the contrary, rainy and wet days show an increasing trend. Generally, June, July, August and September are rainy months and known by keremt (summer) season. As the data of ENMA, the range of rainfall of the woreda in the past three decades was 805.5mm showing that high variability. Furthermore, the mean annual rainfall was about 778.6mm and standard deviation was 140 showing that rainfall of the woreda deviated by 140 from the mean.

Farmers of the study area are highly affected by climate change; however, they have attempted different adaptation strategies to overcome climate change impacts. They have practiced important adaptation options such as crop diversification, using different crop varieties, using short growing crop varieties, applying small scale irrigation, changing planting date and involving off-farm activities (cattle fattening, small ruminant fattening, petty-trade etc,.).

5.2. Conclusion and Findings

- Because of low agricultural productivity, due to low rainfall, high rainfall variability and increased temperature, farmers of the woreda has been practicing different adaptation methods.
- Farmers of the area rely on rainfed agriculture taking into consideration risky of climatic condition. Farming experience, access to extension and access to education were found to enhance positively attributed to adaptation. This implies that education improves awareness of the potential benefits of adaptation could be an important policy measure.
- This study focused on the analysis of farmers' perception on climate change impact and adaptation focusing on the farmers' decisions in response to seasonal variations in climatic and related factors. These decisions are influenced by a number of socio-economic factors that include household wealth (land size and ownership of livestock), access to information of seasonal and long term climate changes, availability of institutions like access to credit and health institutions (human and livestock).
- Using a logit (binary) model, econometric investigation revealed access to extension service, female headed of the household, educational status, age and

farming experience had positive and significant impact on farmers' perception on climate change.

- Age, sex, educational status, access to extension, farming experience and extra income have positive and significant impact on adaptation to climate change.
- Access to credit was found to be significantly and negatively relate to the use of different crop varieties and applying short season maturing crop varieties. Credit is expected to relax the financial constraint and this would be expected to have a positive influence on farm – level climate risk adaptation. However, farmers of the study area are not in a position of taking risk because they do not have rain-fed agriculture, because there is crop failure. On the other hand, there is no sufficient credit institution with limited capacity in the woreda (only Oromia credit association).
- Focus Group Discussions revealed lack of effective access to information of weather condition. There is only one meteorological station of C type. The data that obtained from this station has missing. There is missed data of months as well as years. Most development agents were not in a position of transmitting information regarding daily, monthly and annually weather condition to the farmers.
- Rivers that are flowing bordering the woreda have high capacity. On the other hand, particularly Keleta River is under utilization. Even the Awash River is not properly utilized by the woreda's farmers. Both rivers having high capacity for irrigation but do not give services except for human and livestock drink.
- Farmers of the woreda understudy do not have confidence on rainfall due to the

frequent occurrences of drought and high variability of rainfall. Due to this and low awareness, the utilization of fertilizer and other agricultural inputs are very low.

- Most farmers of the sampled area are using crop diversifications, improved seeds, early maturing crop and changing planting date according to onset and offset of rainfall to adapt the impact of climate change.
- The environment of the woreda understudy is highly fragile. Forests and forest remnants were already cleared by the society and become under crop cultivation. The soil of the woreda is characterized by low moisture retention capacity. Seasonal runoff has created deep galleys.
- As observed from the field the woreda understudy has a plenty plain area which is conducive for mechanized agriculture, particularly for sugar cane plantation, horticulture and fruits.
- Livestock fattening at small scale is common in the woreda. Moreover, the woreda under study has large livestock market and has large market exposure in the region. It is also nearer to large cities (Addis Ababa, Adama, Bishoftu, Shashemene etc.,)

5.3. Recommendation and policy issues

The study recommends the following adaptation strategies to counteract the harmful impacts of climate:

- Promote use of improved crop and early maturing seeds that can resist the impact of climate change;
- Improve the quality of meteorological data and increase the number and their spatial distribution.

