Indira Gandhi National Open University

School of Continuing Education

Studies on the Impact of Climate Change on Agricultural Investment and Coping Strategies: The Case of Metema Woreda, North Gondar Zone, Ethiopia

A Thesis Submitted to Indira Gandhi National Open University for the Partial Fulfillment of the Degree in Master of Arts in Rural Development

By:

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Enrolment No: Id1051237

May 2014

Gondar, Ethiopia

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Declaration

I hereby declare that the thesis entitled "The Impact of Agricultural Investment on Climate Change: the Case of Metema Woreda" submitted by me for the partial fulfillment of MA in Rural Development to Indira Gandhi National Open University, (IGNOU) New Delhi is my own original work and has not been submitted earlier to IGNOU or to any other institution for the fulfillment of the requirement for any course of study. I also declare that no chapter of this manuscript in whole or in part is lefted and incorporated in this report from any earlier work done by me or others.

Place: Gondar, Ethiopia

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Signature

Date: May 2014

Enrolment No. Id1051237

Derje Tesfa Fetene

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CERTEFICATE

This is to certify that Mr. Dereje Tesfa Fetene student of MA (RD) for Indira Gandhi National Open University, New Delhi was working under my supervision and guidance for his thesis work for th course MRDP-001.

His thesis work entitled “The Impact of Agricultural Investment on Climate Change: the Case of Metema Woreda” which he is submitting, is his genuine and original work.

Place: Addis Ababa, Ethiopia ______________________

Signature

Date: _______________ Mengistu Hulluka (Dr.)

Addis Ababa, Ethiopia

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List of Acronyms

AU- African Union

CAADP- Comprehensive Africa Agriculture Development Program

CDM - Clean Development Mechanisms

CSA - Central Statistics Agency

EIA- Ethiopian Investment Agency

EPLAUO-Environmental Protection and Land Administration and use

FAO -Food and Agricultural Organization

FDI- Foreign Direct Investment

GDP- Gross Domestic Product

GHGE- Greenhouse Gas Emissions

IMF- International Monetary Fund

IPCC- Intergovernmental Panel on Climate Change

LAC- Low Developing Countries

MDG- Millennium Development Goals

NEPAD- New Partnership for Africa's Development

NGO- Non-Governmental Organizations

NMA- National Metrological Agency

PPESA- Privatization and Public Enterprises Supervising Agency

RAI- Responsible Agricultural Investments

SAP -Structural Adjustment Policies

SSA- Sub-Saharan Africa

UNEP- United Nation Environmental Program

UNFCCC- United Nations Framework Convention on Climate Change

WARDO - Woreda Agricultural Rural Development Office

WEPLAUO-Woreda Environmental Protection Land Administration Use Office

WFS- World Food Summit

ABSTRACT

Agriculture and food security are the most critical agendas in the world. Climate change and their related socio-economic problems are greatly affecting agricultural activities and food security in Ethiopia. The main objective of this research is to investigate the impacts of agricultural investment to climate change. The specific objectives are: explore the major agricultural investment in crop production, analyze the trend of climate change, identify the major impact of agricultural investment on climate change and identify the local and institutional coping strategies. In order to address these objectives, tow kebeles were selected purposive sampling and data was collected by using direct observation, questionnaire survey, interviews, and focus group discussion, and key informant interviews. Secondary data from published and unpublished sources were also gathered to supplement the primary data. The collected data was systematically analyzed by using both qualitative and quantitative methods were used. Results confirm that most of the interviewed investors understand the changes in temperature and rainfall; the majority believed that temperature has increased (82%) and the rainfall pattern has become unpredictable and decreased (75%). But the trend analysis result refers significant increases of rainfall (2.9mm) and an increasing trend of annual mean maximum and minimum temperature was observed (1.026℃-0.513℃) for the last two decades. As a results of this investors were took remedial actions to counteract the impacts. The most common coping strategies are using fertilizers and shifting cultivation or croup rotation. The Government could contribute to mitigating the impacts agricultural investment to climate change by investing in research (drought resistant and short maturing varieties), soil and water conservation measures, and irrigation and water harvesting development, expanding agricultural inputs, accessing education reforming land policy establishing local meteorology stations, monitoring and publishing climate data,

Key words: Investment, Coping strategies, Climate Change

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

On global basis, climate variability and change may have an overall negligible effect on total agricultural production. However, the regional impacts are likely to be substantial and variable, with some regions benefiting from an altered climate and other regions adversely affected. Generally, agricultural production is likely to decline in most critical regions (e.g. subtropical and tropical areas), whereas, in developed countries it may actually benefit where technology is more available and if appropriate adaptive adjustments are employed (Parry and Rosenwieg, 1994).

Different studies indicated that over the past years, mean temperature level in Africa has increased whereas precipitation level has decreased (IPCC, 2001). Spatial and temporal variability, more intense and widespread drought and aggravated flooding have been experienced in Africa over the past few decades in addition to the decreasing trend in the level of rainfall (Deressa et al., 2007).

Medelson (2000) in his analyses of the impacts of climate change on crop, livestock and mixed crop-livestock production in Africa has indicated that the increasing temperature and a decreasing precipitation will significantly reduce income from agriculture.

Climate change and weather patterns are already being experienced as it is evident in severe impacts on food production, food security and natural resources all over the world. Without the appropriate responses, climate change is likely to constrain economic development and poverty reduction efforts and exacerbate already pressing difficulties especially in countries whose economies are rooted in climate sensitive sectors such as agriculture (Diao, 2010).

Climate change is predicted by scientists to have the main impact on agriculture based economy and livelihood of the populations of less developed world regions, mainly in Sub-Saharan Africa (Kandji et al., 2006).

Dinar et al. (2008) stated that Africa's agriculture is negatively affected by climate change and hence, the realization of the African Green Revolution and its contribution to food security and economic growth in sub-Saharan Africa is highly threatened. In fact, adverse impacts on agriculture sector will exacerbate the incidence of rural poverty. According to FAO (2007), agricultural production and the biophysical, political and social systems that determine food security in Africa are expected to be placed under considerable additional stress by climate change.

Thomas et al. (2007) and Lacy et al. (2006) argued that the value of local knowledge in climate change studies has received little attention and farmers' possess valuable indigenous adaptation strategies that include early warning systems and recognize responses to changes in climate parameters. For example, by maintaining flexible strategies with short and long cycle crop varieties farmers can buffer their livelihoods.

The adoption and successful implementation of new technology and husbandry practices and farmers' adaptation to change in their ecosystems depend on their tendency to perceive and react favorably towards changes in climate and environment. The lack of sufficient knowledge about climate changes and the impact on agricultural production is a setback to long term sustainable agriculture in most developing countries (Kotei et al., 2007).

There are different perceptions across different communities or countries. For example, most people's understanding of the underlying issues and causes of climate change varies a lot, with some taking a more scientific approach and others a more religious one. Some of the perceptions are unscientific, mainly because many subsistence farmers, who are often poorly educated, resort to superstition to explain natural events since it is their only source of 'information'. A study of community perception of climate change in Bolivia by Christian Aid Chaplin (2007) indicates that the perceptions of causes of climate change as lack of respect and carrying out of old rituals and customs. The people also perceived hailstorms as being a punishment from God, which tend to happen particularly where young women have aborted pregnancy and also thought that the world has 'turned over' and the sun is closer to the earth, having 'fallen' from its place in the sky (Chaplin, 2007). Another study conducted in the Sahel by Mertz et al. (2009) found that farmers are aware of climate variability. However, when questions on land use and livelihood change are not asked directly in a climate context, households and groups assign economic, political, and social rather than climate factors as the main reasons for change.

Understanding of climate change, ongoing adaptation measures, and the factors influencing the decision to adapt farming practices is needed to craft policies and programmes aimed at promoting successful adaptation of the agricultural sector (Bryan et al., 2009). For farmers to adapt effectively to climate change, they must have correct perceptions about the state of the climate and possible future trends. In practice, farmers take decisions in the context of their own environment, and differences may exist between perceived and real environments (Mather, 1992). Thus, there is the need for knowledge of how interacting climatic factors will affect crop productivity and soil and water resources.

Better understanding may lead to the choices of better adaptation strategies as one of the policy options for reducing the negative impact of climate change (Adger et al. 2004; Kurukulasuriya and Mendelsohn 2006). Minimizing the impacts of climate change requires appropriate perception and adaptation strategies. Farmer's ability to perceive climate change is a key precondition for their choice of adaptation. In line with this, Maddison (2006) revealed that adaptation to climate change requires that farmers must first perceive that climate has changed, then identify useful adaptations and implement necessary adaptation responses.

The study of coping and adaptive resource management strategies is not new, where a poor and vulnerable population has always dealt with a highly fluctuating natural environment. There are diverging opinions on how well rural populations are dealing with their environmental and economic conditions. Recent studies point to dry land populations as the most ecologically, socially, and politically marginalized lagging behind on most economic and health indices (Reynolds et al., 2007.

Dinar et al. (2008) stated that Africa's agriculture is negatively affected by climate change and hence, the realization of the African Green Revolution and its contribution to food security and economic growth in sub-Saharan Africa is highly threatened. In fact, adverse impacts on agriculture sector will exacerbate the incidence of rural poverty. According to FAO (2007), agricultural production and the biophysical, political and social systems that determine food security in Africa are expected to be placed under considerable additional stress by climate change.

Climate is a primary determinant of agricultural productivity. In turn, agricultural production is essential for sustaining and enhancing human welfare. Hence, agriculture has been a major concern in the discussions on climate change. In fact, the United Nations Framework Convention on Climate Change (UNFCCC) cites maintenance of our societal ability for food production in the face of climate change as one of the key motivations for its existence and for its efforts in stabilizing greenhouse gas emissions (GHGE).

Within the context of growth in food and agriculture, emphasis is placed on productivity because expansion of arable land is very limited in most countries due to physical lack of suitable land and/or because of environmental priorities. In addition, the difference between actual and technically feasible yields for most crops implies great potential for increasing food and agriculture production through improvements in productivity, even without further advances in technology. Investment is of special interest as a limiting factor to agricultural capacity and production because an alarming trend is being observed: public and private investment in agriculture has been declining (WFS, 1996a).

The decline in public investment is of particular concern because public investment in basic infrastructure, human capital formation and research and development are necessary conditions for investment. Public investments also promote technology adoption, stimulate complementary on-farm investment and input use and are needed for marketing the agricultural goods produced (Antholt, et al 1994).

The need for agricultural investment

Continued subsistence farming in Ethiopia’s current context apparently leads to graver poverty and farmland fragmentation unless it eventually evolves onto modern farming which enables a smaller percentage of the population to produce beyond subsistence by mainly targeting at local food supply.

Distinction should thus be made between agricultural investment and massive land acquisition by foreign investors for their home market. It is also to be noted that hasty steps towards large-scale mechanized agriculture in topographic settings where there is much dependence on rhythmic seasonal rainfall rather than surface freshwaters suitable for irrigation cannot bring about the success obtained in agricultural modernization in settings where surface freshwater resources are abundant and where the watershed in the basin is well-managed. Caution and prudence are thus crucial. If, for example, land is allocated to an investor who undertakes an agricultural activity, the farm may incrementally increase the area of cultivation that can gradually enhance commercial farming by incorporating adjacent small-holders through win-win schemes. The schemes may be shareholding plus job options to smallholder farmers or introducing contract farming in which the modern farm can provide mechanized farming services in neighboring farms for consideration (in the forms of payment or sharecropping), and/or outsource certain farming activities to be done by smallholder farmers. There are lessons that can be learnt from the success, efficiency and dynamism of modern farms that were emerging during the late 1960s and the early 1970s, vis-à-vis the poor performance of the same farms after their post-1975 nationalization. One of the core lessons to be drawn is the advantage in modest takeoffs and incremental scaling up in the context of integration with the local communities in which commercial farming takes place (The *Declaration on land issues and challenges in Africa, 2009).*

In contrast to win-win agricultural investments, land grabs target at short term benefits. They are indifferent to local needs and seek massive land acquisitions. Cotula, (2001) underlines the need for enhancing efforts "to secure local land rights, including customary rights, using collective land registration where appropriate" and he further notes the necessity of ensuring "free, prior and informed consent, robust compensation regimes, the provision of legal aid, and good governance in land tenure and administration." In the absence of such rights, land transfers run the risk of abuse under discretionary decisions by various regulatory offices thereby leaving the doors wide open to speculative land acquisitions, displacement and environmental harm. The Heads of State of the African Union (AU) stresses "the urgency of building a solid institutional framework for investment in agriculture" and also states the need for "strong systems of land governance that recognize the diversity and complexity of the systems under which land and related resources are held, managed and used" (The *Declaration on land issues and challenges in Africa, 2009).*

In particular, the *Seven Principles* of Responsible Agricultural Investments (RAI Principles) are meant to serve as a framework of standards for the current global dialogue on large-scale farmland acquisitions. However, the principles are embodied as a discussion note and are meant to be voluntarily ascribed to in fair farmland deals and project implementation. This presupposes a legal regime and an institutional framework which can facilitate the implementation of the thresholds embodied *(Principles* of Responsible Agricultural Investments (RAI Principles) prepared by FAO, IFAD, UNCTAD and the World Bank Group, 2010).

Risks related to agricultural investments

Investments in agriculture are characterized by a variety of risks. While some of them also relate to other investments in developing countries, agricultural production faces a number of specific risks, making investments in agriculture appear more risky than similar investments in other sectors of the economy (World Bank, 2005).

Agricultural risks are often classified into four categories: production, market, financial and institutional risks. But the most common agriculture risk is production outcomes. Because agricultural production often characterized by a high variability of external factors that are imperfectly predictable such as weather and diseases influence the amount of agricultural output generated as well as its quality. Climatic factors can lead to a total or partial loss of crops or herds, and might have long-term implications. And yet, climate change has nonetheless been an opportunity in some cases (World Bank 2005 and Hollinger, 2004).

Agricultural investment in Ethiopia

After the change of government in 1991 in Ethiopia, the country has adopted a Structural Adjustment Policies (SAP) that liberalized the government controlled institutions to a more market-oriented economy (TGE 1992).

The country took structural reform measures in the financial sector, public enterprises and civil service areas including enacting investment law for the country (GoE *et al* 1998). Following the investment law, private investments mushroomed in the country. In the agricultural sector, both domestic and foreign investors have emerged. The2007/08 price boom in food commodities has motivated food import dependent countries to look for option to produce food commodities in countries where there are abundant land and water resources as their food security strategy (Deininger et al 2011). As a result, there is a strong Foreign Direct Investment (FDI) flowing to developing countries to acquire cultivable land and produce food commodities. Countries like Ethiopia, Sudan, Pakistan, etc are target/client countries with abundant agricultural resources whereas countries such as India, China, Saudi Arabia, Turkey, etc are investing countries. There are mixed views whether such investment activities are beneficial to target countries. Some argue that FDI in agriculture will create opportunity for "sustained" and "broad-based development" through enhancing technology transfer, increasing domestic availability of food supply and creating employment opportunities provided that inward investment is well-managed (Deininger et al 2011). Others (Mersha 2009; Grojnowski 2010; Fitzgerald 2010; Rice 2009; Mihretie 2010; McLure 2009) criticized it as "land grabbing", "bio-colonialism", "agro-colonialism" etc. The government of Ethiopia argued that it is part of the country's strategy to achieve its food security objectives. Except some media reports, there are little empirical findings on the issue whether such investments are opportunities or challenges to target countries.

In Ethiopia, agriculture is the foundation of the economy, employing 80 per cent of the country's 82 million people. Some 85 percent of the population lives in rural areas and is mainly engaged in rain-fed subsistence agriculture. Food production is highly dominated by small-scale farmers who largely depend on rain-fed and traditional agricultural practices. This has led Ethiopia to be highly vulnerable to observed climate variability and change and in turn to food insecurity during the past couple of years. Thus, the country's success in agricultural production and household food security is highly determined by the level of perception and adaptation to climate change, population density, levels of rural investment, and external factors such as rainfall patterns, land degradation (ACCEC, 2010).

