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Climate Change and Agriculture in Ethiopia: A Case Study of Mettu Woreda

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Abstract

This paper summarizes the arguments and counterarguments within the scientific discussion on the issue of climate change and its affect on agricultural productivity in Ethiopia. The main purpose of the research is to analyze the impact of climate change on the productivity of agricultural crops. Systematization literary sources and approaches for solving the problem associate were analyzed that indicates there is a significant adverse effect of climate change on agricultural productivity as well as allied fields. The relevance of the decision of this scientific problem is that the community participation and state interventions are required at grass-roots level. Investigation of the topic of climate change and agriculture in Ethiopia in the paper is carried out broadly in the following logical sequence at an appropriate empirical standard level. Methodological tools of the research methods were descriptive statistics and the year of research was 2018-19. The object of research is the chosen for Ethiopia as a whole and case study was carried out in Mettu Woreda to verify the significance. The paper presents the results of an empirical analysis of quantitative data, which showed that there is an adverse effect of climate change on agricultural productivity in the region. The climate change affects agricultural productivity and production through shortening of maturity period and to decreasing crop yields, changing livestock feed availability, affecting animal health growth and reproduction depressing the quality and quantity of the crops, changing distribution rate, contracting pastoral zones, expansion of tropical dry forests and expansion of desertification etc.The research empirically confirms and theoretically proves that highlights the coordination between state and local communities are required to combat the adverse effect of climate change. The results of the research can be useful for policy maker, researchers, academicians and other international organizations like UNEP and UNDP etc.

Keywords: climate change, random sampling, descriptive statistics, crop productivity, food security and livestock.

JEL Classifications: Q15, Q54.

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1. Introduction

1.1 Background of the Study

Global Climate change has an adverse impact on production in particular effects on economy a leading factor affecting, especially, rainfall crops yield. It is likely to exacerbate the demand for irrigation water (Adams etal, 2007). CO_2 increase and crop production: Carbon dioxide is a principle resource for plant growth as such as, the ongoing increase in its conversation. According emerging as one of the most serious threats that humanity may ever face hence it has recently become a pressing issue in various development environment and political forums at the National, Regional and International levels. Many Regional summits worldwide have dedicated discussion sessions on climate change based on the recognition that the global climate change has an adverse impact on a nation's economy in general, and agricultural production in particular Intergovernmental Panel on Climate Change (IPCC, 2010) E.C.

Although no country is immune from the potential impedes of climate change the impacts are highly significant in developing countries which have contributed least to greenhouse gas emissions. The adaptation refers to activities that make people, ecosystems and infrastructure less vulnerable to the impacts of climate change.

This includes things like building defenses to protect coastal areas from rising seas, switching to drought or flood resistant crop varieties, and improving systems to warn of heat-waves, disease outbreaks, droughts and floods (Shanahan et al., 2013). These countries have limited adoptive capacity as compare to the developed countries because of their financial resources, skills and technologies, high level of poverty and their excessive reliance on climate sensitive economic sector such as agriculture.

Agricultural is the dominant sector of the Ethiopian economy it is also fundamental instrument for poverty alleviation, food security and economic growth (WFP 2009). However, this sector continues to be undermined by land degradation, population pressure, and low agricultural productivity. Particularly in Ethiopia, the climate change brings particular risks to poor farmers who largely relied on agricultural crop production and pastoralist. Climate change is anticipated to accelerate the land degradation in Ethiopia (Pender B, 2007). G.C

Especially to Ethiopia, the climate change affects agricultural production through shortening of maturity period and to decreasing crop yields, changing livestock feedavailability, affecting animal health growth and reproduction depressing the quality and quantity of the crops, changing distribution rate, contracting pastoral zoneis, expansion of tropical dry forests and expansion of desertification national meteorology agency (NMA, 2007). The researcher case study area of Mettu woreda is one of the rainy areas in the south western Illubbabor zone, where total population entirely depends on agriculture and livestock production. It has vast number of animals, fertile land and different crop production. Climate-induced recurrent pressures later made it a common experiment among Borana pastoralists primarily to avoid livestock selling required for supplementary cereal purchases in the widely pressing circumstances of declining milk yields (Wassie and Fekadu, 2014).