- Facilitate research and extension services to provide adequate extension information services to ensure that farmers receive up-to date information about rainfall and temperature patterns in the forthcoming season so that they can make well informed decisions about their planting dates,
- Setting up suitable financial systems that will allow small producers to have access to credit and expand off-farm activities. Aware farmers about the utilization of credit. These policies that improve rural household welfare as well as access to credit are also a priority for both short- and long-term adaptation measures;
- Introduce irrigation technologies to reduce the dependency of rainfed agriculture and to secure availability of food.
- Active intervention of concerned parties, especially to ensure actions match local needs and resources,
- Promoting mixed agriculture through improved crop and livestock to diversify livelihood of the farmers in order to resist climate change risk.
- Promoting gender of the household head being female; and access to climate change information in order to take adaptation mechanisms.

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Annex. 1. Seasonal and Annual Distribution and Patterns of Temperature

Year	Bega		Belg		Kiremt		Annual			
	Max	Min	Max	Min	Max	Min	Max	Min	Average	Range
1977	26.4	12.3	28.3	12.9	26.4	13.1	27.1	12.8	19.9	14.3
1978	27.4	16	29.6	14.2	27.5	13.7	28.2	14.6	21.4	13.5
1979	27.3	14.9	29.4	12.8	27.1	14.1	28.0	13.9	20.9	14.1
1980	27.3	14.9	31.1	12	27.4	14.5	28.6	13.8	21.2	14.8
1981	28.2	16.2	28.7	12.5	27.9	14.8	28.3	14.5	21.4	13.8
1982	26.6	16.1	29.5	12.4	27.5	15.4	27.9	14.6	21.3	13.2
1983	27.8	16.1	29.5	13.1	27.7	15	28.3	14.7	21.5	13.6
1984	28.1	16	30.8	12.3	27.3	12.8	28.8	13.7	21.2	15.1
1985	28.1	16.1	29.4	13.4	26.9	14.3	28.1	14.6	21.4	13.5
1986	28.5	15.8	29	12.5	27.2	14	28.2	14.1	21.2	14.1
1987	29.1	16.2	29.3	11.9	28.9	13.6	29.1	13.9	21.5	15.2
1988	28.2	16.5	31.3	12.1	27.2	15.2	28.9	14.6	21.7	14.3
1989	28.2	15.4	29.1	10.9	27.9	13.3	28.4	13.2	20.8	15.2
1990	28.2	15.7	29.1	12.3	28.3	13.9	28.5	14.0	21.3	14.5
1991	28.1	15.5	29.9	11.9	27.5	14.3	28.5	13.9	21.2	14.6
1993	27.6	15.8	28.7	12.3	26.8	13.6	27.7	13.9	20.8	13.8
1994	28.1	15.9	31	12.8	27.2	13.3	28.8	14.0	21.4	14.8
1995	28.8	15.7	30.1	12.2	28.1	13.3	29.0	13.7	21.4	15.3
1996	28.3	16.2	29.8	12.7	27.6	14.4	28.6	14.4	21.5	14.1
1997	27.7	15	30.1	11.5	27.6	13.4	28.5	13.3	20.9	15.2
1998	28.2	14.4	31	12.2	27.5	13.7	28.9	13.4	21.2	15.5
1999	27.4	12.2	30.4	8.3	26.9	9.5	28.2	10.0	19.1	18.2
2000	28.1	14.6	30.8	10.3	27.2	9.7	28.7	11.5	20.1	17.2
2001	28.4	16.2	30	12.3	27.6	12.8	28.7	13.8	21.2	14.9
2002	27	16.8	30.1	11.9	29	13.8	28.7	14.2	21.4	14.6
2003	28	15.7	30.9	12.5	27.1	13.9	28.6	14.0	21.3	14.6
2004	27.8	15.7	29.4	12.6	27.9	13.6	28.4	14.0	21.2	14.4
2005	28.5	16.3	29.8	12.9	28	13.6	28.8	14.3	21.5	14.5
2006	27.8	15.9	30.3	12	27.6	14	28.6	14.0	21.3	14.6
2007	28.5	15.6	30.3	12.8	28.5	14.5	29.1	14.3	21.7	14.8
Std	0.6	1.0	0.8	1.0	0.6	1.3	0.4	1.0	0.5	1.0
Min	26.4	12.2	28.3	8.3	26.4	9.5	27.1	10.0	19.1	13.2
Max	29.1	16.8	31.3	14.2	29.0	15.4	29.1	14.7	21.7	18.2
Ave	27.9	15.5	29.9	12.2	27.6	13.6	28.5	13.8	21.1	14.7