As far as my knowledge is concerned the impacts of climate change to agricultural investment induced problems have not been assessed so far in Metema *woreda*. This is clear that investigating the impacts of climate change to agricultural investment production and coping strategies is important to identify the commonly used coping strategies to increase agricultural investment productivity, and then maintaining food self sufficiency. Due to this reason, assessing the practices and its challenges and producing workable recommendations for practitioners helps them to design appropriate strategies to tackle the problem as early as possible. This study therefore, will analyze the impacts of climate change and coping strategies to agricultural investment.

1.2 Statement of the problem

Many research findings indicated that climate change has significant impacts on tropical regions; particularly poor countries like Ethiopia. Ethiopia is highly affected and vulnerable to climate change impacts. The reasons are attributed to its heavy dependence on rain-fed agriculture together with low level of socioeconomic development and other stressors. (Yesuf et al, 2008).

Agriculture, the main sector of the Ethiopian economy (CSA, 2004), is highly challenged by many factors, of which climate-related disasters like drought and flood, are the major ones (Deressa, 2007). Indeed, Ethiopian agriculture investment is not highly productive and its improvement is constrained mainly because of climatic factors, land degradation, and soil erosion. This is exacerbated by improper land use practices such as, over cultivation and overgrazing, and other socio-economic constraints such as inappropriate policies, subsistence farming and declining farm size mainly due to population growth. Additionally, tenure insecurity, weak agricultural research and extension services, lack of agricultural marketing, inadequate transport network and use of agricultural inputs such as low use of fertilizers, improved seeds and pesticides are the major constraints (Deressa, 2006).

Assessing the impacts of agricultural investment to climate change is crucial for the choice of appropriate production and coping strategies. In order to enhance policy towards tackling the challenges climate poses to agricultural investment the knowledge of selecting appropriate coping strategies is crucial. Some attempts have been made to study the impact of climate change in Ethiopian agricultural investment (NMSA, 2001), (Deressa, 2007). NMSA (2001) identified potential adaptation measures for coping of adverse impacts of climate change in agricultural investment and livestock production, but it failed to indicate the factors that dictate the choice of adaptation measures.

Analysis of the impacts of agricultural investment on climate change and coping strategies in Ethiopia by Yesuf et al. (2008) revealed changing crop variety, soil and water conservation, water harvesting, changing planting and harvesting periods are the most dominant coping strategies of the study area. All the problems mentioned above are very much serious in North Gondar Zone of Amhara National Regional State particularly in Metma woreda.

In Metma woreda, mixed agriculture is the main economic activity of the population, totally dependent on seasonal rainfall. Climate induced uncertainties associated with the seasonal rainfall variability have been the fundamental constraints to agricultural investment production (Sesame and cotton) in the study area. According to WARDO (2004), climatic condition was relatively good, but now the condition has been aggravated because of the introduction of agricultural investment. Some evidences that indicated the change in the study area are variability and amount of rainfall, intensive soil erosion and over cultivation, flooding and landslides, high prevalence of crop pest, weeds and livestock diseases.

Due to resettlement program and a great flow of investment in the *woreda (study area)* a high land fragmentation is occurred. This in turn leads to the shortage of cultivated land and reduced per capita land size available for agricultural investment.

This has been one of the reasons for the decreasing trend of agricultural investment productivity and for intensification of resource depletion in the study area (Yirga Asefaw, Personal Communication, and 10 July, 2013). Farmers' perception of climate change is crucial for their choice of adaptation strategies. In order to enhance policy towards tackling the challenges climate poses to farmers, knowledge of the adaptation methods and factors affecting farmers' choices is crucial. Some attempts have been made to study the impact of climate change on Ethiopian agriculture (NMSA 2001; Deressa, 2007). NMSA (2001) identified potential adaptation measures for coping with adverse impacts of climate change on crop and livestock production, but it failed to indicate the factors that dictate the choice of adaptation measures.

In response to perceived long-term changes in climate, farm households implemented a number of adaptation measures to reduce the vulnerability of climate change impacts. Analysis of the impacts of climate change and adaptation on food production in Ethiopia by Yesuf et al. (2008) revealed changing crop variety, soil and water conservation, water harvesting, planting of trees and changing planting and harvesting periods as the choice of adaptation measures by the farmers. Among these methods of adaptation, planting trees was the dominant measure adopted by most of the farmers.

All the problems mentioned above are very much serious in north Gondar Zone of Amhara National Regional State particularly in Metema Wored. According to the statistical data available, know a day's Metema woreda has large number of population which is among the densely populated *woredas* in the Region with very high fertility and high rate of population growth (Woreda's Agricultural and Rural Development Office 2010).

In Metema woreda, mixed agriculture is the main economic activity of the population which totally depends on seasonal rainfall. Climate induced uncertainties associated with the seasonal rainfall variability have been the fundamental constraints to agricultural production (crop and livestock) in the study area. That is, agricultural productivity of this *woreda* is decreasing from time to time because of different factors such as high variability of rainfall amount, intensive soil erosion due to highland nature and ruggedness of the landform in the whole places of the woreda which in turn has difficulty to advance irrigation technology. Flooding and landslides, high prevalence of crop pest, weeds and livestock disease, backward technologies practiced, environmental and natural resource degradation, poverty, poor infrastructure and high population pressure are also some factors to be mentioned. Due to these factors, the production of the woreda has decreased from time to time (ARDWO 20013).

The high involvement in agricultural investment in the *woreda* is a cause for high land agricultural fragmentation, this in turn leads to the shortage of agricultural investment land and reduced per capita land size available for farming. This is also found to be one of the reasons for the decreasing trend of agricultural investment productivity and intensification of the depletion of resources in the study area.

All these current trends, worsening effect spills over to other areas. If the situations continue with such trend, they may bring more serious impact on agricultural investment. It may lead to deterioration of available natural resources and disruption of biodiversity and ecosystems, which may have far-reaching effect on sustainability of the physical environment in the long-run. Hence, the well being and quality of life of the people would seriously be affected. Moreover, there has not been any research conducted on this issue in the study area. Thus, it becomes important to run this research in Metema woreda so as to know the status of the problem and investigate the impacts of agricultural investment on climate change and coping strategies in the study area.

1.3 Objectives of the study

1.3.1 General objective

The general objective of this study is to understand the current impact of agricultural investment on climate change and identify coping strategies at the local level.

1.3.2 Specific objectives

The specific objectives of the study are to:-

- Explore the major agricultural investment in crop production;
- Analyze the trend of climate change in the study area;
- Identify the major impact of agricultural investment on climate change in the study are; and
- Identify the local and institutional coping strategies.

1.4 Basic Research questions

To achieve the proposed objective, the researchers have formulated the following basic research questions. These are:

- Which ones are the major agricultural investments in crop production in the study area?
- What is the trend of climate change on the study area?
- What is the major impact of investments on climate change on agricultural production in the study area?
- What are the major local and institutional coping strategies in the study area?

1.5 Scope of the study

This study is delimited to investigate the impact of agricultural investment on climate change in North Gondar zone particularly Metma woreda. The issues need to be investigated in this study are, the level of impacts, types of coping strategies and common coping strategies used by most investors.

1.6 Significance of the study

Agriculture is by far the most important sector in the Ethiopian economy. But the sector is highly challenged by climate change. To minimize and solve such challenges and problems, it is very important to investigate impacts of agricultural investment on climate change and coping strategies.

Information on impacts of agricultural investment on climate change and identifying the major coping strategies, will considerably helps to policy makers. The study will also help to draw attention of decision makers, non-governmental organizations (NGOs) and other concerned bodies and urge them to plan alternative strategies to tackle the related problems. The study will also serve as a bench-mark for further research in the topic under investigation and other similar problems.

First, it will provide information for investors and professionals on climate change and identify the barriers of adaptation strategies, which will considerably an indicative for the policy and decision makers. Accordingly, the local administration may use the findings of the study to develop appropriate adaptation strategies to reduce the negative impacts that climate change and associated extreme weather events which has posed up on the community. These strategies will have paramount role in promoting agricultural investment development and overall livelihoods of the rural community. Second, the study will also helps to draw the attention of decision makers, non-governmental organizations (NGOs) and other concerned bodies and urge them to plan alternative strategies to tackle the related problems. Third, the study will serve as a bench-mark for future further researchers who will be interested to undertake researches in the topic under investigation and other similar problems. Finally, the study will depict areas that may need further research.

1.7 Conceptual Frameworks

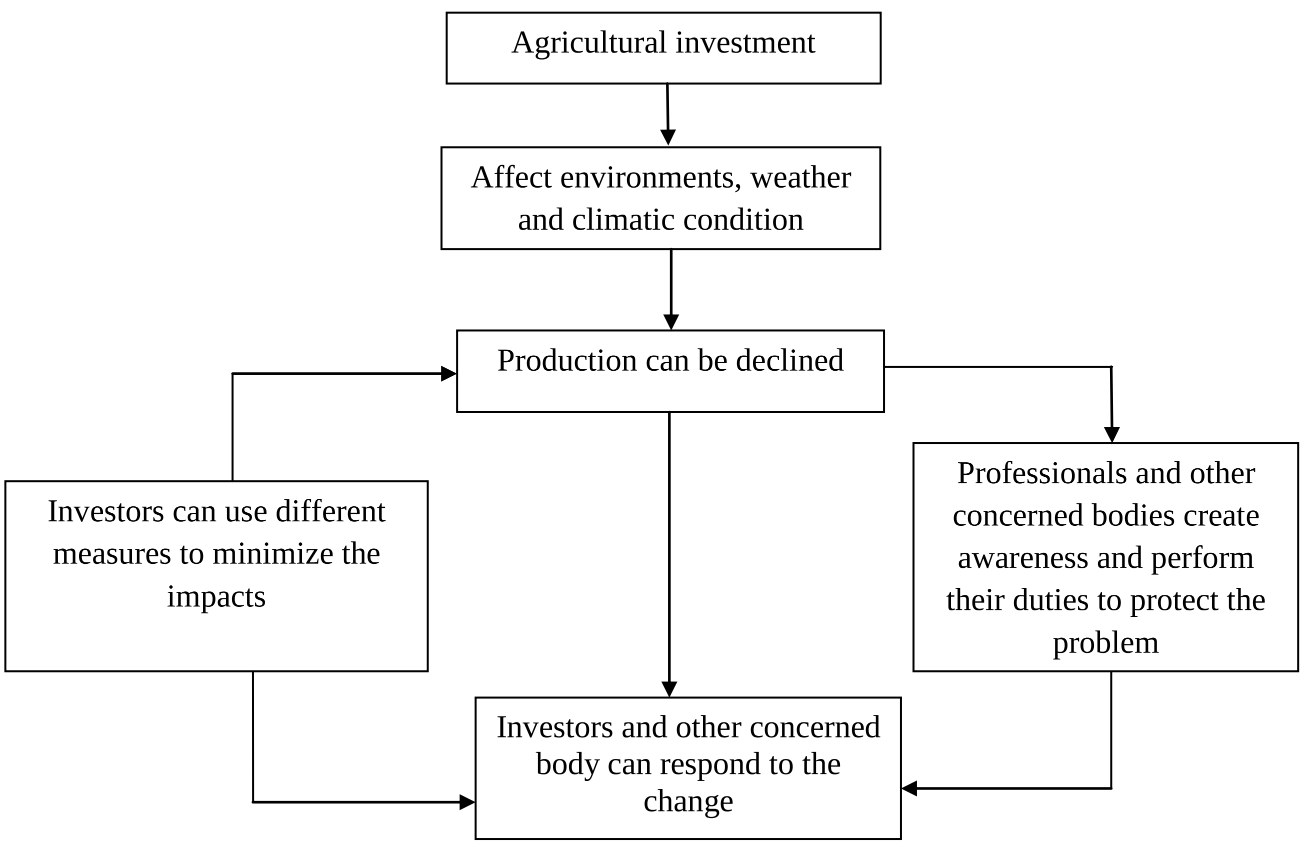
Climate change poses new and highly uncertain risks, chiefly in terms of changing rainfall. Recent research suggests that rainfall changes at the national level may be perceived differently at local scales (West et al, 2008), either because of local variations or because rainfall records fail to capture key factors such as intensity or timing.

The impacts of agricultural investment to climate change are crucial for their choice of adaptation and decisions to invest up on a number of adaptation options to mitigate the impacts of climate change. However, perceptions are influenced not only by actual conditions and changes, but are also by other factors. In relation to this, Gbetibouo (2009) found that having fertile soil and access to water for irrigation decrease the likelihood that farmers will perceive climate change; however, education, beliefs ,indigenous people right, information, income, knowledge, experience ,access to extension services increase the likelihood that farmers perceived to climate change.

Understanding the impacts of agricultural investment to climate change is closely linked to the initiatives aiming to protect traditional knowledge and indigenous people's rights. Local perceptions of change have played an important role by filling in the gaps of knowledge and evidence and enable the formulation of effective adaptation strategies at the national, district and sub-district levels. Many adaptation processes are initiated, supported and carried out by indigenous communities trying to protect their rights to ancestral lands and culture. To achieve sustainable livelihoods through indigenous forest, watershed, irrigation and eco agriculture management systems; it is very important to protect and understand the rights of indigenous peoples and their ownership over ancestral lands are mandatory (Ellis, et.al. 2004).

Vulnerabilities to climate and other shocks and stressors may be changing due to internal factors affecting the individual and community, or external factors such as the environment, government policy and economics. Therefore, adaptation strategies are affected by farmers' perception, such as information, income, experience, access to extension service knowledge, beliefs, etc. Based on the above theoretical explanation, the following conceptual framework is developed, to investigate farmers' perception and adaptation strategies to climate change in the study area.

Fig. 1 Sketch showing chain effect of climate change



Source: own sketch

1.8 Definitions of Conceptual Terms

Climate change: Climate change (CC) refers to a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity (IPCC, 2007).

Climate variability: Variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all temporal and spatial scales beyond that of individual weather events. Variability may result from natural internal processes within the climate system (internal variability) or from variations in natural or anthropogenic external forcing (external variability) (IPCC, 2001b).

Perception: perception is the process of attaining awareness or understanding the elements of the surrounding environment based on what is observed or thought physical sensation. In the case of climate change, perception refers to whether farmers understand the changing patterns of temperature and rainfall over time or not and respond to the negative impacts through adaptation (Maddison, 2006).

Investment: Investment is the change in fixed inputs used in a production process. In the narrowest definition, investment is the change in the physical capital stock, that is, physical inputs that have a useful life of one year or longer (land, equipment, machinery, storage facilities, livestock). However, Eisner (1985) estimated that less than 20 percent of total growth in the United States comes from physical capital formation, while Denison's (1967) estimates were 10 to 15 percent.

The above figure clearly depicts that climate change and its variability and extremes can affect the livelihood assets of the farmers. In this case farmers' can perceive the changes of temperature and precipitation. As a result of this, farmers start to give responses or to adapt the impacts. However, the perception and adaptation can be affected by different determinants such as education, knowledge, experience, information, income, access to extension, gender, land tenures, access to credit service, age of the household head, land size, income.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Concepts and Definition of Climate change:

Before to elaborate the impacts of agricultural investment, it is better to explain and elaborate the global challenges of climate change. Climate change is the natural phenomenon but is also accelerated by human activities (O'Brien *et al.*, 2006). Climate changes are likely to manifest in four main ways: slow changes in mean climate conditions, increased inter-annual and seasonal variability, increased frequency of extreme events, and rapid climate changes causing catastrophic shifts in ecosystems (Adger, 2004).In IPCC report (2007), climate change was understood as any change of climate over time due to natural changes or results of human activities. With this definition, climate change can be the resulting changes of internal processes or external forces (Nicholls, 2007). In accordance with United Nations Framework Climatic variability means the fluctuation that occurs from year to year and the statistic of extreme conditions such as severe storms or unusually hot seasons (ISDR, 2008). According to Oxfam organization, climatic variability is natural variations in the climate that are not caused by greenhouse gas emissions (e.g., it rains more in some years and less in others).