Climate change poses huge challenges to the global economy and to social development. Its impacts will disproportionately affect Sub_Saharan African countries such as Ethiopia because of their economies is highly dependent on climate sensitive activities such as rainfed agriculture. In Ethiopia, agricultures about 47% of the country's Gross domestic product (GDP) and more than 70million that is people (85% of the Ethiopian population) depend on agriculture directly or indirectly for their livelihoods (Index Mundi, 2014).Therefore, any effect on agriculture will significantly affect the Ethiopian economy. It is predicted that climate change will lead to recurrent droughts and reducing the amount of land that can be used for agriculture and consiquently decreasing crop productivity. Ethiopia is the home to Africa's largest livestock population, and is the world's tenth_largest producer of livestock and livestock products (Macdonald and Simon, 2011), which make up about 10% of the country's foreign currency earnings (Pantuliano and Wekesa, 2008).Frequent and extensive droughts in the country have a considerable effects on Ethiopia's livestock. Decreased rainfall shrinks the availability of water resources and reduces the productivity of grassland. The number of animals per household declined on average'to three oxen from ten; to seven cows from 35; and to six goats, down from 33'(MacDonald. and Simon, 2011).Climate change is expected to increase the surface of temperature of the earth and the ocean, raises the sea levels, alter the global distribution of rainfall, affect the direction of ocean currents and major airstreams, and increase the intensity and frequency of extreme weather. It is already causing loss of life, damaging property and affecting livelihoods in all the nations. However the impact will be higher on low_ income countries (LDCs). Mixed crop_live stock systems are prevalent in much of the developing world (Herrero e al., 2010), and climate change and changing climate variability in the future may affect the relationship between crops and livestock in the landscape in many places. In places that will become increasingly marginal for crop production, livestock may provide an alternative to cropping system. Such type of transitions could be occurred up to 3% of the total area of Africa, largely as a result of increases in the probability of season failure in the drier mixed crop_livestock systems of the continent; these are projected to increase from the current rate of approximately one year in five to one year in four or three, depending on the combination of emissions scenario and climate model used (Jones&Thornton, 2009).Changes in climate variability and in the frequency of extreme events may have substantial impacts on the prevalence and distribution of pests, weeds, and crop and livestock diseases. Crop production is a branch of agriculture that deals with growth crops for use as food and fiber (WFP 2011). Degree programs in crops production are available at undergraduate and graduate levels. Graduates are eligible for a variety of agriculture careers. Crop production includes grains, cotton, tobacco, fruits, vegetables, nuts, and plants. Different crops grow best in different areas of the country. Warmer climates are ideal for growing citrus crops, Northern states are best for growing apples and blue berries and the mid West ideal for growing grains, including wheat crop producers usually work from sunrise to sunset during planting and harvesting seasons. Crop production depends on the

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availability of arable land and is affected in particular by yields, macro economic uncertainty as well as consumption patterns; it also has great accidences on agricultural commodities'

Prices. The importance of crop production is related to harvested areas, returns per hectare (yields) and quantities produced. Crop yields are the harvested production per unit of harvested area for crop products. In most of the cases yield data on area harvested. The actual yield that is captured on farm depends on several factors such as the crop's genetic potential, the amount of sunlight, water, and nutrients absorbed by the crop, the presence of weeds and pests. Crop production is measured in tonnes per hectare, in thousand hectares and thousand tonnes.