Annex. 2. Mean maximum and minimum temperature by month and year

Year	January		February		March		April		May		June		July		August		September		October		November		December		Annual	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1977	25.8	15.6	25.8	16.4	29.2	12.4	29.3	11.8	29.1	10.9	27.2	14.2	25.9	10.1	25.6	13.8	27.0	14.1	27.4	14.2	25.8	14.1	26.7	5.4	27.1	12.8
1978	27.8	18.3	27.7	16.9	28.8	15.0	30.8	13.5	31.2	11.5	30.2	11.7	26.7	12.1	26.0	15.0	27.1	15.8	27.5	15.7	27.6	16.4	26.6	13.8	28.2	14.6
1979	25.4	14.6	27.9	15.3	29.1	13.0	30.8	11.1	29.7	11.7	29.0	14.8	26.0	12.2	26.4	14.0	27.2	15.2	28.3	15.1	28.1	15.2	27.6	14.5	28.0	13.9
1980	26.5	14.3	30.1	14.5	31.5	11.2	31.0	10.2	31.9	12.0	29.5	12.0	26.6	13.9	26.2	16.2	27.2	15.7	27.9	16.1	26.9	15.3	27.6	13.9	28.6	13.8
1981	29.2	15.7	28.7	16.1	27.6	12.8	27.8	12.5	30.9	8.7	32.5	13.2	27.1	12.6	25.9	17.0	26.0	16.2	28.6	15.6	27.9	17.4	27.1	16.0	28.3	14.5
1982	28.0	15.6	28.1	16.0	30.3	12.0	29.6	10.9	29.9	10.7	30.8	15.0	27.0	14.3	24.9	16.1	27.2	16.2	26.6	16.2	26.1	16.9	25.9	15.8	27.9	14.6
1983	26.9	15.3	28.6	14.8	29.6	11.8	29.7	13.0	30.0	12.6	29.9	12.4	27.9	13.8	25.7	17.1	27.4	16.7	28.6	16.8	28.5	16.4	27.0	15.9	28.3	14.7
1984	27.1	15.5	28.9	15.9	31.8	11.8	32.8	10.8	29.9	10.6	28.5	9.8	26.6	9.1	26.9	15.4	27.2	16.7	29.6	16.5	29.1	16.3	26.8	15.6	28.8	13.7
1985	28.5	15.9	28.3	15.3	31.2	12.1	28.5	14.0	29.5	12.4	30.5	12.5	25.6	12.1	24.7	16.5	26.7	16.1	28.6	16.3	28.5	17.0	26.6	15.2	28.1	14.6
1986	27.6	15.0	27.0	14.5	28.8	12.6	28.9	12.4	31.3	10.7	28.2	10.1	26.3	14.0	27.1	15.2	27.3	16.8	29.3	16.5	29.3	16.4	27.7	15.5	28.2	14.1
1987	27.2	15.2	29.8	13.7	29.0	11.2	29.8	11.3	28.8	11.3	30.2	11.8	29.1	11.6	27.1	16.3	29.2	14.7	30.4	15.9	29.9	17.1	29.0	16.6	29.1	13.9
1988	28.4	16.0	29.3	14.5	32.4	12.8	31.1	9.7	32.5	11.3	30.3	14.1	25.7	15.2	26.1	15.2	26.7	16.4	28.3	16.1	28.3	16.9	27.6	16.8	28.9	14.6
1989	27.5	15.8	25.7	15.4	30.4	11.8	28.7	7.0	31.7	9.4	31.2	10.1	26.7	12.8	26.1	14.5	27.6	15.9	28.7	14.2	28.9	15.5	27.7	16.0	28.4	13.2
1990	27.2	15.6	27.4	15.4	27.8	10.4	29.0	9.4	32.1	14.2	32.6	12.7	27.3	14.5	25.9	14.1	27.3	14.4	28.3	15.4	29.1	16.0	28.4	15.8	28.5	14.0
1991	29.7	15.9	29.4	15.7	29.5	12.3	30.3	10.0	30.5	9.4	29.9	13.4	26.8	13.6	26.1	15.2	27.3	15.2	28.3	15.6	27.3	16.1	27.1	14.5	28.5	13.9
1993	25.7	15.8	26.5	15.8	31.0	12.4	29.7	10.0	27.6	10.9	27.4	14.7	26.3	11.6	26.4	12.4	27.2	15.9	28.9	15.3	28.8	16.8	27.1	15.5	27.7	13.9
1994	28.6	15.3	29.9	16.1	31.0	12.5	31.4	11.7	31.7	10.9	29.7	9.9	26.8	10.9	25.3	16.0	27.3	16.5	28.9	15.8	27.1	17.4	27.6	15.0	28.8	14.0
1995	28.0	14.8	30.2	15.8	29.5	11.3	29.1	11.7	31.7	9.9	32.1	9.5	27.6	13.2	25.7	15.2	27.1	15.3	29.2	15.0	29.3	16.6	28.5	16.6	29.0	13.7
1996	27.5	16.2	30.3	14.7	29.9	12.0	29.6	9.9	29.5	14.2	28.1	14.8	28.0	11.5	26.9	16.0	27.3	15.1	29.2	15.2	28.2	16.7	28.2	16.6	28.6	14.4
1997	28.0	16.2	29.1	16.0	31.2	10.0	28.3	10.4	31.7	9.6	29.1	13.4	26.3	10.6	26.3	14.4	28.7	14.9	28.4	14.7	27.0	14.8	27.3	14.5	28.5	13.3
1998	29.9	14.1	28.2	12.7	32.5	13.9	31.3	11.0	31.9	11.0	31.0	11.8	27.3	12.6	25.7	15.3	26.1	15.2	27.3	14.8	27.6	14.7	28.1	14.0	28.9	13.4
1999	28.8	13.8	28.6	12.4	29.4	11.0	31.2	5.3	32.4	4.7	29.7	8.2	25.5	8.1	25.9	11.5	26.5	10.4	26.5	11.7	27.0	12.0	27.3	11.5	28.2	10.0
2000	28.9	11.0	30.1	10.3	31.4	8.7	31.1	11.3	30.7	10.7	29.9	5.4	25.8	5.6	25.6	13.6	27.4	14.1	28.3	15.4	27.9	16.1	27.3	15.9	28.7	11.5
2001	27.1	15.8	29.5	15.4	28.9	12.1	31.2	11.2	30.5	10.7	29.9	10.0	26.4	10.8	25.8	15.5	28.2	14.9	30.0	16.7	28.5	16.1	28.2	16.2	28.7	13.8
2002	27.6	15.8	27.0	13.5	30.2	12.3	30.8	10.5	32.4	11.4	31.1	11.8	29.7	12.0	26.9	15.8	28.4	15.4	27.4	17.2	26.9	17.5	26.3	16.6	28.7	14.2
2003	27.9	15.8	30.5	16.1	30.6	12.1	29.4	11.1	33.0	10.7	30.1	12.5	25.9	12.1	25.6	15.3	26.7	15.9	29.2	14.0	28.6	16.6	26.2	16.2	28.6	14.0