Climate extreme (weather extreme event) is small changes in average conditions that can have big influence on extremes such as droughts or floods. These changes are already noticeable, and the trend is expected to continue (Selvaraju et al., 2006).

Perception is a necessary prerequisite for adaptation (Maddison, 2006 and Deressa, 2007). The concept adaptation is new for the research community and has origins in natural sciences (Smit, 2006). Adaptation refers to the process of adapting and the condition of being adapted. According to Burton, (1992as cited in Smit et al., 1998), adaptation in social sciences was concerned with the process through which people reduce the adverse effects of climate on their health and well-being, and take advantage of the opportunities that their climatic environment provides. Similarly, Carter et al. (1994) described that adaptation refers to any adjustment, whether passive, reactive or anticipatory that can respond to anticipated or actual consequence associated with climate change.

2.2 The Need for Climate change Adaptation

Taking adaptation into account is imperative in the climate change impact and vulnerability assessment (Smit *et al*., 1999). To fully account for vulnerability to climate change, an assessment of impacts needs to account for those adaptations that are likely or even reasonable to assume to happen. Without assessment of such adaptations, the impacts researchers could well overstate the potential negative effects of climate change. An additional reason for assessing adaptation is to inform policy makers about what they can do to reduce the risks of climate change (UNEP, 1998). Indeed, the important role of adaptation as a policy response by governments has been recognized internationally. Article 4.1b of the United Nations Framework Convention on Climate Change (UNFCCC) states that parties are committed to formulate and implement national and, where appropriate, regional programs containing measures to mitigate climate change and to facilitate adequate adaptation to climate change. The Kyoto Protocol (Article 10) further commits parties to promote and facilitate adaptation, and deploy adaptation technologies to address climate change (UNFCCC, 2007). Ethiopia, like many other countries, recognizes adaptation as an important component of its climate change response strategy and is exploring adaptation options in agricultural, water, health and other sectors in its National Adaptation Program of Action (NMSA, 2007).

There are convincing arguments for a more comprehensive consideration of adaptation as a response measure to climate change. First of all, anthropogenic greenhouse gas emissions are already affecting average climate conditions and climate extremes which can no longer be prevented even by the most ambitious emission reductions (Fussel and Klein, 2005; Fussel, 2007b). Second, climate will continue to change for the foreseeable future as a result of accumulation of greenhouse gases emitted in the past and the inertia of the climate system, the rate of global warming in the next few decades is projected to be substantially faster than in the last few decades, largely irrespective of the emission scenario (IPCC, 2007). Third, the effect of emission reductions takes several decades to fully manifest, whereas most adaptation measures have more immediate benefits. Fourth, adaptations can be effectively implemented on a local or regional scale, whereas mitigation requires international cooperation, so that the efficacy is dependent on the actions of others. Fifth, most adaptations to climate change also reduce the risks associated with current climate variability, which is a significant hazard in many regions (Smit *et al*., 1999; Fussel and Klein, 2005). Finally, many measures undertaken to adapt to climate change have important ancillary benefits, for example reducing current climate-sensitive risks (Fussel, 2007b).

2.3 Types of Climate Change Adaptation

As it is already discussed, adaptation means the adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities IPCC (2007). There are many more types of adaptation used to reduce the negative impacts of climate change and exploit positive opportunities the changing climate condition provides.

According to Fankhauser et al. (1999), adaptation can be anticipatory or reactive based on timing and depending on the degree of spontaneity; adaptation can be autonomous or planned.

Reactive adaptation: means institutions, individuals, plants and animals actions, which are implemented after the fact. As reactive adaptation is informed by direct experience, recourses can be targeted to known risk. In this sense, adaptation historically has been largely but not entirely reactive (Burton et al., 2005).

Anticipatory adaptation: are decisions that are carefully discussed to take in advance for reducing potential effects of climate change before fact. Adaptation to climate change is a continuous process; therefore it is hard to distinguish between which actions are carried out after and which actions are carried out before. Anticipation requires foresight and planning while reaction does not. IPCC (2001) mentioned adaptation as adjustments or interventions, which take place in order to manage the losses or take advantages of the opportunities presented by a changing climate. Adjustments or interventions in this concept include natural and human systems adjustments or interventions of government organizations, non-government organizations, private sectors, public sectors and policies as well. However, in reality, anticipation and reaction are mixed and people often combine both reactive and anticipative adaptation strategies to cope with and adapt to climate extremes and climate variability.

Autonomous adaptation: is defined as natural or spontaneous adjustments in the face of climate change (Carter et al., 1994) which means that autonomous adaptation takes place without intervention of an informed decision-maker (Schneider et al. 2001).

Planned adaptation: refers to intervention of human and activities/ actions have been planned before (Carter et al., 1994). Planned adaptation requires action strategies that base on climate change perception and need actions to respond well to such changes (Kelein, 1999). Autonomous adaptation invariably occurs in reactive adaptation to climatic stimuli as a matter of course, without directed intervention by a public agency (Schneider etal., 2001; Kelein and Maciver, 1999) while planned adaptation in human system can be reactive or anticipatory (Kelein and Maciver, 1999).

According to the IPCC (2001), climate change is already happening, and will strengthen even if global greenhouse gas emissions are curtailed significantly in the short to medium term (Adger, 2004). This fact combined with Africa's vulnerability to climate change means that planned adaptation is becoming a must. Most adaptation measures such as better management of agriculture and water resources through the development of a more reliable system of seasonal predictions, or diversifying livelihood sources through engaging in different economic activities (e.g. utilizing forest products as a buffer to climate induced crop failure from farming in climatically marginal areas (Dinar *et al*., 2008) are also necessity for the present circumstances. The majority of national communication reports (e.g. Sudan, South Africa, Ghana) mentioned the development of more and better heat- and drought-resistant crops as future adaptation options for agriculture and food security, this is in addition to improving the production efficiencies in arid lands and marginal areas.

In terms of adaptation of forestry, examples include the decentralization of local governance of resources i.e. the Community Based Natural Resource Management (CBNRM) approach to promote the use of ecosystems goods and services as opposed to a reliance on agriculture (Dube *et al*, 2005) and the manipulation of land use. Moreover, some National Communication Reports e.g. Ethiopia, mentioned the establishment of seed banks that maintain a variety of seed types to preserve biological diversity and provide farmers with an opportunity to diversify their products and tree cover. Soil conservation and well-managed tree plantations, are also emphasized (Mortimore, 2001).

It is interesting that identifying the types of adaptation which are explained by different authors, will help to suggest appropriate adaptation strategies to the study area. Therefore, understanding adaptation concepts is important to make the foundation for investigating and identifying impacts of climate change as well as choosing the appropriate adaptation measures in order to reduce negative climate changes effect, and in turn significantly reduce vulnerability and risk for human, environment and nature in climate change context.

2.4 Methods of Coping and Adaptation Assessment

The fact that climate change adaptation research is a recent phenomenon; much has not been done so far and thus limits comparison among methodologies and debating on the appropriateness of any given model. Despite the fact that because of methodological similarities, researchers in the field of climate change traced their methodologies from agricultural technology adoption and other related models involving decisions to whether to adopt on not a given course of action and the steps economic agents take in the process of action (Maddison, 2006; Temesgen, 2009; Barungi and maonga, 2011).

Agricultural technology adoption methods are based on farmers' utility or profit maximizing behaviors (Maddison, 2006, Barungi and maonga, 2011). The assumption is that farmers may adopt a new technology only when the perceived utility or profit from using this new technology is considerably greater than the traditional or the old method. While utility is not directly observed, the actions of economic agents are observed through the choices they make (Temesgen, 2009; Barungi and maonga, 2011). However, their capacity also constrains them to adopt new technologies. Madison (2006) noted that African farmers have been constrained by different factors to adopt climate change adaptation strategies.

Probit and logit models are the most commonly used models in the analysis of agricultural technology adoption research. Binary probit or logit models are employed when the number of choices available is two (whether to adopt or not). The extensions of these models, most often referred to as multivariate models, are employed when the number of choices available is more than two. The most commonly cited multivariate choice models in unordered choices are multinomial logit (MNL) and multinomial probit (MNP) models. Multivariate choice models are advantages over their counterparts of binomial logit and probit models in two aspects (Wu and Babcock, 1998). First, they allow exploring both factors conditioning specific choices or combination of choices and second, they take care of self- selection and interactions between alternatives (Temesgen, 2009).

2.5 Determinants of understanding to climate change

Understanding is the process of attaining awareness or understanding the elements of the surrounding environment based on what is observed or thought physical sensation. In the case of climate change, perception refers to whether farmers understand the changing patterns of temperature and rainfall over time or not and respond to the negative impacts through adaptation (Maddison, 2006).

Adaptive capacity depends on the ability of community and society to respond to the changing climatic conditions (Brooks & Adger, 2005). According to Smit and Wandel (2006), population pressure or scarce resource may reduce the capacity of community as well as of individuals, while economic development or technology or institutions improvement, financial access may lead to an increase adaptive capacity. Moreover, communities have a strong kinship network may increase adaptive capacity though collective action and conflicts solution between its members (Smit and Wandel, 2006; Brooks and Adger, 2005 and Pelling, 2005).

Impact assessments have recognized the importance of farmers' perceptions and risk management choices more recently. Certainly the earlier focus on the potential biophysical impacts of climate change scenarios on agricultural production has shifted to include considerations of possible adaptations by producers (Smit and Skinner, 2002).

Perception is a necessary prerequisite for adaptation (Maddison, 2006; Temesgen *et al*., 2009; Temesgen, 2010). These authors assert that large numbers of farmers in many of African countries including Ethiopia have already perceived increasing temperature, decreasing rainfall, and changes in the timing and duration of rainfall. The perception of farmers is consistent with the report by the respective countries' Meteorological Services Agency (NMSA, 2001).

Farming experience, education, farm income, non-farm income, information on climate, farmer to-farmer-extension, and number of relatives in a village were also identified as the major determinants of farmers' perception. However, Maddison (2006) didn't identify number of relatives in a village as case. The argument on the likely impact of education, age of the household head, farm and non farm incomes on perception is more or less similar to the case with adaptation; because these factors make farmers to access more information on both perception and adaptation. Maddison (2006) noted that farmers who have more experience, connection with experienced neighboring farmers, and access to climate information were in a better position to distinguish climate change.

Understanding of the impacts agricultural investment to climate change is crucial for their choice of adaptation and interest to invest for climate change mitigation actions. However, perceptions are influenced not only by actual conditions and changes, but are also influenced by other factors. A study by Gbetibouo (2009) found that having fertile soil and access to water for irrigation decrease the likelihood that farmers will perceive climate change; however, education, experience, access to extension services increase the possibility that farmers perceived climate change.

Adaptation is widely recognized as a vital component of any policy response to climate change. It is a way of reducing vulnerability, increasing resilience, moderating the risk of climate impacts on lives and livelihoods, and taking advantage of opportunities posed by actual or expected climate change (Maddison, 2006). In response to perceived long-term changes in climate, farm households implemented a number of adaptation measures to reduce the vulnerability of climate change impacts. Several studies on climate change impact and vulnerability have proposed various adaptation options for the farming community. Maddison (2006), Yesuf *et al*. (2008, Temesgen et al. (2009, Temesgen

(2010) identified different adaptation strategies used by farmers. The most common adaptation method used by almost all countries (except Cameroon and South Africa) was planting different crop varieties. Soil conservation, water harvesting, change planting dates, change crop variety, off-farm activities, migration, change farming type (from crop to livestock and vice-versa), and adoption of new technologies were most identified adaptation options.

Mertz et al., (2008) also pointed out that using crop varieties mostly vegetables; keeping animals in stables; replacing draught horses with cattle (cheaper to feed); and using manure as the main adaptation strategies to counter perceived climate impacts on agricultural production in the Sahel region of Africa.

Numerous factors have been identified as barriers to adaptation :Madison,(2006), Deressa et al.,(2008), Nhemachena and Hassan (2008) states that, lack of information on choice of adaptation option, lack of financial resources, shortage of land, poor potential for irrigation and labor constraints are the major factors for the choice of appropriate adaptation strategies. However, lack of information on choice of adaptation option was the major barrier to adaptation. Climate mitigation strategies must be seen as a collective concern for sustainability of agricultural production and livelihoods of many people especially those in developing countries.

The extent of climate change impacts on agriculture can be ameliorated by the perception and level of adaptation of farmers. Studies have shown that African perception and understanding of climate change are poor. For instance, Taderera (2010) reported that South African awareness of climate change was literally interpreted as ‘changing weather’ and this may influence the extent of adaptation.

2.6 Requirements for perception and adaptation to climate change

2.6.1 Local knowledge

Local and traditional knowledge is increasingly valued as important information to include when preparing for disasters Mertz et.al (2009). It is embedded in local culture and social interactions and transmitted orally over generations (Bizikova, 2008). Place based memory of vulnerable areas, know-how for responding to recurrent extreme events, and detection of abnormal environmental conditions manifest the power of local knowledge.

Because local knowledge is often tacit and invisible to outsiders, community participation in disaster management is essential to tap this information as it can offer alternative perspectives and approaches to problem-solving (Battista, 2004) Turner. Within a climate change context, indigenous people as well as long-term residents often conserved their resources in situ, providing important information about changing environmental conditions as well as actively adapting to the changes (Macchi et al. 2008). Research is emerging that helps to document changes that local people are experiencing (Salick et al, 2009). Although this evidence might be similar to scientific observations from external researchers, the fact that local communities are observing it is initiating discussions about existing and potential adaptation to climate changes from within the community

2.6.2 Local government

Governance structures are pivotal to addressing disaster risk and informing responses as they help shape efficiency, effectiveness, equity, and legitimacy (Adger et al. 2003). Some places centralize climate change management practices at the national level. This may be due to the ways in which many climate extremes affect environmental systems that cross political boundaries resulting in discordance if solely locally managed but could also be based on old practices of operations. In other places, actions are more decentralized, emerging at the local level and modified by local contexts (Bizikova et al., 2008). Local governments play an important role as they are responsible for providing infrastructure, preparing and responding to disasters, developing and enforcing planning, and connecting national government programs with local communities (Huq et al. 2007)

One of the emerging challenges faced by the world’s agricultural sectors is a changing climate. Climate change alters the basics of productive ecosystems, impacts on natural resources and affects food security. From a socio-economic perspective, smallholder farmers, forest dwellers, herders and fishers, groups least able to adapt, will be the most affected by climate change. Moreover, climate change cannot be effectively addressed without addressing emissions from the agricultural sectors, estimate to contribute some one-third of all greenhouse gases. As a result, there is a growing need to ensure that climate change considerations are mainstreamed into agricultural investment projects and programmes with particular interest on the linkages with and among food security and rural livelihoods.

With reference to this, this chapter reviews literature agricultural investment on climate change and its impacts on. It begins by looking at global climate change in general and literature on agricultural investments on climate change impacts in developing countries including Ethiopia is also reviewed.

2.7 Concepts and definition of climate change

Climate change is one of the greatest challenges of the 21st century. The concept acquired a number of different meanings in the scientific literature. The IPCC (2001) report defined it as variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all temporal and spatial scales beyond that of individual weather events. It may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability). Derek (2007) describes as variations (ups and downs) in climatic conditions on time scales of months, years, decades, centuries, and millennia including droughts and floods.

In the most general sense, the term "climate change" denotes the inherent characteristic of climate which manifests itself in changes of climate with time. The degree of climate variability can be described by the differences between long-term statistics of meteorological elements calculated for different periods. In this sense, the measure of climate variability is the same as the measure of climate change. The term "climate change" is often used to denote deviations of climate statistics over a given period of time such as a specific month season or year, from the long-term climate statistics relating to the corresponding calendar period. To Robert (2009) the term climate change means variability on time scales of a few years to a few decades (i.e., shorter than a climatic averaging period).

2.8 Global climate change

Historically the earth's climate has always had cyclical trends and variations through the centuries, although with constant averages (IPCC, 2001). Current climatic trends show a deviation from historic trends. The rate of change and the cause of change have been of concern to scientists all over the world. Temperature records collected for over a period of 100 years shows that, the Earth's surface temperature has risen by more than 0.7 degrees Celsius since the 1800s (IPCC, 2007). Historical temperature data shows deviation of global atmospheric temperature measures from the global average temperature, from 1850 to 2008 and the gradual increase in the temperature. The temperature anomaly refers to the difference from an average and this measure gives a more accurate picture of temperature change.