1.2. Statement of the problem

The impact of climate change on agriculture in developing countries is day by day increasing. As a consequence many African countries whose economies are largely based on weather sensitive agriculture are vulnerable to climate change. This vulnerability has been demonstrated by the devastating effects of recent flooding and various prolonged drought in the 20th century. It is widely recognized that climate change and occurrence of extreme weather conditions among the major factors affecting the agricultural production, and higher temperature and changing precipitation levels cause to climate change would decrease crop yield in Africa Haile, A. (2005).E.C. Ethiopia is one of the least develop one country in the world, with a Gross Domestic Product (GDP) of US & 47.53 billion and population of 94.1 million NBE, (2006). At present the contribution of agricultural in GDP, and for the large majority of the employment. More over the sector is dominated by the small scale farmers who arender were employed largely on rainfed Agriculture and traditional practices a state render Ethiopia as a highly vulnerable to climate change. According to World Bank WB (2007) Estimate change in Ethiopia is projected to reduce yields of the wheat staple crop by 33% in the coming years. This amount to a serious threat is food security as well as constraints to achievement of major development goals. Rainfall variability is an important characteristic of climate change in Sub_Saharan Africa that imposes crop production risks, especially on rainfed subsistence cultivation systems on marginal land. Water availability is the most critical facter for sustaining crop productivity in rainfed agriculture. Even if a drought tolerant trait is introduced, water is not available to crops; because of rainfall variability from season to season greatly affects soil water availability to crops, and thus poses crop production risk. Ideally, crop irrigation 94.1 million depletion of water on ground. Subsistence farming can be found in a wide range of environmental conditions from very suitable to marginal lands.Variability in seasonal rainfall (I.e, the accumulated amount of rainfall from the planting to the harvest of a crop) is higher in the areas with smaller amount of rainfalls. Concerning the impacts of climate change inthe area research of study, by high altitude regions such as mountainous lands in Ethiopia and Kenya, where temperature is the limiting facter for plan growth, arise in temperature possibly wil increase crop yield, but in lowland areas, will increase the risk of water stress(Thornton et al.2009).Precipitation variability due to climate change results in increased irrigation water demand(Nelson et al.2009).In addition, precipitation variability is expected to intensify the magnitude and frequency of flood and drought events that are both detrimental to agricultural industry.(pachuari and Reisinger 2007).These events will likely further decrease crop water availability and threaten the productivity of the rainfed agriculture system in east Africa. The study area of Mettu woreda is one of the rainy areas a high proportion of rainfall in the country, and the rainfall is evenly distribute, and the total population is entirely depending on agriculture and livestock production in Ethiopia. The agricultural activities are chronically affected by climate change. Result shows that the productivity of crop production, livestock, and degradation of resource are high temptation over the period of time. The large number of population in the worked is engaged in the primary economic sector activities mainly on agriculture. It is evident that due to illiteracy, and poor human skills identify the impact of climate change on crop production in Mettu woreda. More over since there is no documented study that were conducted specifically targeting the impact of climate change on crop production in Mettu woreda reluctant availability concerning the findings to the same problem and this study would have to bridge gap. However there is not enough discussion on how to solve the problem of climate variability affecting the sensitivity or biological, food system in primary sector agriculture, and food security.

1.3. Objective of the study

1.3.1 General Objectives

The general objective of this study was to analyze the impact of climate change on agricultural crop production in the Mettu Woreda.

1.3.2 Specific Objectives

The specific objectives of the study are as follows:

- To access the impact of climate change on agricultural crops in the study area.
- To access the impact of climate change on livelihood in the Mettu Woreda.
- To intimate the policy of adaptation strategies of climate change to farmers' for avoiding adverse effects of climate change.

1.4. Research Questions

That study would try to excel the answer following questions:

1) What was/were the impact of the climate change on crop productivity?
2) What was the impact of climate change on livelihood in the Mettu Woreda?
3) What were the major climate change adaptation strategies were being implemented by the Households?

1.5. Significance of the Study

The study would provide important information regarded by the provision of how to tackle the adverse impact of climate change on agricultural crop productivity and livelihood in the study area. It has also to provide an input for policy makers to modify the policy of climate change as according to the problems at grassroots level in the country. Furthermore, the study would be helpful for researchers, academicians, farmers and students to identify the problem of climate change and sustainable development.

1.6. Scope of the study

Scope of the study pressured on impact of climate change on crop production in Mettu woreda. That study was limited only to Mettu woreda because of attempted to analyze the agricultural crop production farmers to facilitated accessibility which comes beyond the researcher. So, due to these and other constraints the study was not settled the whole or some party of the woreda.

1.7. Limitation of the study

Because of many constraints this study was also not without limitations. The main limitations to be faced by researcher was to collected correct information/data on an impact of climate change on agricultural productivity over the period of time at local level particularly in Mettu Woreda. Moreover, the study have to be based on only limited systematic sample of peasant in the research area and consequently the study would have to suffer from correct information to some extent because of many hidden and unhidden problems like illiteracy, the knowledge about climate change by the respondents, lack of time and money, lack of literature available etc.

1.8. Organizing of the study

This study would have been organized into three chapters like chapter one emphasis the introduction of whole study included the background, statement of the problem, objectives of the study, research questions, significance, scope and limitations of the study. However, the second chapter deals with review of literature which included theoretical and empirical literature review. The third chapter is related to data sources, determination of sample size and research methodology to be used to analysis the data and interpretation.