2004	27.6	16.2	27.1	15.0	29.9	11.7	30.0	12.6	30.8	11.1	29.9	11.7	26.8	12.1	27.0	15.0	28.0	15.5	27.8	15.4	28.2	16.2	27.7	15.1	28.4	14.0
2005	28.1	16.1	27.1	15.1	29.9	12.5	31.6	11.6	30.8	12.3	29.9	12.2	26.8	12.1	27.2	15.0	27.9	15.1	29.5	15.8	28.7	16.9	27.9	16.5	28.8	14.3
2006	27.6	16.1	30.5	16.6	29.8	11.9	30.0	11.3	30.8	8.1	29.9	11.8	26.8	14.0	26.2	14.7	27.4	15.5	28.4	15.5	28.5	16.9	26.9	15.1	28.6	14.0
2007	27.7	15.4	27.8	14.7	30.8	12.1	31.0	11.6	31.7	12.9	30.9	14.0	27.7	13.4	27.0	14.9	28.3	15.5	29.3	15.4	28.9	16.2	28.1	15.2	29.1	14.3
Ave	27.7	15.4	28.5	15.0	30.1	12.0	30.1	11.0	30.9	10.9	30.0	12.0	26.8	12.1	26.1	15.1	27.4	15.4	28.5	15.5	28.1	16.1	27.4	15.1	28.5	13.8