Some facts about global climate change include: increasing temperature (0.74°C increase per annum), melting polar icecaps, uncontrolled forest fires and annual average increase in sea level of 3.1 mm (Spore, 2008). Such changes have already had some impacts on the natural equilibrium at the risk of the survival of human beings. It is also assumed that African countries that depend on natural resources and rain fed agriculture are more vulnerable to the risk of climate change. For example, the Intergovernmental Panel on Climate Change (IPCC 2007a) has estimated that, by 2020, agricultural production would decline by 50% in some countries with rainfed agriculture. Similarly, UNEP (2006) has predicted that, by 2025, about 480 million people in Africa could be living in water-stress areas and, by 2085; up to 40% of wildlife species habitat in Africa could be lost. According to Spore (2008), a recent study by the World Bank has also predicted that, with the future trend of climate change, many African farmers will be shifting from crop to livestock production, which might be rational ecologically and economically. The wide range of estimates of climate change using different climate models, which is compounded by the difficulty to perceive small degrees of change, may lead to an underestimation of the big impact to be expected and may delay timely action.

2.9 Climate change in East Africa

In Africa, Climate change is expected to adversely affect agricultural production. A range of climate models suggest median temperature increases between 3°C and 4°C in Africa by the end of the 21st Century, roughly 1.5 times the global mean response. Countries in Sub-Saharan Africa are particularly vulnerable to climate change impacts, because of their limited capacity to adapt. The development challenges that many African countries face are already considerable, and climate change will only add to these. In Kenya, where the poverty rate is 52 percent and 73 percent of the labor force depends on agricultural production for their livelihood, poor farmers are likely to experience many adverse impacts from climate change (FAOSTAT 2010). Because agricultural production remains the main source of income for most rural communities in the region, adaptation of the agricultural sector is imperative to enhance the resilience of the agriculture sector, protect the livelihoods of the poor, and ensure food security.

In East Africa, there are very few places where rainfall means are likely to decrease; however, increases in rainfall are not likely to lead to increases in agricultural productivity as a result of poor spacing and timing of precipitation increase (Herrero et al. 2010).

The Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) of 2007 revealed that climate change is real and is already happening at an unprecedented rate. The adverse impacts of climate change are a major challenge to socio-economic development globally. The African continent including the East African region is particularly vulnerable to impacts of climate change affecting key economic drivers such as water resources, agriculture, energy, transport, health, forestry, wildlife, land and infrastructure, disaster risk management among others. The impacts include; water stress and scarcity, food insecurity, diminished hydropower generation potential, loss of biodiversity and ecosystem degradation, increased incidence of disease burden, destruction of infrastructure, high costs of disaster management as result of increased frequency and intensity of droughts, floods and landslides associated with the El Nino phenomenon. The impacts are most felt by the poor rural and urban populations in the region. The vulnerability of East Africa to climate change is linked to the fact that the economies of the Partner States are dependent on climate-sensitive natural resources including water and land resources.

The (IPPC, 2007) highlighted that Africa will be one of the continents that will be hard hit by the impact of climate change due to a increased temperature and water scarcity. Yet Africa represents only 3.6 percent of emissions. The IPCC Report pointed out that there is “very high confidence” that agricultural production and food security in many African countries could be severely affected by climate change and variability. The Report projected that yields of crops in some countries could be reduced as much as 50 percent by 2020, with smallholders being the most affected.

Climate change is already having profound impacts in developing countries, especially in sub-Saharan Africa (SSA), with the increasing frequency and intensity of climate-related disasters, notably recurrent droughts, floods and erratic rainfall. Africa’s vulnerability to climate change is also exacerbated by the multiple other stresses it faces such as natural resources degradation, high dependence on rainfed agriculture and inadequate infrastructure, also low levels of technology, widespread poverty, weak governance and thus low level of adaptive capacity to climate variability and change.

2.10 Climate change in Ethiopia

In Ethiopia, it is assumed that the temperature has been increasing annually at the rate of 0.2°C over the past five decades. This has already led to a decline in agricultural production, and cereal production is expected to decline still further (by 12%) under moderate global warming (Ringer 2008). 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 rained agriculture, lack of awareness by policy and decision-makers about climate change and lack of appropriate policies and legislation (Wondwossen, 2008).

Over the last decades, the temperature in Ethiopia increased at about 0.2° C per decade. The increase in minimum temperatures is more pronounced with roughly 0.4° C per decade. Precipitation, on the other hand, remained fairly stable over the last 50 years when averaged over the country. However, the spatial and temporal variability of precipitation is high, thus large-scale trends do not necessarily reflect local conditions.

The future changes in precipitation and temperature as projected by various global climate models. Most of the global climate models pro-ject an increase in precipitation in both the dry and wet seasons. Studies with more detailed regional climate models, however, indicate that the sign of the expected precipitation change is uncertain. The temperature will very likely continue to increase for the next few decades with the rate of change as observed.

Investment

Investment is the change in fixed inputs used in a production process. In the narrowest definition, investment is the change in the physical capital stock, that is, physical inputs that have a useful life of one year or longer (land, equipment, machinery, storage facilities, livestock). However, Eisner (1985) estimated that less than 20 percent of total growth in the United States comes from physical capital formation, while Denison's (1967) estimates were 10 to 15 percent.

Economists recognize that, though difficult to measure, a comprehensive agricultural investment measure should include improvements in land, development of natural resources and development of human and social capital in addition to physical capital formation. Human capital is the stock of knowledge, expertise or management ability. Since it is directly influenced by educational, training and extension institutions, variables such as education level or extension contacts are often used as proxy measures. Public and private expenditures on R &D are often used to proxy the level of human capital as well. Coen and Eisner (1987) specifically include R&D, education and training as forms of human capital investment.

Social capital is the stock of personal relationships and knowledge of institutions that an individual or household has. This affects the individual's access to risk minimizing inputs like credit, insurance and land title. In other words, social capital measures the ability to utilize social networks and institutions. Status, gender and group affiliations are often used as proxies for social capital in economic studies. However, education and transportation, as well as the range of social institutions available, can also influence social capital.

Asymmetry of Investment and Risk

A key characteristic of investment is its irreversibility, often referred to as asymmetry (Nelson, Braden and Roh, 1989). Once investments are made, there are few other productive activities for which they can be used. Dixit and Pindyck (1994) formulate the problem of the irreversibility of investment under uncertainty as the decision to pay a sunk cost and in return receive an asset with a value that can fluctuate. They demonstrate that under uncertainty actual investment will always be less than the expected present value of investment, the difference being attributable to the irreversibility of industry specific investments.

Agro-climatic factors may exacerbate the asymmetry of agricultural investment, as is the case when the land is suitable only for a particular crop. Other forms of investment, such as tractors and farm machinery have few other alternative uses besides agriculture, while human and social capital particular to agriculture may not adapt well to other sectors. Contrast this with investments made in capital markets or even factories. The former can be moved around to the most profitable enterprise, while, in general, the latter can be modified to produce more profitable products. Due to this fixity of agricultural assets and the uncertainty it entails, farmers are often reluctant to invest in equipment, land improvements or human capital. Uncertainty may cause the level of investment to be "sub-optimal", resulting in deteriorating physical and human capital and mining of soil nutrients.

Drawing on fixed asset theory, Nelson, Braden and Roh (1989) hypothesize that it is more difficult to dispose of capital specific to agricultural production than to add to the stock of specialized capital. This implies that periods of disinvestment (through depreciation) will be greater than those of investment in agriculture. Thus, in any given year net agricultural investment is likely to be negative (depreciation is higher than gross investment). Because investment is irreversible, farmers only invest during years when profits are high and/or borrowing costs are low.

Rosenzweig and Binswanger (1993) find that agricultural investment behavior of farmers reflects their risk aversion, with poorer farmers accepting lower returns in exchange for lower risk to smooth their consumption. The wealthy are less risk averse; they can afford to accept higher risk in seeking higher returns. Hence, they find that wealthier farmers, particularly those with larger farms and diversified incomes, have higher rates of farm investment on a per hectare basis. They suggest that consumption credit and/or crop insurance would increase the overall profitability of agricultural investments.

Public Expenditures and Investment in Agriculture

Public expenditures on agriculture include short-term costs as well as long-term investments. Investment in agriculture and forestry includes government expenditures directed to agricultural infrastructure, research and development and education and training. Data on the proportion of all central government expenditures spent on agriculture and forestry are incomplete, particularly for African countries. Comparisons between developed and developing countries reveal that there is greater variation among developing countries than industrial countries. In industrial countries in 1992, the range of expenditures was between 0.4 to 9.1 percent, with most countries clustered around 1.5 percent. For those developing countries reporting, agricultural expenditures were between 1.5 to 7.9 percent in Africa, 1.7 to 23 percent in Latin America and 0.20 to 19 percent in Asia (IMF, 1995). As a percentage of expenditures, agricultural expenditures generally declined from 1988 to 1993 in Africa, Eastern Europe and industrialized nations, declined for some Asian countries, increased for China and were mixed for Latin America.

Human capital development is a key component of public agricultural investment. Judd, Boyce and Evenson (1991) examined the role of public expenditures in agricultural research and extension on agricultural output. They show that between 1959 and 1980, real spending on research and extension programs increased by factors of four to seven and that research intensities more than tripled for the lowest income developing countries. They show a decrease in the disparity between countries over time. They estimate world agricultural research public-sector expenditures at US$7.4 thousand million and world public sector agricultural extension expenditures at US$3.4 thousand million (both in 1980 dollars). Africa had the smallest share of world research expenditures (5.7 percent) and human resources (5.5 percent), yet a larger share of world extension expenditures (14.8 percent) than Asia and the second largest world share of extension human resources (20.7 percent). Calculating public sector expenditures as a percent of agricultural product, Africa's expenditures are higher than those of South and Southeast Asia.

The composition as well as the amount of public expenditure on agriculture is also of concern. As early as 1978, an FAO study identified a lack of investment in education and training in developing countries as an impediment to agricultural growth (Beal, 1978). In absolute and relative terms, expenditures on education and training by developing countries were less than those of developed countries. Beal proposed a target for education expenditures of at least 4.6 percent of GNP (the developed country average) and at least one field level extension worker per 1000 farm families.

2.11 Measuring Agricultural Productivity

Models of production growth have been used to measure the change in output, to identify the relative contribution of different inputs to output growth and to identify the Solow residual or output growth not due to increases in inputs.

Three different types of economic models have been used to investigate production growth:

i. index numbers or growth accounting techniques,
ii. econometric estimation of production relationships and
iii. Nonparametric approaches.

Each approach can be used to measure aggregate agricultural output or TFP. Each approach has different data requirements, is suitable for addressing different questions and has strengths and weaknesses.

Growth accounting involves compiling detailed accounts of inputs and outputs, aggregating them into input and output indices to calculate a TFP index (Diewert, 1976, 1980, 1981). The initial focus of growth accounting studies in the 1950s and 1960s was on partial measures of growth; only capital and labor were examined. However, growth accounting methods were unable to demonstrate much of a link between the amount of physical capital formation and output growth (Denison, 1987). Denison's (1967) growth accounting study of the 1950s and 1960s determined only 10 to 15 percent of growth could be accounted for by capital formation in non-residential plant and equipment (Cornwall, 1987). Nor did Bosworth (1982) find much of a role of reduced capital formation in the economic stagnation of the 1970s. Work by Abramovitz (1956), Solow (1957) and Kendrick (1973) "showed beyond reasonable doubt that the modern growth of the United States economy was in proportionate terms at least three-quarters due to increased efficiency in the use of productive inputs and not to the growth in the quantity of resource inputs per se " (Metcalfe, 1987). This implied that quality of inputs matters more than quantity.

The failure of economics in the 1950s, 1960s and 1970s to find strong relationships between capital formation and economic growth was due in part to a narrow definition of capital formation and partly due to failure to control for other inputs. The unexplained growth was of the order of half the change in real output. Subsequent studies have tried to close this gap by including more inputs (fertilizer, pesticides, etc.), or finding ways to quantify inputs (human capital) for the analysis. The Solow residual has been referred to as efficiency, technological progress, economies of scale, or a "measure of our ignorance" (Cornwall, 1987).

During the 1990s, there was a revival of interest in "new growth accounting" approaches, including endogenous growth models. The resurgence of interest in growth models has come in part from researchers incorporating omitted variables in their analysis, particularly measures of human capital, and new developments in the theory of growth. Hsieh (1998) developed a dual approach to computing the Solow residual using the growth in input prices rather than input quantities. Endogenous growth theory incorporates R&D as an intermediate input in the production process (Romer's [1990] varieties model) or views technological progress as improvements in the quality or cost of intermediate inputs (Grossman and Helpman's [1991] quality ladder model). Obsolescence in technology differentiates the quality ladder model from the varieties model (Barro, 1999). Both models contain endogenously driven technological change and exogenous technological change.

2.12 Agriculture and climate change in Ethiopia

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. The problem is very serious in the arid and semi-arid areas, especially among the pastoralists.

Small-scale, mixed crop and livestock farmers dominate the agricultural sector, which is the mainstay of the country’s economy. Based on variations in agro ecological settings, five major farming systems exist in Ethiopia. These are the highland mixed farming system, the lowland mixed agriculture, the pastoral system, shifting cultivation, and commercial agriculture (Befekadu and Berhanu 2000). The highland areas constitute about 45 percent of the total crop area, including about four–fifths of the total population and supporting about 70 percent of the livestock population of the country.

Under these diverse farming systems, different varieties of crops and species of livestock are produced. The major crops grown include cereals, pulses, oil seeds, spices and herbs, stimulants, fruits, sugarcane, fibers, vegetables, and root and tuber crops. The major livestock species raised include cattle, sheep, goats, camels, donkeys, horses, mules, poultry, and pigs. Crop production is estimated to contribute on average about 60 percent of the total agricultural value, while livestock accounts for about 27 percent and forestry and other subsectors account for about 13 percent (MEDaC, 1999).

The major socioeconomic constraints in crop production include inappropriate polices; declining farm size and subsistence farming due to population growth; land degradation due to inappropriate use of land, such as cultivation of steep slopes; and over cultivation and overgrazing. Additionally, tenure insecurity, weak agricultural research and extension services, lack of agricultural marketing, inadequate transport networks, inadequate use of agricultural inputs, and the use of backward technologies are other constraints. The major causes of poor production in the livestock subsector include inadequate feed and nutrition, low level of veterinary care, occurrence of diseases, poor genetic structure, inadequate budget allocation, limited infrastructure, and limited research on livestock. The major environmental problem in both crop and livestock production is recurrent droughts, hailstorms, floods, and pest incidence (Befekadu and Berhanu, 2000).

2.13 Overview of Ethiopian Agricultural Sector

Agriculture remains by far the most important sector in the Ethiopian economy for the following reasons: (i) It directly supports about 85% of the population in terms of employment and livelihood; (ii) It contributes about 50% of the country's gross domestic product (GDP); (iii) It generates about 90% of the export earnings; and (iv) It supplies around 70% of the raw material requirement of ago-based domestic industries (MEDC, 1999).

Rain-fed crop production is the basis of all subsistence farming in most parts of the country and accounts for more than 95% for the land area cultivated annually. In general, mixed type of farming both animal and crop production are important (MOA, 2000). Ethiopian agriculture is predominantly characterized by traditional methods of farming with very little change in farming practice over the past few centuries. The continuous use of such farming practice over a long period of time with little or no soil conservation measures has significantly eroded the fertility of the soil and has made agricultural outputs highly susceptible to minor climate change (CSA, 2000).

Ethiopian agriculture is particularly sensitive to climate change and vulnerable to accelerated soil erosion. This leads to changes in crop production system (CRGE, 2010). In general, agriculture which includes crops, livestock, forestry, fisheries and aquiculture is the most important sector of the national economy and the main source of livelihood for Ethiopian population (EPA, 2010).