2. Literature review

2.1. Theoretical Literature Review

2.1.1 Definitions and Concepts

Climate: climate usually defined as the average weather or more rigorously as statistical description in terms

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of the mean and the variability of relevant quantities over 30 years, as defined by World Meteorological Organization (WMO.2007).

Weather: is a short term phenomenon, describing atmosphere, daily air temperature. Pressure on humidity, wind speed (IPAC, 2007). E.C

Vulnerability: the characteristics and circumstance of community, system or asset that make it susceptible to damaging effects of hazard United Nations Framework Convention on Climate Change (UNFCC 2010). G.C.

Climate variability: variation in mean state and other satisfied (Fleineal, 2007) E.C.

Climate change: A change in the state of climate that can be identified (example by using satisfied tests) by change in the mean or variability of its properties and that exists for an extended period, typically decades or longer.

Climate change can be due to natural internal process or external force to persistent anthropogenic changes in the composition of the atmosphere or in land use (IPACC, 2008). E.C.

2.1.2 Theory of Climate Change

The theory of climate change that most people are familiar with is commonly called anthropogenic (man-made) global warming or AGW for short. That theory holds that man-made greenhouse gases, primary carbon dioxide occurred many years' age (Joseph.B, 2010).

At least seven theories of climate change enjoy some support in scientific community. With the anthropogenic global warming theory, this booklet identifies seven theories, anthropogenic Global warming with other five that do not claim man made emission is the major cause of climate change. The five alternative theories are as follows:

Bio thermostat- raising temperatures and levels of carbon dioxide in the atmosphere trigger biological and physical responses that have cooling effect, like a natural thermostat.

Cloud formation and albedo: -changes in the formation of albedo of clouds create negative feedback that cancels out all or near all of the warming effect of the higher level of the carbon dioxide.

Human forcing besides greenhouse gases: - man kind greatest influence on climate is not its greenhouse gas emission but its transmission of earth's sure face by clearing forests, irrigation deserts and building city.

Ocean currents: global temperature variations over the past century where due to the slowdown of ocean's Thermo-hyaline circulation. Planetary motion: natural gravitational oscillation of the solar system included by planet's movement through space drive climate change. Joseph bats (2010) E.C.

Solar variability: changes in coronal ejection's and magnetic fields of the sun cause changes in cloud formation, ocean currents and wind, (Joseph bast 2004) E.C.

2.1.3 Climate Change and Agriculture

High temperature reduces rainfall one side and increase rain fall variability consequenting reducing crop productivity that affects food security in low income (LDC) and agriculture based economy like Ethiopia thus the impact of climate change is determined to countries that depends on agriculture as the main live hood (Edward Jones 2007). Climate change causes climate variability of temperature and precipitation as well as the frequency and severity of weather events direct effect the climate change includes change in solid moisture land and water condition, change in frequency of fire and pest infect and the distribution of disease, the potential for system to sustain advert impact on agriculture is determined by its capacity to adopt the changes (Mohan and Rob, 2006) .E.C. Vulnerability is not the same for populations living under different social, economic, political, institutional and environmental conditions. For example, pastoralists in Yabello Woreda tend to be more vulnerable to climate change than farmers (Oxfam international, 2010).

Climate change has the potential to undermine sustainable development, increase poverty the realization of the millennium development goals. In June 2007 report by the United Nations Environment Programme (UNEP) suggested that the confl ict in Darfur has in part been driven by climate change and environmental degradation. An effective way to address the impact of climate change is by integrating adaptation measures in to just amiable development strategies,

So as to reduce the pressure on natural resources, improve environmental risk management, and increase the social welfare of the poor. Climate changes can influence human directly, through impacts on health and risk of extreme property on lives, liveholds and human settlements and directly through impacts on food security and the availability of natural resources too.The bio physical effects of climate change on agriculture includes changes in production and price which plays an autonomously, altering crop mix input use production food demand, food consumption and trade (Oxfaism, A .2006 E.C).

Climate variability are type of changes (temperature, rain fall, assurance of extremes) magnitude and rate of climate change that cause the impact on the area of the public health, agriculture, food security forecast settlement, energy, industry and financial service, changes physical and socio economic system have been identified in many regions United Nations Framework Convention On Climate Change(UNFCC,2008 E.C).Variability is the degree to which stem (such as socio ecological system) is likely to be wounded or experience herm or stress in the natural or social environment (Kinsperson et al .2003 E.C).