Table. 3. Monthly Number of Rainy and Wet Days by year

Year	January		February		March		April		May		June		July		August		September		October		November		December		Tot
	Wet day	Rainy day	Wet day	Rainy day	Wet day	Rainy day	Wet day	Rainy day	Wet day	Rainy day	Wet day	Rainy day	Wet day	Rainy day	Wet day	Rainy day	Wet day	Rainy day	Wet day	Rainy day	Wet day	Rainy day	Wet day	Rainy day	Wet day
1977	4	6	1	2	5	5	6	9	7	9	7	8	14	20	15	18	10	10	15	16	2	3	0	0	86
1978	1	1	8	9	1	3	4	4	3	5	5	5	13	17	17	20	15	18	3	5	0	0	2	2	72
1979	7	9	1	2	5	7	3	3	12	14	9	9	14	15	14	15	12	14	3	3	0	0	2	2	82
1980	9	13	0	0	1	1	5	6	3	3	9	9	25	29	29	30	20	25	17	20	1	4	0	0	119
1981	0	0	3	3	15	18	9	11	1	1	2	4	18	19	14	19	12	13	2	2	1	1	0	0	77
1982	3	3	6	6	3	3	5	6	7	8	5	6	14	15	19	22	8	11	8	9	8	10	4	5	90
1983	8	14	5	8	6	6	6	6	12	12	2	4	15	18	12	19	9	12	3	3	0	0	1	1	79
1984	0	0	0	0	2	2	0	1	12	12	8	10	16	21	16	16	11	12	0	0	0	0	1	1	66
1985	2	2	0	0	4	4	9	10	7	9	2	3	20	22	17	19	10	12	0	3	0	1	4	9	75
1986	0	0	6	7	6	6	9	17	4	4	9	14	16	17	7	9	7	11	2	4	0	0	1	2	67
1987	0	0	3	4	8	12	6	7	14	15	1	3	13	15	18	19	10	12	0	3	0	0	0	0	73
1988	3	3	2	4	1	1	5	5	2	2	8	13	13	16	16	17	14	16	4	5	0	0	1	1	69
1989	0	0	3	4	3	4	5	5	0	2	9	10	15	16	31	31	11	11	2	3	0	0	2	3	81
1990	4	18	13	16	7	9	10	11	4	4	1	1	13	14	20	23	26	31	14	28	0	0	0	0	112
1991	0	0	3	5	17	26	3	3	21	29	21	29	31	31	31	31	26	31	14	28	0	0	2	11	169
1992	6	17	14	25	17	26	17	28	21	29	20	29	31	31	31	31	26	31	14	28	3	12	2	11	202
1993	5	5	5	6	0	0	9	10	6	6	6	7	13	14	13	13	12	13	6	8	0	0	2	11	77
1994	0	0	0	0	5	6	6	7	6	6	11	11	31	31	12	14	28	31	2	3	2	3	2	2	105
1995	0	0	3	3	5	5	7	8	3	3	6	7	7	7	17	18	10	12	1	1	0	0	1	1	60
1996	3	3	0	0	10	10	7	8	8	8	10	11	12	12	15	16	10	12	0	0	2	3	0	0	77
1997	2	2	0	0	4	4	21	30	1	2	9	12	14	16	14	15	10	12	9	9	2	12	2	12	88
1998	4	21	11	15	17	28	21	30	4	5	4	4	17	18	16	17	12	12	7	8	0	0	0	0	113
1999	2	2	0	0	5	7	0	0	1	2	10	10	14	15	12	14	10	12	14	15	2	14	2	12	72
2000	0	0	0	0	1	1	6	7	21	30	23	30	15	17	15	17	27	31	18	29	2	14	2	12	130
2001	0	0	1	1	11	13	3	3	11	12	23	30	17	17	13	15	8	9	1	1	0	0	1	1	89
2002	4	21	10	25	4	6	4	6	4	6	8	9	10	11	8	9	7	9	18	29	2	13	2	12	81