2.13.1 Crop production

The diverse climate of the country and the multiple utilizations of crops have promoted the vast majority of agricultural holders to grow various temporal and permanent crops. Temporary crops are crops that are grown in less than a year's time, sometimes only a few months, with an objective to sow or replant again for additional production following the current harvest (CSA, 2000). The diverse agro-ecological conditions enables Ethiopia to grow a large variety of crops including cereals (teff , maize, wheat, barley , millet, oats, etc), pulses (horse beans, field peas, lentils, chick-peas, haricot beans, vetch, etc), oil seeds (linseed, niger-seed, fenugreek, rapeseed, sunflower, castor bean, groundnuts, etc), spices and herbs (pepper, garlic, ginger, mustard, etc), stimulants (coffee, tea, chat, tobacco, etc), fruits (banana, orange, grape, papaya, lemon, menderin, apple, pineapple, mango, avocado, etc), sugarcane, fibers (cotton, sisal, etc), vegetables (onion, tomato, carrot, cabbage, etc), root and tuber crops (potato, enset, sweet- potatoes, beets, yams, etc) (MEDC, 1999).

2.14 Agricultural investment in Ethiopia

Agriculture plays a vital role for economic growth and sustainable development. Investment in the sector has been shown to be an effective instrument to alleviate poverty and enhance food security. Evidence suggests that gross domestic product (GDP) growth originating from agriculture is twice as effective in reducing poverty as GDP growth linked to the non-agricultural sectors. In developing countries, agriculture generates on average 29 percent of their GDP and employs 65 percent of the labor force (World Bank, 2007). Despite its importance, investment in developing world agriculture has been limited. However, agricultural investment has grown significantly in recent years, spurred by increased agricultural prices and food security concerns of developmental agencies and governments. A discernible trend in the growth of agricultural investment in developing countries is the increasing use of fund structures ─ agricultural investment funds.

The level of investment in agriculture is positively correlated with food security and poverty reduction. Regrettably, agricultural investment in developing countries decreased sharply over the last decades. Substantial increases are needed to eradicate hunger and poverty, create decent jobs and livelihood opportunities and ensure environmental sustainability. As the largest on-farm investors, farmers must be central to agricultural investment strategies. Their investments must be stimulated and complemented by governmental and donor investments in public goods.

Investments by private companies along the entire value chain also play an important role. However, the benefits of agricultural investments will not arise automatically and some forms of investment carry risks for local communities and the environment. FAO promotes responsible investment in agriculture through empirical research and by supporting various consultation processes.

The agriculture sector PIF (Policy and Investment Framework) preparation is the logical follow up of the CAADP (Comprehensive Africa Agriculture Development Program) compact. Ethiopia completed the preparation and signing of the CAADP Compact in August 2009, which is an initiative of the African Union’s New Partnership for Africa’s Development (AU/NEPAD) footed on a vision and strategic framework to eradicate hunger and poverty and place the continent, at all levels, on a path for sustainable socio-economic growth. PIF is a 10 years road map prepared on the objective of producing a national level strategic investment planning framework that can be used to guide the prioritization, planning and implementation of current and future public and development assistance investments that contribute to sustainable agricultural growth and rural development, food security, and poverty reduction.

It is also prepared to assist the Government of Ethiopia and its development partners to identify salient policies linkages and any policy changes, institutional arrangements and coordination mechanisms that might be recommended for the next nationwide development plan aligned with existing Government of Ethiopia, CAADP, and REDFS investment pillars, and programs (Demese c.et al., 2010)

Many studies show that investment to increase productivity of owner-operated smallholder agriculture has a very large impact on growth and poverty reduction. The fact (ASTI/CGIAR, 2009) that investment to bring about such productivity increases in Africa has historically been in 2005 PPP dollars only a fraction of what has been spent in Asia-Pacific and LAC countries is often seen as one of the reasons for Africa's lackluster record in terms of rural growth since the Green Revolution began. Thus any investment—public or private—in lower income countries and rural areas that can close this gap is desirable in principle. Yet even when investments seem to hold promise of raising productivity and welfare and are consistent with existing strategies for economic development and poverty reduction, it is important to also ensure that they respect the rights of existing users of land, water and other resources, that they protect and improve livelihoods at the household and community level, and that they do no harm to the environment.

Private investment in the agricultural sector offers significant potential to complement public resources. Many countries with reasonably functioning markets have derived significant benefits from it in terms of better access to capital, technology and skills, generation of employment, and productivity increases. Moreover, new technology, the emergence of value chains, demands for traceability, the need to adhere to rigorous standards, and consumer demands arguably favor greater scale and integration. Some large investments have managed to achieve broad-based benefits via contract farming, other out grower arrangements, and joint ventures with local communities, by leasing rather than acquiring the land or by formulating innovative schemes for sharing both risks and rewards.

Ethiopia has huge investment potentials for agricultural development. For the past five consecutive years the agriculture sector was growing faster with more than 11% average annual growth. Currently investment in agriculture sector is found to be more attractive and profitable in diverse sub-sectors ranging from food products, industrial raw materials to bio-fuel. The agriculture sector accounts for 47% of the GDP, provides 85% of employment and 90% of foreign currency earning. The total area of the country is about 111.5 million ha, out of which 74.3 million ha. is suitable for annual and perennial crop production and only 15 million is under utilization.

According to the Ethiopian Investment Agency (EIA), the areas with the most promising potential for investment are agriculture, agro-processing, textiles and garment, leather and leather products, tourism, mining and hydropower. Of the FDI projects licensed by 2003, 46.57 percent were in manufacturing and processing; 40.7 percent in trade, hotels and tourism; and 12.7 percent in agriculture and mining (UNCTAD, 2004). China, India, Sudan, Germany, Italy, Turkey, Saudi Arabia, Yemen, the United Kingdom, Israel, Canada and the United States are currently the major sources of FDI into Ethiopia.

FDI into Ethiopia began increasing with the liberalization reforms that started in 1992 following the end of the Derg military regime and years of civil turmoil. The new democratic administration sought to eliminate constraints on foreign investment and to establish a more conducive business environment. Ethiopia has gradually shifted from a state-controlled economy towards a market-oriented one. New investment proclamations have been published and amended, and privatization of state enterprises is ongoing.

2.15 The Need for Agricultural Investment in Ethiopia

Continued subsistence farming in Ethiopia’s current context apparently leads to graver poverty and farmland fragmentation unless it eventually evolves onto modern farming which enables a smaller percentage of the population to produce beyond subsistence by mainly targeting at local food supply.

Distinction should thus be made between agricultural investment and massive land acquisition by foreign investors for their home market. It is also to be noted that hasty steps towards large-scale mechanized agriculture in topographic settings where there is much dependence on rhythmic seasonal rainfall rather than surface freshwaters suitable for irrigation cannot bring about the success obtained in agricultural modernization in settings where surface freshwater resources are abundant and where the watershed in the basin is well-managed.

Caution and prudence are thus crucial. If, for example, land is allocated to an investor who undertakes an agricultural activity, the farm may incrementally increase the area of cultivation that can gradually enhance commercial farming by incorporating adjacent small-holders through win-win schemes. The schemes may be shareholding plus job options to smallholder farmers or introducing on tract farming in which the modern farm can provide mechanized farming services in neighboring farms for consideration (in the forms of payment or sharecropping), and/or outsource certain farming activities to be done by smallholder farmers. There are lessons that can be learnt from the success, efficiency and dynamism of modern farms that were emerging during the late 1960s and the early 1970s, vis-à-vis the poor performance of the same farms after their post-1975 nationalization. One of the core lessons to be drawn is the advantage in modest takeoffs and incremental scaling up in the context of integration with the local communities in which commercial farming takes place. In contrast to win-win agricultural investments, land grabs target at short-term benefits. They are indifferent to local needs and seek massive land acquisitions. Cotula underlines the need for enhancing efforts "to secure local land rights, including customary rights, using collective land registration where appropriate" and he further notes the necessity of ensuring "free, prior and informed consent, robust compensation regimes, the provision of legal aid, and good governance in land tenure and administration." In the absence of such rights, land transfers run the risk of abuse under discretionary decisions by various regulatory offices thereby leaving the doors wide to speculative land acquisitions, displacement and environmental harm. Therefore, from this point of view agricultural investment is essential for Ethiopia. But the sector highly needed critical analysis, caution and care.

2.16 The Role of Agricultural Investment in Ethiopia

Agriculture plays a vital role for economic growth and sustainable development. Investment in the sector has been shown to be an effective instrument to alleviate poverty and enhance food security. Evidence suggests that gross domestic product (GDP) growth originating from agriculture is twice as effective in reducing poverty as GDP growth linked to the non-agricultural sectors. In developing countries, agriculture generates on average 29 percent of their GDP and employs 65 percent of the labor force (World Bank, 2007). Despite its importance, investment in developing world agriculture has been limited. However, agricultural investment has grown significantly in recent years, spurred by increased agricultural prices and food security concerns of developmental agencies and governments. A discernible trend in the growth of agricultural investment in developing countries is the increasing use of fund structures — agricultural investment funds.

The level of investment in agriculture is positively correlated with food security and poverty reduction. Regrettably, agricultural investment in developing countries decreased sharply over the last decades. Substantial increases are needed to eradicate hunger and poverty, create decent jobs and livelihood opportunities and ensure environmental sustainability. As the largest on-farm investors, farmers must be central to agricultural investment strategies. Their investments must be stimulated and complemented by governmental and donor investments in public goods.

Investments by private companies along the entire value chain also play an important role. However, the benefits of agricultural investments will not arise automatically and some forms of investment carry risks for local communities and the environment. FAO promotes responsible investment in agriculture through empirical research and by supporting various consultation processes. Due to this fact the sector has been play a very significant role in the economy. According to EPLAUO (Environmental Protection Land Administration and Use Office), luck of appropriate use the land and the environment as well as luck of skilled man power the sectors can aggravate and affects the environment greatly. This results the change in weather and climatic condition in the study area.

Climate change influences all facets of human activity, particularly in agrarian economies (Glantz et al., 1991). Ethiopia is one of the most vulnerable countries experiencing drought and floods as a result of climate variability and change. Vulnerability analyses for Ethiopia under climate change (Deressa, 2006) indicates that changes in rainfall patterns and increasing temperatures are expected to have significant negative impacts on environment and water resources, crops and livestock, human health and other farming livelihoods. The livelihoods of many millions of people in the country are critically dependent on climate. Achievement of the Millennium Development Goals (MDGs) envisioned by the government will be possible only if the country successfully adapts and copes with climatic variability and change (Akililu &Alebachew, 2009).

Ethiopia's agricultural sector, which is dominated by small scale, mixed crop, and livestock farming, is the mainstay of the country's economy. Its dependence on agriculture makes the country particularly vulnerable to the adverse impacts of climate change on crop and livestock production (Temesegen, 2008). Causes for vulnerability of Ethiopia to climate variability and change include very high dependence on rain-fed agriculture, 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 (Abebe , 2007).

According to FAO (1999), general impacts of climate change on agriculture include reduction in soil fertility, decreased livestock productivity directly (through higher temperatures) and indirectly (through changes in the availability of feed and fodder), increased incidence of pest attacks and impacts on human health affecting human resource availability.

2.17 Effects of climate change on agricultural investments

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The IPCC (2007) report has noted that climate change is causing major social and economic development setbacks with potentials of unprecedented reversals in overall national development in vulnerable countries like Ethiopia, and urged national governments and the international community to pay attention to the problem. Agriculture is one of the oldest economic activities and the backbone of our food supply, without it the world's population would experience food insecurity (IISD &EARG, 1997), but it is the most vulnerable sector to the effects of climate change (Aziz et al., 2011).

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2.18 Policies on Climate Change in Ethiopia

Policy makers play an important role to reducing climate change. Recently, many countries are mainstreaming climate change into their development plans. The Ethiopian energy policy address issues pertaining to climate change. The policy has been approved in 1997 before climate change has got high priority on the international agenda. It commends that the current population to use resources without compromising the survival of future generation. Ethiopia's share to global GHG emission is very minimal. However, emissions from agriculture and energy sectors double since 1994. These two sectors are the major emitters in Ethiopia accounting for 85% and 15% of the total gas emissions, respectively.

This shows that there is high potential for mitigation through these sectors. Clean Development mechanisms (CDM) measures from agriculture and hydroelectric plants, geothermal and wind turbine, conservation of energy through efficient and switching energy sources, usage of compact and efficient vehicles, changing means of transport to fuel efficient modes of transport and usage of efficient stoves are some of the strategic directions that the government promoted in its policy documents. These directions are consistent with the United Nations Framework Convention on Climate Change (UNRCCC) recommendations.

In addition, the Ethiopian government gives emphasis to climate change adaptation and mitigation in the five years development plan. The Plan embodied climate change issues to make national development paths more sustainable as compared to the previous Plans. Although it's difficult to evaluate the effectiveness of the plan in terms of implementation at this stage, the plan gives due emphasis to the construction of hydroelectric dams and medium to large scale irrigation schemes, and the development of other renewable energy sources like wind, solar and bio-fuel.

Although Ethiopia has abundant water resources and hydroelectric potential and capacity, only less than 5% of water has been developed for irrigation. In addition only less than

5% of the Nile basin was employed for irrigation development. That lead that the per capita electricity to be the least in the world with more than 80% of the population living without access to electricity and relying on firewood, charcoal dung, kerosene, gas and bio-gas which are major sources of high CO2 emission.

For the first time in its history, the construction of large scale dam with about an installed capacity of 5225 MW has been introduced in the Blue Nile River. This project has also a potential to develop more than 35% or 250,000 hectares of land around Nile River. However, this time the irrigation part seems overlooked by the government to focus on the electricity generation. The implementation of this project will have many financial, political and institutional challenges, however. More than anything else, climate variables could be big challenges to fill the dam in a way that could not affect the downstream flow. If the project is realized, passing all the inside and outside changes, it will end the historic dominance of Egypt and Sudan on Nile water. In return, the supply of energy in Ethiopia from renewable sources will reach 10,000MW at the end of 2014/15.

2.19 Coping strategies to climate change in agriculture

It has now been widely accepted that climate change is one of the biggest challenges facing agriculture in the 21st century. Among those who are most affected are poor agricultural households in the developing world, even though these are the ones who have contributed least to climate change. Climate change is expected to increase both temperatures and extreme events (floods and droughts) in Ethiopia while there is less certainty regarding rainfall changes.

There is an increasing body of research focusing on the question of how agricultural households will be affected by climate change, and how they perceive climate change (Nelson et al. 2010; Deressa et al. 2009). In view of these predicted effects on poor agricultural households, there is an urgent need to identify the strategies that are best suited to support these households to adapt to climate change.

Coping strategies to climate change includes many possible responses, such as changes in crop management practices (e.g., choice of fields, planting dates, planting densities, crop varieties, etc.), livestock management practices (e.g., feeding and animal health practices, transhumance timing and destinations, etc.), land use and land management (e.g., fallowing, tree planting or protection, irrigation and water harvesting, soil and water conservation measures, tillage practices, soil fertility management, etc.),livelihood strategies (e.g., mix of crops or livestock produced, combination of agricultural and nonfarm activities, temporary or permanent migration, etc.).

Coping strategies can greatly reduce vulnerability to climate change by making rural communities better able to adjust to climate change and variability, moderating potential damages, and helping them cope with adverse consequences (IPCC, 2001). A better understanding of farmers' perceptions of climate change, ongoing adaptation measures, and the decision-making process is important to inform policies aimed at promoting successful adaptation of the agricultural sector. Coping strategies will require the involvement of multiple stakeholders, including policymakers, extension agents, NGOs, researchers, communities, and farmers.

Regarding the impacts of climate change on agricultural investment in Ethiopia, different literature identified the following coping strategies:

- Crop diversification as a reaction to reduced productivity. This strategy was not considered very sustainable or efficient, as it can only help marginally.
- Fallowing, as a reaction to reduced productivity of soils. This is sustainable, but requires sufficient possession of land.
- Using crop residues, Grow and store herbs and straw for animals, as a reaction to reduced fodder availability. It is sustainable and works mostly.
- Water harvesting (retention and storage measures, terracing) as a reaction to water shortage. This strategy was considered to work well and being sustain-able, as it can also increase groundwater levels.
- Constructing ponds against water shortage.
- Planting trees, as a measure against soil erosion.