2.1.4 Ethiopian Agriculture

Ethiopian agriculture is predominantly agrarian society and the majority of population in the country is engaged in the agriculture. For Agriculture in Ethiopia contributes 4% in GDP, and account about 80% of export and 80% the labor force employment. Ethiopian has a great agricultural potential because of its vast areas of fertile hand, diverse climate generally adequate rain falls and large labor force. Inspite of these potential, however, the Ethiopian agricultural remained under developed because of Drought, which has persistently affected the country since the early 1970‘s and poor economic base (low productivity, week infrastructure, and low level of technology yet agriculture is the country most promising economic sector) (Demeke and Ferede, 2005 E.C).

Ethiopian farming largely produces only enough food for the peasant holder and their finally for consumption, having little for selling crops are the major production and source of food in the country since most of the habitates in the country depends on agriculture. Therefore, all famines occurred in Ethiopia attributing to crop failures.

The major problem of crop production in Ethiopia is the low productivity due to the lack of irrigation on infectious disease and insects control, heavily dependencey on the rain fall and shortage of techniques for proper conservation and utilization of water for full and supplemental irrigation caracal stage of crops (Degefe, T., 2004 E.C).

2.1.5 Climate Change and Agriculture in Ethiopia

The agriculture sector in Ethiopia is dominated by small u farmers who employee largely rain fed and traditional practice stage which renders Ethiopian highly vulnerable to climate change According to the world bank WB (2007), The Climate change is projected to reduce shield of maize staple crop by 3_19% in Ethiopia (Jones and Thornton e tal, 2009).These amount a serious threat to food security and to achievement of the major development goals. The rain fall and temperature are important determinates of crop harvest and unfavorable realization of either the amount or of crop harvests, and unfavorable realization of either the amount or the temporal distribution of rain fall triggers food short age and famine. Due to low rates of adoption, most of the promoted practices have been only partially successful. In some cases, dis-adoption or reduced use of technologies has been reported (Tadesse and Belay, 2004).

The recent mapping on vulnerability and poverty in Africa put Ethiopia as one of the council most vulnerable to animate change with the least capacity to respond (Beau and holden, 2008). Indeed, Ethiopia has experienced at least five (5) major nation’s drought since 2001 (Yusuf et al: 2008). Cycles of drought creates poverty traps for many households, country easy tasks to build ups assets and increase income. Survey data shows that between 2001 and 2004 more than half of all households in the country experienced at least one major drought shocks. These shocks are major cause of translate poverty had households been able to smooth consumption and then poverty in 2004 would have been at least 14% lower and translate in to eleven million fewer people below the poverty line. Food shortage and famine associated with rainfall cause situation of high dependency on international food aid. Ethiopia is one of the larger food receipt countries in Africa that accounts to 20-30% of all food aid to sub Saharan Africa (Bezu, w .and Holden, T. 2008 E.C).

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2.1.6 Climate Variability and Observed Trends in Ethiopia

Base line climate that was developed using historical date of temperature and precipitation from 2001-2004 for selected station Showed the year. The year variation of the rain falls for the period from 2001-2005 over the country expressed in terms of normalized rain fall average for 42 stations (NMSA, 2011). E.C

The country during this period 2001-2005 has experienced both dry and wet years over the last 54 years. Annual rain fall is likely to decrease through most of the African regions, with exception of Africa, where annual rain falls projected to increase.

Trend analysis of annual rain fall in Ethiopia shows that rain fall remained more or less constant when averaged over whole country, while declining trend has been observed over the northern and south western Ethiopia Intergovernmental Panel on Climate Change (IPCC, 2010). E.C

As mentioned in National Meteorological Agency (NMA, 2007) the year to year variation of annual minimum temperature with in Ethiopia for period of 2001-2005 is experienced in terms of temperature difference from the mean and average over 40 stations. The result shows that a country has experienced both warm and cool year over last 54 years. However, the recent clearly revealed that there has been a warming trend in the annual minimum temperature over the past 54 years. It has been increasing by about 0.37 0c every 10 year.