2003	1	1	3	3	5	5	10	10	1	1	9	12	20	22	16	20	13	16	0	0	0	2	3	3	81
2004	5	20	11	20	20	29	22	30	24	30	24	30	31	31	13	16	11	15	3	3	2	2	0	0	166
2005	1	4	9	25	20	29	7	10	12	15	9	10	10	17	18	18	18	19	1	1	2	2	0	0	107
2006	4	21	4	4	6	10	20	30	25	30	6	6	31	31	31	31	11	12	16	28	0	0	5	5	159
2007	3	3	3	4	21	29	22	30	24	30	23	30	31	31	31	31	27	31	17	29	2	15	2	15	206

Annex. 4. Questionnaires

Questionnaire # 1. To be Completed by Household Head (Farmer)

The main objective of this questionnaire is to understand Dodota Woreda's Farmers' perception toward climate change, impact and variability and their adaptation towards the prevailing problem. This type of local level study is important for planners as well as decision makers at different level. Therefore, the information that you provide is believed to help the concerned bodies in understanding farmers' knowledge toward climate change, impact and climate variability and their adaptive capacity toward problems due to climate change. Accordingly, you are kindly requested to give answers freely and openly. Any information you give is kept confidential. Thus, your cooperation is very essential to achieve the desired goal of the study.

Anbesu Biqila

Thank you

Thank you for your cooperation in advance.

I. Identification Data

1. Household Head code number ___________________________
2. Date of interview ______________________________________
3. Name of Enumerator ___________________________________
4. Name of the respondent's Kebele Administration ______________________
    - Village (Gotte) name____
5. Checked by supervisor ____
    - Signature ____________________
    - Date ________________________

II. Hypothetical variables that affect adaptation of farmers in the study area

- **This section includes general information about the farmer.**

1. Age of the head of the farm household___________________________
2. Educational status a/ Literate b/ Illiterate: If literate number of years of formal schooling attained_________
3. Sex a/Male b/Female
4. Number of family members_______________
5. Main occupation of the family head a/Farming b/ other: If other please explain______________________________
6. has the household accessed to extension services: a/yes b/no
7. Size of Farmland_________________________
8. Number of farming Oxen___________________________________
9. Number of Cattle______________________________________
10. Number of ruminant animals (goat, sheep)____________________________
11. Number of pack animal (ass, mule, horse)_____________________________
12. Number of camel if there____
13. What is the source of information regarding weather condition?
    a/ extension services b/ media c/other if other please specify
14. Do you have access to credit from any sources? a/yes b/no
15. For how long did you practice farming?______________________________
16. Do you have extra income other than farming? a/yes b/no If yes please specify____
17. Did you encounter food shortage in the past 3 decades? a/yes very much b/ yes b/no I do not: if yes how many times did you encountered food shortage in the past 30 years?_______________
18. Are you accessed to market? a/yes b/no

19. Are you accessed to veterinary services to get services to your cattle?
    a/yes b/no
20. Are you accessed to human health facilities? a/yes b/no
21. Is there water scarcity in your local area? a/yes b/no
    If yes, from where did you get drinking water during drought?

III. Farmers' perception of climate change based on the past 30 years experiences

1. In your opinion, do you think that there is climate change in your local area?
   1. Yes, very much 2/Yes 2. No, there is no 3. I do not know
2. Is there change in amount of rainfall during main rain season?
   1. Yes 2. No 3. I do not know
3. Was the amount of rainfall increased or decreased?
   1/ Increased 2/ Decreased 3/ No change 4/I do not know
4. Has the timing of the onset of rain in the main season shifted?
   1. Yes 2. No 3. I do not know
5. Has rain started late than normal?
   1. Yes 2. No 3. I do not know
6. Is rain of main season early withdrawn than normal?
   1. Yes 2. No 3. I do not know
7. Is there drought?
   1. Yes 2. No 3. I do not know
8. Is there an increment of drought frequency or occurrences of drought?
   1. Yes, very much 2/yes 3/ Not at all 3. I do not know
9. How is the occurrence of drought?
   1. Increased 2. Decreased 3. I do not know
10. Is your planting date changing due to change in the onset of rain?
    1. Yes 2. No 3. I do not know
11. Does the planting date change apply to most crops?
    1. Yes 2. No 3. I do not know
12. Is the amount of precipitation sufficient for full cropping during drought period?