- Diversification of incomes through livestock, bees and poultry, against reduced incomes.
- Petty trade (grain and other sales), as a reaction to reduced incomes.
- Reduction of expenses, as reaction to reduced incomes.
- Reduction of food consumption a general reaction to food insecurity. It works (as it almost has to), but it is not sustainable and dangerous.
- Saving and borrowing, as a strategy against famines/droughts works

Generally, Positive agricultural investment can benefit investors, small-scale producers, communities and governments. However, the benefits are not automatic, and require effort by both businesses and governments alike to ensure they do no harm and have a positive impact on local communities.

Public investment in agriculture is vital and cannot be replaced by the private sector. Governments must give priority to investments in key public goods, such as capacity building, infrastructure, and research systems, to help small-scale producers who are not yet market-ready ensure their food security and livelihoods. Private investment should complement public sector investment. Unfortunately, not all private investments in agriculture are positive; current policy environments and business practices often encourage investment that exacerbates poverty. However, when coupled with the right policy environment, private investment can be catalytic to inclusive economic growth, environmental sustainability, and long-term poverty reduction. Such achievements require innovation, a long-term focus and a more inclusive approach by the private sector. The general principles outlined above have the potential to propel private investment towards positive outcomes.

But the policy environment has also proven essential to shaping private investment. Particularly important are specific regulations that ensure all rights are upheld, such that investments do no harm‘. But, beyond these key fundamentals, incentives are required to ensure that private investment does more good‘, creating a just food system for all.

CHAPTER THREE

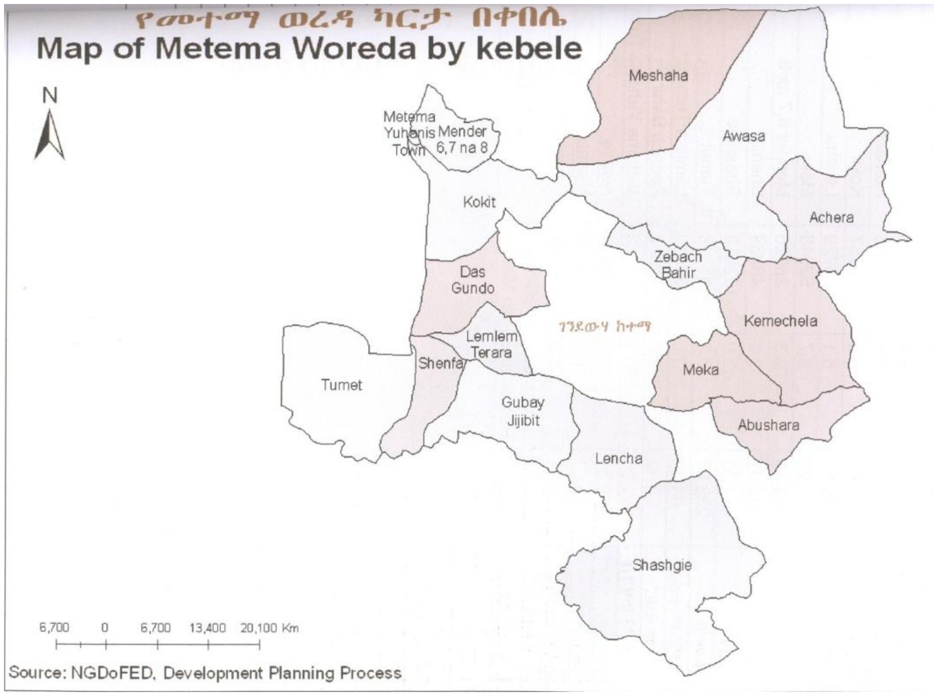
RESEARCH DESIGN AND METHODOLOGY

3.1 Descriptions and Site selection of the study area

The study was conducted in Metma woreda of North Gondar Zone, Amhara Region and the total area coverage of the woreda is 404,085 hectares. Like other part of the country, climate change is the most critical problem of the *woreda.* As a result, agricultural productivity is decreasing from time to time because of different factors such as environmental and natural resource degradation due to the introduction of agricultural investment, high variability of rainfall amount, deforestation, and soil erosion. In addition to this flooding, high prevalence of crop pest, weeds and livestock diseases, and backward technologies practiced, poverty, poor infrastructure and high population pressure are the major factors for the changes of weather and climatic condition of the woreda (WRDO 20013).

Mixed farming is the most dominant livelihood activities of the woreda. Land is the most important asset of households for the productions of crops and rearing of animals. Oxen are the major plowing engines. The most commonly produced crops in the woreda are sesames, sorghum, and cotton (WRDO, 2007).

Map of Metema Woreda



Source: Developed from arch geographical information system (GIS), 2013.

The reason for selecting this woreda was; the researchers' familiarity with the study area and the local culture, absence of previous study conducted in the *woreda* on the impacts of agricultural investment on climate change and the assumption of better accessibility of the relevant data so as to complete the study on time.

As it is mentioned earlier, the woreda is predominantly rural, encompassing 1 town and 17 rural kebeles where, according to the traditional climatic classification system, the area is classified as kolla (arid) with hotter climate. The target sites of the study area are the two kebeles, Metema Yohanes or Delello and Tumate).

3.2 Sampling Techniques and procedures

According to WEPLAU (2012) (Woreda Environmental Protection and Land Administration and Use office), the total number of investors was 309. Different researchers stated that respondents' have homogenous characters, and the researcher limits the number of respondents for the study. In addition, the researcher considers resource and time limitation to complete the work. Thus, only 60 sample investors were assessed.

First, by using purposive sampling, two rural kebele investment sites were selected, because they are the most attractive sites for agricultural investment among the others. Second, to select the respondents from the study area probability proportionate to size method was used.

In addition 4 agricultural and rural development officials and 4 Woreda Environmental Protection and Land Administration and Use officials were selected purposely. It is very important to understand or assess the association of professionals and investors on the impacts of agricultural investment on climate change.

Finally, the 60 sample investors were drawn by employing systematic random sampling technique using Woreda Environmental Protection and Land Administration and Use office registration list. To make the sample representative, female investors were purposefully being included. i.e

$\frac{N_i}{N} = n$ where, N_i = total investors in each *kebele*

N = the sum of all the investors in the sample *kebeles*

n = sample size of investors in the study area

Table 1: Distribution of the sample investors by selected kebele

Name of selected kebele	Total number of investors	Number of investors to be selected
Metma Yohanes (Delelo)	296	57
Tumet	13	3
Total	**309**	**60**

3.3 The Nature of Data and Methods of Data Collection

The study was using both primary and secondary data. Secondary data had been obtained from Metma *Woreda*. In addition to this, information from important literatures, such as, the publications of the Central Statistical Authority (CSA), internet sources, archives, document files, research, and journal articles, different conference proceedings, and others was used. On the other hand, the primary data were obtained from personal observation, interviews, focus group discussion and household questionnaire survey.

Household survey: The survey was the main tool to obtain detailed information from each of the sampled investors through structured questionnaires that include both close-ended and open response option type of questions. Generally, this household survey was expected to provide important information about the impact of agricultural investment on climate change.

Direct personal observation: Observation was made by the researcher and if possible together with Woreda Environmental Protection and Land Administration and Use officials and other voluntary groups.

Key informant interviews: It was performed through an interview with experts in the woreda agricultural office, Woreda Environmental Protection and Land Administration and Use officials, development agents in the sample *kebeles*, and the elderly people who might have accumulated knowledge about the past and present climatic trends and agro-ecology of the study area. The interview was recorded using tape records so as not to miss any piece of information.

Focus group discussions (FGD): FGD was used as a supplementary data collection instrument. The FGD is carried out before the household survey so as to make them not to be biased. This discussion was organized having 4-6 members both male and female at each sample *kebele*. Open- ended questions are prepared for guiding FGD to gather data from these selected informants. The summarized idea obtained in the discussion of the different focus groups were arranged and used to enrich and triangulate the data obtained from interview.

3.4 Methods of Data Analysis

Descriptive statistics was used to analyze the data collected in the study area.

3.4.1 Descriptive statistics

Both quantitative and qualitative data analytic methods were used in this study area. The quantitative methods include mean, percentage, cumulative percentage, median, frequencies, and the likes. The data was analyzed using averages, standard deviations and coefficient of variations. And thus, the results were displayed using tables, graphs and charts. To understand the impact of agricultural investment on climate change, Spearman's rank correlation coefficient was employed. Similarly, descriptive statistics such as frequency, crosstabs, and chi-square was used to characterize the impact of agricultural investment on climate change. The results at the end were, therefore, be illustrated by using tables, graphs, pie charts and other diagrams. Excel sheets for raw data entry and Statistical Packages for Social Scientists (SPSS) version 16 was used to analyze the data and present the findings.

3.4.2 Organization of the Study

The study is organized in to five chapters. Chapter one deals with introduction of the problem, statements of the problem, objective, scope, significance of the study, chapter two is about review of the related literature, chapter three presents methodologies of the study, chapter four discusses results of the study, and chapter five attempts to present summary of the study, conclusion and recommendations of the study. Finally, the necessary appendices are attached at the end of the paper.

CHAPTER FOUR

MAJOR FINDINGS AND PRESENTATION OF THE STUDY

The first section assesses the general characteristics of the study area, such as climate and agro-ecology, socio-economic activity and demography. The second section presents the major findings of the study area; which explore the major agricultural investment in production, analyze the trend of climate change in the study area, identify the major impact of agricultural investment on climate change and identify the local and institutional coping strategies.

4.1 Socio-economic activities

This sub-section provides baseline socio-economic data. Because of high flow of investors in the area agricultural investment was decreaseing from time to time. In addition population, arable lands were fragmented, fallows shortened, the productivity of the agriculturally suitable land declined, marginal lands and steeper slopes were encroached upon for cultivation, and trees were cut to create more land for cultivation and fuel. This led to severe land degradation. Mixed farming is the most dominant livelihood activities of the woreda. Land is the most important assets of households for the productions of crops and rearing of animals. Oxen are used ploughing. Donkeys and mules are playing significant role in transportation of people and goods. The most commonly produced agricultural investment crops were sesame, cotton and corn. (WRDO, 2007) (Table 2).

Table 2: **Major Agricultural Investment Crops in the Woreda**

Kebele	**Main Agricultural Investment Crops the study area**
Delelo	sesame, cotton and corn
Tumet	sesame, cotton and corn

Source: WRADO (2007)

As it is mentioned earlier, the woreda is predominantly rural having 5 town and 17 rural kebeles where, according to the traditional climatic classification system, 9 *kolla* (semi-arid low lands), and the remaining bereha (arid low land) regions. The target community members selected for this particular study were investors who were directly involved in the work.

4.2 Sex Composition of the Respondents

Based on the socio-economic profiles of WRDO (2007), the woreda is inhabited by a total population of 157,836 out which 92.04% were residing in the rural area and the remaining 7.96% were living in urban area. The total male and female population in the woreda is 50.2% and 49.8% respectively. Due to altitude and temperature the population distribution in the woreda was varying from place to place. The result revealed that 98.3% of the farmer's were male whilst 1.7% was female. Thus the data the majority of the respondents were male.

Among the 60sample respondents', 93.3% were in the age range below 30years; 1.3% in the range of 46-65 years and 8% were above 65. (Table3).

Table 3: Age categories of the respondents'

Age	Sample keble			
	Delelo		Tumet	
	Frequency	Percent	Frequency	Percent
Below 30	2	5.1	0	0
30-65	35	89.7	54	98.2
>65	2	5.1	1	1.8
Total	**39**	**100**	**55**	**100**

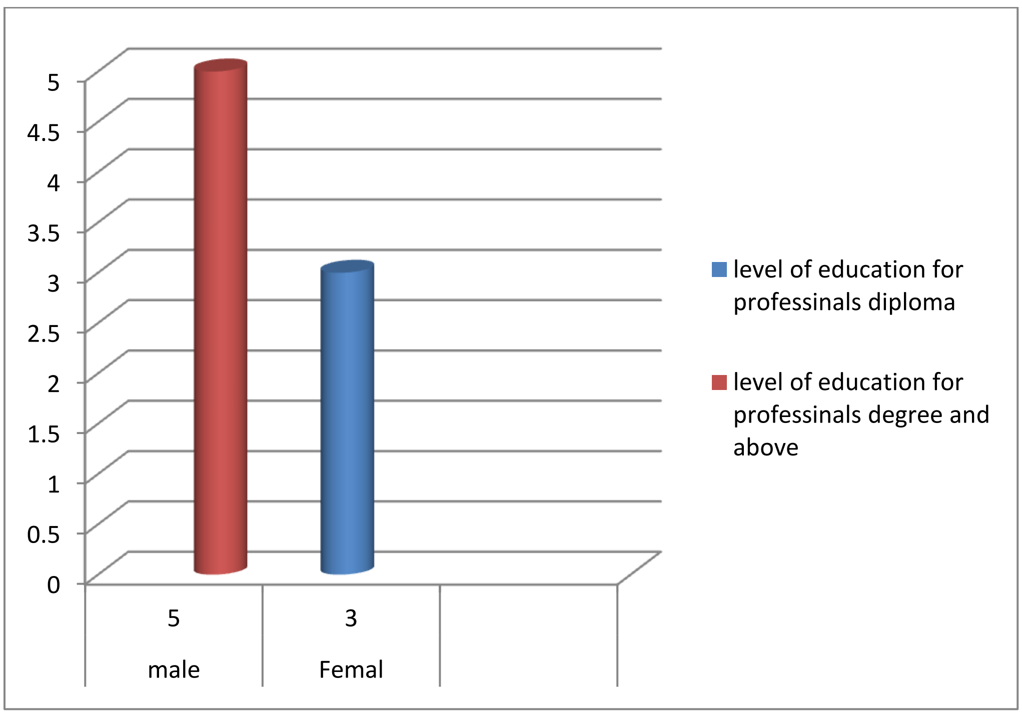
Source: survey data and own calculation

Table 4: Level of education crosses tabulation (investors)

Kebele	Level of Education							Total
	Illiterate	**Only Read and Write**	**Grade 1-4**	**Grade 5-8**	**Grade 9-10**	**Grade 11-12**	**Diploma and above**	
Delelo	0	3	8	10	7	20	**2**	**57**
Tumet	0	0	0	0	2	1	**0**	**3**
Total	**0**	**3**	**8**	**10**	**9**	**21**	**2**	60

Source: survey data and own calculation

Figure 2: Level of education of professionals



Source: survey data

With regard to education only 1.71% can read and write, 4.56% and 5.7% had attended primary school (1-4), and junior secondary school (5-8), respectively 3.99%, 11.4%, had obtained high school and preparatory education respectively and the remaining 1.14 were diploma graduates. This indicates that large proportion of investors completed high school completed. (Table5). This also implies that, a large proportion of the respondents have had attended formal educational. Among the professionals 62.5% were degree holders and the remaining diploma holders (Fig.2).

Size of Land holdings of the investor

Table 5: Size of Land holding of the investors

Farm size (ha)	Frequency	Percentage
10-20	20	33.3
21-30	25	41.7
31-40	6	10
41-50	6	10
Above 50	3	5
Total	**60**	**100**

Source: survey data and own calculation

Most investors land holding size was 21-30 ha and very few investors relatively owned very large land area (Table 5). It is very difficult to manage or control the impacts of climate change on huge land the study area. According to professionals and concerned bodies, land distributions for agricultural investment has no formal procedure to follow some investors own very huge land area while others farm small area of land.

4.3 Climate and Agro-Ecology of the study area

Climate is traditionally classified based on altitude and temperature. Topographically, the altitude of the woreda is from 980 meter above sea level to 1820 meters (Table6). Average annual temperature in the woerda varies between 10C and 38C (WRDO, 2007).