1. Yes 2. No 3. I do not know

13. Do you feel temperature of the area is changing?

1. Yes, very much 2/Yes, I do 3. No, I do not 4. I do not know

14. Do you feel temperature is increasing?

1. Yes, very much 2/Yes, I do 3. No, I do not 4. I do not know

15. Is diversity of crops changing?

1. Yes 2. No 3. I do not know

16. Has crop diversity increased because of climate variability?

1. Yes 2. No 3. I do not know

17. Did you encounter complete crop failure?

1. Yes, very much 2. Yes 3. No, there is no 4. I do not know

18. Increase problem of frost?

1. Yes 2. No 3. I do not know

19. Increase problem of heavy rain and hail?

1. Yes 2. No 3. I do not know

20. Is there an increase of livestock health problem due to climate change?

1. Yes, very much 2/Yes 3. No, there is no 4. I do not know

21. If yes, what kind of Animal diseases more frequently affect your animal?

22. How many livestock died in your house because of drought or climate change caused problem?

23. Is there an increase of human health problem due to climate change?

1. Yes 2. No 3. I do not know, if yes, what kind of health problem did you encountered?______________________________

IV. Farmers' level of adaptation strategies

1. Do you use different crops cultivation?

    1. Yes, very much 2/yes 3. No I do not 3. I do not know

2. Do you use different varieties of crops?

    1. Yes 2. No 3. I do not know

3. If yes please explain crop varieties that you are using.
4. Did you apply short season growing crop and drought tolerance varieties?

    1. Yes 2. No 3. I do not know

5. If yes, what are they?
6. What is your copping mechanism when you encountered long period drought?
    1. Selling cattle 2. Migration 3. No copping mechanism 4/eating seeds 5/Borrowing money from relative or credit association
7. What are your diversity adaptation mechanisms?
    1. Crop diversification
    2. Growing short maturing crops
    3. Being selective in crop variety
    4. Shift in cropping pattern
    5. Using small scale irrigation
    6. Others ------if others pleas specify

Questionnaire # 2. In-depth interviews of certain groups (Kebele representative and woreda sectoral representative as indicated in methodology section)

1. What does climate change mean?____

   ____
   ____
   ____
   ______

2. What are manifestations of climate change? ________________________________

   ____
   ____
   ____
   ____

3. What does climate variability, climate change impact and adaptation and main differences?

   ____
   ____
   ____
   ____

4. What are the main causes of climate change? ________________________________

   ____
   ____
   ____
   ____
   ____

5. How can you adapt to climate change? ______________________________________

   ____
   ____
   ______

6. What is your opinion about the current climate change status in your local area? ____

____

____

What are the main impacts caused by climate change?

____

____

Who are more concerned about the impacts of climate change?

1. Social status: male or female

    Old or young

2. Economic status: Poor or rich

7. What are the major factors associated with the perception of farmers about the impacts of climate change on socioeconomic?____________________________________|_

____

____

____

8. Who is the most important to provide information about the impacts of climate change to the community? ______________________________________

____

____

____

|_______

9. Were you affected by the past drought? If the answer is yes mention the impact of drought on your wealth (crop production, livestock, food security, health and drinking water) ____

____

10. During drought period, how people cop up the problem occurred? _______________

____

____

__

11. Is there migration due to drought? If yes, where did you migrate? ______________
____

12. How many family heads are under food insecure and get food aid from international donors? ____

13. How many kebeles are under safety net due to climate change? __________________

14. How many kebeles are graduated due to farmers become self sufficient crop producer?

____

____

____

Declaration

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

The examiners' comments have been dully incorporated.

Declared by:

Name: Anbesu Bikila Jilcha

Signature: ____

Date: ____