Like most parts of Ethiopia, there are four distinct seasons in the woreda, i.e winter, summer, autumn and spring (these are traditionally called Bega, Keremt, Meher and Belg respectively). Keremt or summer is the main rainy season in the woreda occurring from June, July and August and Belg season is the small rainy season occurring from February to May, which is mostly common in the woreda as well as country level but, the belg rainfall is extremely decreasing. The minimum and maximum annual rainfall distribution of the woreda ranges from 1200-1700 mm (Table 6). Due to climate change, the temperature and rainfall distribution in the woreda is highly abnormal. The decline of keremt and Belg rains together with widespread drought and famine had complicated the agricultural activities in general. Because, the woreda is predominantly dependent on rain- fed agricultural activity (ARDO, 2007).

Table 6: Altitude, Temperature and Rainfall Distribution of the study area

Major Elements	**Minimum**	**Maximum**
Altitude (M)	**980**	**1820**
Temperature (°C)	**10**	**38**
Rainfall (M.M)	**1200**	**1700**

Source: NMA (2011)

4.3.1 Trends of Climate Change in the study area

Climate change is expected to create a serious risk on environment, agricultural production and food security of most developing countries including Ethiopia. The Ethiopian climate is characterized by great variation in different parts the country and a history of climate extremes such as drought and flood, and increasing and decreasing trends in temperature and precipitation is common in the country. History of drought in Ethiopia dates back to 250B.C. Since then drought have occurred in different parts of the country at different times (Webb and von Braun 1994) even though there is a long history of drought in Ethiopia. Studies show that the frequency of droughts has increased over the past few decades, epically in the low lands (Lautfze et.al., 2003).

Literature suggests that the effectiveness of national systems for managing disaster risk in a changing climate can improved if they integrate assessments of changing climate extremes and disasters into current investments, strategies, and activities; seek to strengthen the adaptive capacity of all actors; and address the causes of vulnerability and poverty recognizing climate change as one such cause (Schneider, 2004; UNEP, 2006).This practice, might require appropriate temperature and rainfall data, information, and knowledge about the impact of climate change. Climate change shocks and extremes had resulted in a prolonged and recurrent drought in the study area. Most respondents perceived that, abnormal distribution of rainfall which are heavy and unseasonal had occurred for decades. On the other hand, the interviewed respondents perceived that the overall temperature increase and dramatic declining trends of rainfall were the common problems in the study area. Officials also confirmed the idea of the investors. However, officials and Environmental Protection and Land Administration and Use (EPLAUO) stated that the challenges are more severe in the lowland (kolla) and arid (beriah) agro-zones.

4.3.2 Analysis of Meteorological Data on Rainfall and Temperature

4.3.2.1 Rainfall data analysis

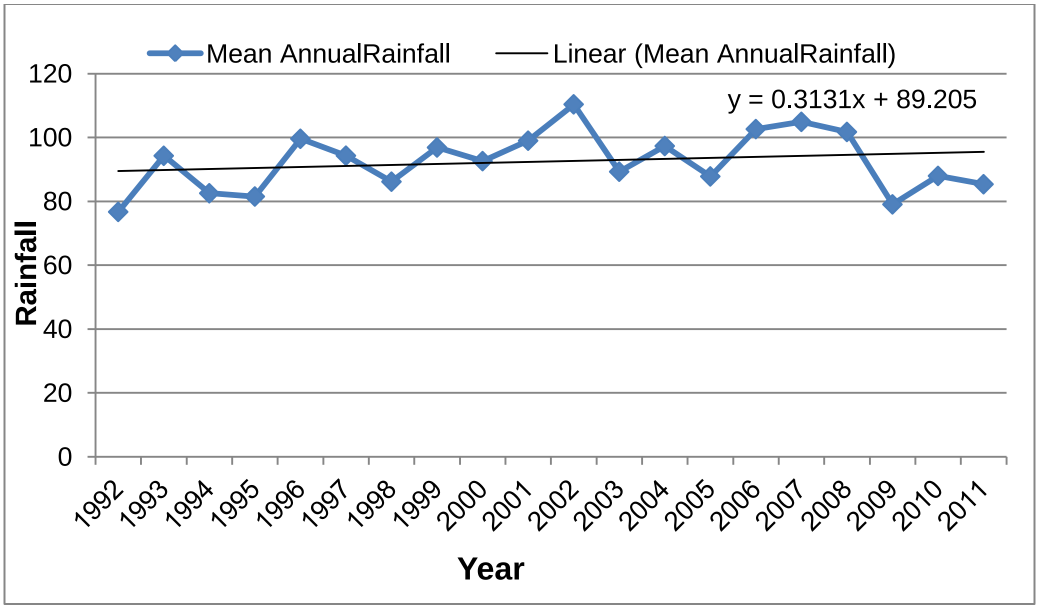
Different studies had indicated that the mean temperature and precipitation have changed over time. According to NMS (2001), average annual rainfall of the country showed a very high level of variability over the past years, even though the trend remaind more or less constant.

The main rainy season of Lay Metema is during June to August and contributes up to 76% of its annual rainfall. The second short rainy season from September to October covers nearly 19 % (App.6). The annual average rainfall is 1700 mm NMA (2011). Estimations from data obtained from NMA (2011) had indicated a general decline and fluctuation in the average annual rainfall between1992-2011. The seasonal and annual rainfall shows an increasing trend (Fig.1). However, we can clearly see that it is becoming highly variable from year to year. But the analysis result shows that significant increases of rainfall for a decade (2.9 mm).

The interviewed respondents asserted that, the distribution and regularity of rainfall were unusual, the main rainy season is also seen as becoming progressively shorter; it now starts later and finishes earlier than it used to and the rains in general are becoming more unpredictable.

According to EPLAUO (Environmental Protection Land Administration and Use Office), years ago, rains would normally start in the middle of May and continue until the beginning or/ and the end of September, but now it is more common for rains to start at the end of June and stopped in the middle of August. As a result, farmers are increasingly unsure of receiving enough rain to cultivate food crops.

Figure 3: Annual means Rainfall for Metema Woreda (1992-2011)



Source: NMA (2011)

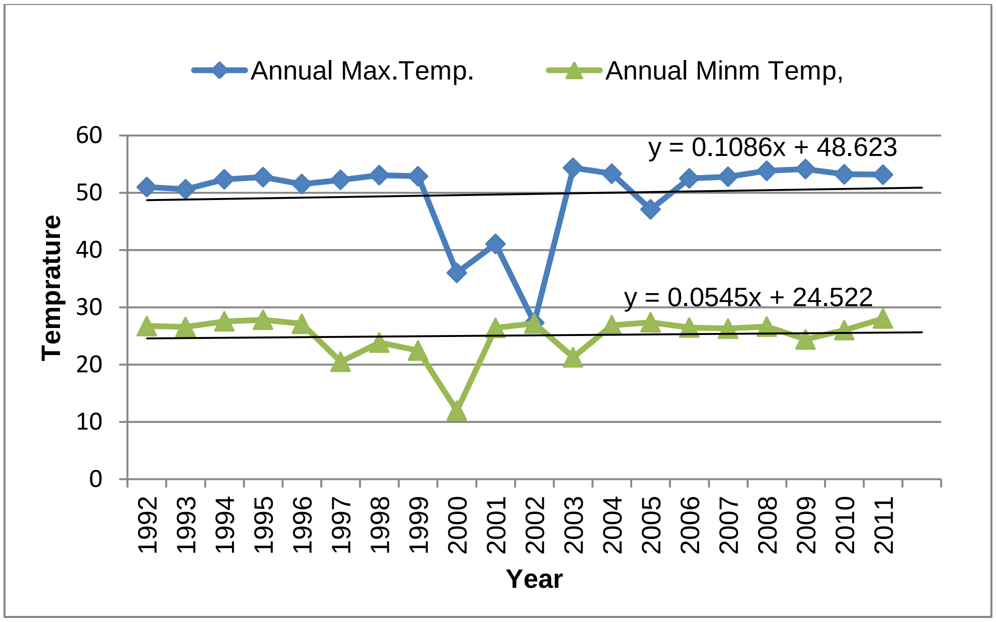
4.3.2.2 Temperature data analysis

The average annual minimum temperature over the country has increased by about 0.25 °C every ten years, while the average annual maximum temperature has increased by about 0.1°C every decade (NMS, 2007).

Another notable change often commented upon is a change in temperature. Average annual mean minimum temperature throughout the country indicates an increase of 0.37 °C every decade (NMA, 2007). In agreement with this an increasing trend of annual mean maximum and minimum temperature was observed around Metema woreda with 1.026 °C - 0.513°C every decade, respectively (Fig.. 2).

As can be seen in figure 4 below, the trend analysis of both annual mean minimum and maximum temperatures follow increasing trends. This is in agreement with the investors and the professionals (82%) in the study area towards temperature change.

Figure 4: Annual mean max. And min. temperature for Metema Woreda



Source: NMA (2011)

In summary, analysis on trend lines for temperature and rainfall by investors and professionals are in line with the analysis of meteorological data on rainfall and temperature and indicates a decreasing trend in the study area .within the woreda in general and the study area in particular, the rainfall seasons are getting shorter (late starting and early ceasing) but sometimes, with heavy and erratic rainfall the total amount of annual rainfall could be in the increasing trend. On the other hand, the amount of mean annual maximum and minimum temperature has comparatively increased. In general, meteorological data analysis and the survey data on rainfall and temperature had shown a similar trend.

4.4 Level of understanding of temperature and rainfall by investors

4.4.1 Level of Understanding of Investors onTemperature

Based on cross-sectional survey data collected from 60 investors on their understanding of the patterns of temperature and rainfall. 82% of the investors had responded that there was an increase in temperature while 3.3% of the investors observed a decrease in temperature and the remaining, 15% did not perceive any change or no temperature change at all (Table 7). Pearson chi-square test was applied in order to see assess the existing association between agricultural investment and climate change in the study area.

The result shows that there was no statistically significant variation on agricultural investment and climate change at 5% probability level.

Table 7: Temperature understanding of investors

Kebele	Respondents						X^2
	Increase	%	Decrease	%	No Change	%	
Delelu	47	78.3	2	3.3	9	15	162.8(df=2)
Tumet	2	3.3	0	0	0	0	
Total	**49**	**81.6**	**2**	**3.3**	**9**	**60**	

Source: Survey data (2013) and own calculation

4.4.2 Level of Understanding of Investors about Rainfall

With regard to rainfall, 75% of the investors perceived a decrease in rainfall and 16.7% perceived an increase in precipitation. The rest 8.3%, reported that they do not observe any change (Table 8). To explore the relationship between agricultural investment and climate change, the same statistical analysis was performed. However, the result indicated that there was no statistically significant variation on agricultural investment and rainfall for the two kebeles at 5% probability level.

In addition, almost half of the respondents, had stated that, the onset of the rains is becoming more unpredictable, as they may come early or late. The rains may stop very early and be more erosive because there is less vegetation cover. In general, increased temperature and declined precipitation are the predominant understanding of the respondents in the study sites.

Table 8: Understanding of investors rainfall

Kebele	Responses					
	Increase	%	Decrease	%	No	%

					change	
Delelo	10	16.7	42	70	5	8.3
Tumet	0	0	3	0	0	0
	10	16.7	45	75	5	8.3

Source: survey data and own calculation

4.2 The Major Impact of Climate Change on Agricultural Investment

One of the emerging challenges faced by the world's agricultural sectors is a changing climate. Climate change alters the basics of productive ecosystems, impacts on natural resources and affects food security. From a socio-economic perspective, smallholder farmers, forest dwellers, herders and fishers, groups least able to adapt, will be the most affected by climate change. Moreover, climate change cannot be effectively addressed without addressing emissions from the agricultural sectors, estimate to contribute some one-third of all greenhouse gases. As a result, there is a growing need to ensure that climate change considerations are mainstreamed into agricultural investment projects and programmes with particular interest on the linkages with and among food security and rural livelihoods (Glantz et al., 1991).

With reference to this, climate change and its impacts on agricultural investment have been global agenda for decades. It begins by looking at global climate change in general and its impact on agricultural investments in developing countries including Ethiopia has also been reviewed in many literatures.

To investigate the impacts of climate change on agricultural investment, it is better to know the level of understanding of investors and professionals.

Table 9: Major environmental problems of the study area

Problems	Kebele			
	Delelo		Tumet	
	Frequency	Percentage	Frequency	Percentage
Drought	39	65	3	5
Flood	11	18.3	0	0
Spread of different and Animal disease	5	8.3	0	0
Spread of alien weeds	2	3.3	0	0
Total	**57**	**100**	**3**	**100**

Source: survey data and own calculation

In addition to understanding of temperature and rainfall pattern, it is also very important for the investor to have a perception of the most common environmental problems. In this study, however environmental shocks and stresses are the most critical problems at the study site. Drought, flood, different plant and animal diseases and the spread of alien weeds have been the most common problems. Among the investor and professionals 70%claimed drought was the major problem (Table).

In order to assess the degree of association between investors and professionals in the issue of common environmental problems in the study area, spearman rank order correlation coefficient (rs) was computed. The result revealed that the responses of investors and professionals were highly correlated. Because t=calculated is less than (1.44) t=critical (3.182) Therefore, the value of the highest percentage were those problems highly rated by the respondents whereas problems with values of lowest percentage rankings were taken as the least preferred problems.

On the question of obtaining legal documents entitlements, 88.3% of the investors did not have any legal documents and only the remaining 11.7% had legal documents (Table 10).

Table 10: Responses to acquisitions acquisition of legal document

Responses of investors	Frequency	%
No	53	88.3
Yes	7	11.7
Total	60	100

Source: Survey data and own calculation

4.5 Coping and adaptation Strategies of Climate Change in the Study Area

Perception and understanding of climate change is a necessary prerequisite for coping and adaptation strategies (Madison, 2006; and Deressa, 2007). In the study area in particular and the national level in general, the ability of investors to cope and adapt to climate shock and extremes events are very limited due to different factors such as, lack of technological resources, lack of information on choice of adaptation options, lack of financial resources, shortage of land, poor potential for irrigation and shortage of labor force Madison, 2006; Deressa et al., 2008; Nhemachena and Hassan, 2008).

Deressa et al. (2008) had indicated that crop yield had declined by 32.8% as result of climate change associated problems such as drought, hailstorm, and flood, etc. Investors therefore, have tried to develop their own strategies to mitigate climate change. According to some authors the most common coping and adaptation methods or strategies were soil and water conservation, planting different crop varieties, change planting dates, off-farm activities, migration, change farming type (from crop to livestock and vice-versa), and adoption of new technologies. The effects of weather and climate variations and extremes in the study area in particular and the national level in general are making agricultural activities more difficult. The extended and increasing temperature, combined with the declining of rainfall and the frequency of the drought, as well as the distinct degradation of the soils, have resulted in low production and also create complicated social and economic problems.

To find out whether the sample investors had used coping strategy or not and the reasons for their choice of these strategies, investors were asked questions relating to their coping strategies and options to climate change. The respondents had revealed that the most common coping strategies in the study area were using of fertilizers and rotation system of cash croup or shifting cultivation. Among the investors interviewed, 86.7% use some methods of coping strategies while the reaming 13.3% do not use any coping strategy.

Table 11: Responses of investors on about coping strategies

	Responses of investors				
	Yes	**%**	**No**	**%**	**Total**
Implement coping strategies	52	86.7	-	-	52
No implement any coping strategy	-	-	8	13.3	8
Total	**52**	**86.7**	**8**	**13.3**	**60**

Source: Survey data and own calculation

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Ethiopia is one of the poorest countries in the world with the majority of its people are living under the poverty line. One of the major reasons why poverty is so high in the country is the economy's heavy dependence on agricultural activities. This study has focused on the impacts of climate change on agricultural investment; to identify the major impacts and coping strategies.

Based on the findings of the study, it was possible to understand that large number of investors have good understanding about the changes in temperature and rainfall. They were aware of the rising temperatures, frequency of drought and flood, the increment in the volume of rainfall, and the unpredictable and irregular pattern of distribution. Late onset and early offset of the rainy seasons has also been observed. In addition to this, the analyses show that farmers' living in lowland have been most likely affected by climate change and also highly vulnerable to an increase in temperature and decrease in rainfall.

According to survey data and interviewed results, investors understand the impacts. As a result of this, investors had tried to use some coping strategies. The main coping strategies of investors in the study area were: fertilizer and shifting cultivation or rotation of crops. The study although stated that investors who have large agricultural land, they have low capacity to minimize environmental impacts.

5.2 Recommendations

Based on the findings of the study the following recommendations were forwarded:
Agricultural investment plays a very crucial role in the economy because the sector has been shown to be an effective instrument to alleviate poverty and enhance food security. Therefore, even if the sector has played such types of roles, it has a number of environmental impacts. To minimize the impacts government and other concerned bodies must design appropriate policy and strategies that will help investors to implement coping and adaptation methods through such strategies as local awareness creation campaign,

mainstreaming climate change issues into other trainings and conducting awareness meetings.

To do this, education is found to be an important tool for the creation of awareness on climate change, their related problems and the implementation of coping and adaptation methods. However, in this study it was possible to identify that the majority of investor have limited educational background. Due to this fact investors were been resistant to accept new agricultural inputs and modern technologies. In addition, improving indigenous knowledge of coping and adaptation strategies should be distributed through meetings, farmer to farmer extension, extension agents and village level social meetings. Investment on nonfarm sector should be under take by government as well as development actors on the ground as it reduces the pressure on natural environment and improve the capacity of investors to access more level of income and then be able to afford some of the adaptation options that are somehow expensive.

Improve access to climate information in cooperating with extension service and providie location specific meteorological information through radio and other communication pathways available to investors. Strengthen extension advice, which plays a great role in promoting coping and adaptation strategies. In this regard, awareness raising and training on the issues of climate change and their related problems is crucial.

Strengthening and building coping capacities, through expanding and integrating measures in various long term national and local development sectors like agriculture, water supply, health, biodiversity, etc. Introduce appropriate technologies to the rural community (introduced diversify drought resistant and early maturing crops, building water harvesting schemes etc) .This can be done by the government offices especially, EPLAUO.

Finally agricultural investment plays a very crucial role in en the economy. Government or policy makers consider the current condition and design appropriate economic policy. It is researcher also highly recommended that, government especially local administrators should be committed to minimize on the impacts climate change on agricultural investment to. In addition, EPLAUO has responsibility to provide professional support for investors by introducing best coping and adaptation strategies through learning by doing, learning by copying, and learning from instruction.

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APPENDIX – I: Questionnaire

Indira Gandhi National Open University School of Continuing Education

Questionnaire

For investors

The main purpose of this questionnaire is to identify and understand the impact of agricultural investment on climate change and coping strategies. Since your response has great influence on the study. Your cooperation in answering the questions will highly appreciate.

Direction for the respondents':

1. Don't write your name
2. Please, give appropriate answer to the following question by putting "X" in the box and write the space provided.

Part one: back ground information:

1. Name of the village ____________________ Kebele________________
2. Sex A. male ☐ B. Female ☐
3. Level of education
   A. Illiterate ☐
   B. Only read and write ☐
   C. Grade 1-4 ☐
   D. Grade 5-8 ☐
   E. Grade 9-10 ☐
   F. Grade 11-12 ☐
   G. Diploma and above

4. Age: A. below 30 ☐ B. From 31- 45 ☐ C. From 46-65 ☐ D. Above 65 ☐

5. Marital status: A. Married ☐ B. unmarried ☐ C. Divorced ☐

Part two: For investors about major environmental impacts

1. Which type of environmental impacts do you observe after you invest this area? A. deforestation B. soil erosion C. landslide D. all E if any other----------------------------------

2. When you invest in the area, do you consider the environmental impacts?

A. yes ☐ B. No ☐

3. If your response is yes, which type of consideration you use A. based on research impacts mitigation measures ☐ B. awareness creation ☐

C. giving training to the local people ☐

D. all ☐

4. From the above alternatives, which type of action you use?

A. based on research impacts mitigation measures ☐

B. awareness creation ☐

C. giving training to the local people ☐

D. all ☐

5. Do you believe your consideration/action is effective? A. yes ☐ B. No ☐

6. If your response is yes what type of change is observed--------------------------------------
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Part three: For investors about major crop production

1. Which type of crop production you produced? A. Sesames ☐ Cotton ☐

C. Sorghum ☐ D. all ☐

2. For what purpose do you produce? A. consumption ☐ B. export ☐ C. all ☐

3. Is the area is suitable for agricultural investment? A. yes ☐ B. No ☐

4. If your response is yes/No, write the reason--

5. Is there any information about the area before you invest here?

A. yes ☐ B. No ☐

6. If your response is yes, where do you get the information? A. Government ☐

B. media ☐ C. all ☐

7. Based on your work experience, agricultural investment is profitable?

A. yes ☐ B. No ☐

8. If your response is yes, which type of crop more profitable?

A. Sesame ☐ B. Cotton ☐ C. Sorghum ☐ D. all ☐

Part four: For investors Trends of climate change in the study area

1. Do you have any climate information about the area before you invest?

A .yes ☐ B. no ☐

2. If your response is yes, what is your source of information A. Government ☐

B. media ☐ C. professionals ☐ D. all ☐

3. Is there any climate change in the area after you invest this area?

A. yes ☐ B. No ☐

4. If your response is yes, what type of climate change you observe?

A. Temperature increase ☐ B. Temperature decrease ☐

C. Rainfall increased ☐ D. Rainfall decrease ☐

E. no change in temperature and rainfall

Part five: For professionals

1. As a profession which types of crop highly produced by the investors?

A. sesames ☐ B. cotton ☐ C. shogun ☐ D. all ☐

2. Do you believe the area is suitable for agricultural investment? A. Yes B. No

3. If your response sis yes, what is your rationalities based on professions? -----------------
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4. As a professional, does the investor has legal documents to invest in the woreda?

A. yes ☐ B. no ☐

5. If your response is yes, where did you have the license?

A. from region ☐

B. from zone ☐

C. from woreda ☐

D. all ☐

6. Does the investor consider environmental impacts? A. yes ☐ B. no ☐

7. If your response is yes, what type of consideration is performed?

A. awareness creation ☐

B. developing indigenous adaptation method ☐

C. by using institutional adaptation strategies ☐

D. all ☐

E. if any other--

The following are a list of possible reasons or responses of professionals for the impacts of agricultural investment on climate change and coping strategies. Based on your experience and observation rank the items according to their contribution, indicate 5=for extremely high, 4= very high, 3=high, 2= medium and 1= low, please putting 'X' mark in front of each items

No	Local and institutional coping strategies	1	2	3	4	5
1	Changes in crop management practices (e.g., choice of fields, planting dates, planting densities, crop varieties, etc.),					
2	Livestock management practices (e.g., feeding and animal health practices, transhumance timing and destinations, etc.),					
3	land use and land management (e.g., fallowing, tree planting or protection, irrigation and water harvesting, soil and water conservation measures, tillage practices, soil fertility management, etc.),					

Interview for investors

1. What is your intention when you invest this worda?
2. Do you have any experience before you invest in this area?
3. Do you have any consideration for environmental impacts?
4. Is there any climatic and environmental change or impact observed, when you invest in this area?
5. What types of coping mechanisms or strategies used?

Interview for professionals

1. The woreda is one of the most attractive areas for agricultural investment. In your view, what are the major reasons for the investors to invest in the woreda?
2. As a professional, does the woreda have any guide line in providing investment license?
3. Based on your work experience, is there any climate and environmental change observed in the area?
4. Does the investor have been using environmental impact minimizing measure?

APPENDIX – II: Mean Annual Rainfall

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1992	0	0	2.7	51.7	80.7	86.8	249.5	218.2	117.6	79.6	11.9	21.6	76.69167
1993	0	3.5	30.8	78.5	104.2	166.6	305.4	201.9	136.6	86.7	16.5	0.5	94.26667
1994	0	1	0	7.8	84.5	156	289.4	265.9	125	37.9	20	2.8	82.525
1995	0	0	34.5	23.9	99.3	105.9	283	307.1	91.8	11.9	0.9	19.8	81.50833
1996	0	4.4	22.2	83.6	183.8	194.7	249.3	290	75.8	67.7	23.2	0.4	99.59167
1997	0	1.8	28.4	42.8	124.2	176.8	239.9	230.4	33.1	200.3	40.2	13.7	94.3
1998	0	0	10	3.7	88.5	169.2	241.3	359.5	79	79.6	3	0	86.15
1999	22.2	0	0	26.4	80.1	92.5	285.4	242.5	133.4	239.6	7.1	33.1	96.85833
2000	0	1.4	2.6	46	38.4	229.5	284.7	232.6	105.5	169.2	1.2	0	92.59167
2001	0	0.6	2.1	29.4	56	254.8	358.5	310.4	74.5	91.6	10	0	98.99167
2002	0	0	0	16.6	87.1	197.4	312.7	247.6	76.8	45.2	5.8	4.2	110.3778
2003	0	22.1	11.1	0	37.9	244.2	318.7	280.7	134.9	21.7	0	0	89.275
2004	1.6	3.7	5.9	37.6	1.4	181.4	378.3	312.3	112.4	67.6	65.7	0	97.325
2005	0	11.2	60.8	12.1	24.2	137.5	304.1	274.2	169.3	42.8	17.4	0	87.8
2006	0	0	10.8	27.8	152.6	98.7	291.5	305.3	192.5	87.4	29.9	35	102.625
2007	4.8	0	15.8	45.1	101.6	162.2	340.7	355.1	126.6	96.2	10.6	0	104.8917
2008	1.7	0	0	63.5	104.7	228.5	365.6	301.5	106.6	15.7	17.9	15.1	101.7333
2009	1.8	12.5	2.7	12.6	8	195.2	293	300.4	58.2	46.1	3.2	14.8	79.04167
2010	19.7	0	23.8	45.4	145.9	105.4	266.6	325	71.7	37.4	14.6	0	87.95833
2011	2.5	0	19.9	23.8	104.7	172.00	230.9	268	103.5	52.3	46.6	0	85.35
total	54.3	62.2	284.1	678.3	1707.8	3355.30	5888.5	5628.6	2124.8	1576.5	345.7	161	1849.853
average	5.171429	5.92381	27.05714	64.6	162.6476	319.55	560.8095	536.0571	202.3619	150.1429	32.92381	15.33333	173.5484

APPENDIX – III: Mean Maximum and minimum Temperature

year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1992	52.44375	54.38667	59.10625	58.27097	56.84375	51.30968	43.8	41.6875	46.42581	47.725	48.95484	50.96875	50.99358
1993	51.6	52.41379	56.26875	54.01935	53.2125	47.12258	43.90625	45.7375	46.79355	49.6375	52.83226	53.825	50.61409
1994	56.0125	56.63448	57.86875	59.41935	55.9375	48.04516	42.64375	43.05	47.96774	52.825	53.09677	54.68125	52.34852
1995	54.75872	56.01379	57	57.40645	56.20625	51.8	43.5875	44.30625	49.60645	53.55625	54.77419	53.66875	52.72372
1996	53.76875	57.7	57.1875	56.37419	51.54375	46.34839	45.09375	44.53125	49.07097	52.5375	52.25806	51.9	51.52618
1997	52.84375	56.48276	57.71875	56.44516	52.19375	48.64516	44.9375	47.06875	52.28387	51.7625	52.43226	54.225	52.25327
1998	54.65	56.13103	59.7	62.59355	57.00625	51.16129	44.08125	43.325	49.45806	51.0625	53.50968	54.2625	53.07843
1999	54.70625	60.32414	59.60625	60.14194	56.45	51.31613	43.6125	44.9625	49.06452	48.69375	52.87742	52.73125	52.87389
2000	55.20625	58.08667	60.64375	55.10968	56.6	50.05806	45.272	0	0	0	0	51.35556	36.02766
2001	53.17419	57.48966	56.8	59.69677	56.2129	46.53103	43.9625	41.70667	26	0	0	51.35556	41.07744
2002	0	0	0	0	0	49.144	46.22308	46.49231	50.368	53.59231	54.52	27.608	27.32897
2003	56.3125	58.54483	59.6125	61.29677	62.3625	50.94839	44.775	44.73125	48.30323	53.575	56.15625	55.61875	54.35308
2004	56.75625	57.76	60.68125	58.05806	60.325	50.11333	44.9	45.4	48.46897	50.75	53.12903	53.50625	53.32068
2005	44.20625	50.01379	48.325	49.36774	47.73125	44.64516	35.1625	38	48.97419	51.575	53.14839	54.11875	47.10567
2006	55.9875	59.4069	58.9625	58.69677	53.7875	49.02581	45.2625	44.63125	47.8	51.89677	52.32903	52.35	52.51138
2007	53.56875	56.91034	60.05625	58.32903	56.39375	47.64516	44.325	45.6625	48.96774	52.475	54.35484	54.925	52.80111
2008	56.31613	58.67931	62.19032	58.57241	54.51	48.60333	46.15806	47.24194	50.91667	52.95484	54.62667	55.14839	53.82651
2009	55	57.71724	58.02	60.46452	59.89375	53.43871	46.03226	47.1	50.73077	52.15484	55.27742	53.83871	54.13902
2010	54.6	57.65517	58.56429	59.48387	55.24667	50.09333	45.19333	45.4	50.43871	53.98	54.08	53.8875	53.21857
2011	54.55625	58.97241	57.63226	60.96935	55.125	49.55484	46.91875	45.09375	48.21935	54.18125	52.46452	54.1125	53.15002

APPENDIX – IV: Mean Minimum Temperature

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1992	356.9	337.3	488.2	493	507.1	442.8	416.9	429.8	402.4	433	387.4	361.6	421.3667
1993	344	351.6	469.7	455.5	485.9	435	429.4	417	403.5	433.1	387.9	401.6	417.85
1994	416.2	381	439.7	513.4	494.5	443.6	437.4	428.4	415	432.2	412.1	383.4	433.075
1995	413.8	391.3	449.6	501.3	506.3	452	447.8	437.6	407.9	419.4	410.7	412.7	437.5333
1996	381.8	432.8	475.9	481	485.7	428.3	431.2	423.4	410.6	401.9	391.4	382.2	427.1833
1997	369.3	386.7	476.4	465.6	465.6	433.9	438.5	451.4	96	0	0	0	298.6167
1998	349.6	321.4	412	429.2	450.1	408.4	365.5	347.2	330.2	335	321.2	431.6	375.1167
1999	0	0	0		0	366.6	370.4	372.4	335	314.8	294.4	306.9	337.2143
2000	345.7	366.6	371.8	441.6	43.8	0	0	0	0	0	0	261.6	152.5917
2001	318.9	373.4	463.2	505	502.8	412	441.4	431.6	383.5	407.4	366.9	261.9	405.6667
2002	0	0	0	494	494.3	445.7	433.7	425.4	389.2	409.5	395.7	356.4	427.1
2003	354.6	405.2	480.6	490.8	560.9	442.8	433.5	438.1	397.3	0	0	0	333.65
2004	370.8	375	478.5	484.9	520.9	442.4	418.7	420.3	385.3	405.7	393	370.9	422.2
2005	355.4	429	468.8	533.8	431.2	429.7	440.2	435.1	412.9	387.1	375	384.5	423.5583
2006	398	386.5	451.4	455.5	461.4	419.8	416.6	417.6	365.6	516.1	360.6	333.4	415.2083
2007	316.5	346.8	456.1	431.9	612.1	400.8	344.5	437.8	410	369.2	381.7	373.7	406.7583
2008	394.1	382.2	501.9	488.4	468.7	417.5	403.1	420.6	398.8	398.2	354.9	395.1	418.625
2009	367.1	239.8	0	471.1	342.9	384.1	424.2	429.9	308.5	394.5	206.6	349.6	326.525
2010	365.4	276.1	410.7	224.6	56.9	175	444.5	447.2	408.1	418.6	399.5	363.5	332.5083
2011	378.4	393.1	471.6	487.6	501.6	458.1	447.7	428.8	427.6	423.8	371	486.9	439.6833