2.1.7 Rainfall and Temperature Variability

The rain fall is highly variable both in amount and distribution across region and season (Tesfaye.k, 2003). The seasonal and annual rain fall variations are result of macro scale pressure system and monsoon flaws which are related to the change of pressure system (Haile, 2005). The special variation of the changes in the intensity, position and direction of movement of their rain producing systems over the country (Temesgen .T, 2000) More over spatial distribution of the rain fall in Ethiopia is significantly influenced by topography which has also many unexpected right valleys. Central lift valley is one of the environmentally very vulnerable areas in Ethiopia. Being a closed basin relatively small international inland and water resource as have far reaching consequences for ecosystem, goods, service and potentially undermine the sustainable use of the area water for agriculture and industry (soda ash production). The water level of the lake has retreated 5 to 6 km thus reducing in the lake's size is about half of its origin size (Attained .Al 1992). E.C

2.1.8 Projecte Climate Change in Ethiopia

Over the coming decades, climate change is projecte to Ethiopia lives of billions of people around the world. Under the Productive Safety Nets Programme (PSNP) more than 7 million people have benefited from the PSNP, enabling them to meet consumption needs, reducing the risks they faced and providing them with alternative options to selling productive assets. While the PSNP has had significant impact, challenges remain (Guush B, et al. 2011).No region or country is invulnerable to its impacts: however, the extent of vulnerability differs widely. projected climate changes could not only have serious environmental, social and economic implications but implication for peace and security and migration, how the specific impacts of climate change will depend on the climate variance and change its experiences as well its geographical, social, cultural, economic and political situation. Like many sub-Saharan African countries, Ethiopia is facing climatic changes that are expected to have long range impacts on its food supply, United Nation Development Programme (UNDP, 2010).

As the result, countries require a diversity of adaptation measures that reflect their unique circumstance, National Adaptation programmed of Action (NAPA, 2007). E.C. Future climate change cannot be adequately predicated without a sound understanding of the feature expectation of the emission and concentration of greenhouse gases in the atmosphere, which will depend on socio economic trend including population and economic growth, technological changes and energy demand (Aschalew. A, 2007). E.C.

According to National Meteorological Agency (NMA, 2007) climate projection for Ethiopia have been generating using the software MAGICC (model for assessment of greenhouse gas include climate change) regional and global climate scenario generator coupled model for their period centered on the year 2030-2050 and 2080.

2.2. Empirical Review

Recardian model to estimate the impact of the climate change in US agriculture using cross sectional data for about 3000 regions in US (Mendelssohn, et am, 2007). Their result shows that estimate has complicated effects on specifically they found that increased temperature is likely to reduce average from values, but increased perception by corresponding 8% average leads to loss in land value from warming to an annual neighborhood damage of 4.5%. However, the same policy change scenario results in a 1% gain when the crop revenue approaches.

A number of studies that employed the Recardian approach have supported by an advert impact of the climate change on agriculture used from level data to examine and the agricultural impacts and adoption of climate change in India (Meudelsolin, etal, 1994). They found that the diverse climate change would lead to huge losses in India they found that diverse climate change would leads to huge losses in agricultural revenues even if farmers where to adopt their farming practices to climate change (Brohan et at., 2006).

It is founds that combination with increasing carbon dioxide, temperature and rain fall is likely to have adverse effects on agricultural production in Tunisia (Etesian, etal, 2010). This results supports findings by (Rosen Weig and Parry, 1994) who found that increased temperature and carbon dioxide reduces production in India, because of the lack of African studies sensitivity for us. Their result shows that the most pessimistic forecast implies that African countries may lose 47% of their agricultural revenue because of global warming, while across sectional forecast supports of only 6% agricultural revenue. With the expected fall in contribution of agriculture to GDP overtime the Authors conclude that the damages from climate change to African agriculture may be expected to range from 0.13% to 2% of GDP by 2100.they further ague that every region in Africa will experience some negative climate changes impact. They conclude that climate is an important determinant of house-holds welfare, and therefore that providing new technology and capital may be effective strategy for increasing rural income in hostile climate region.

Used the Rechardian model to analyzes the impact of climate on south African sugarcane production, using time series data for both irrigated and dry land farming (Deressael, 2005).The authors show that climate change has significant nonlinear impacts on next revenue with higher sensitivity future increases in temperature than precipitation. Further they found that doubling carbon dioxide, which leads to rise in temperatures by two degrees Celsius and precipitation by seven degrees, would have negative impact on sugarcane production. They also found that irrigation in sugarcane production does not provide an effective option for reducing climate change in South Africa. Also used the Rechardian approach to analyze the economic impacts of climate on major South Africa field crops they found that crop is quite sensitive to marginal

Charge in temperature compared to charge in precipitation (Hassan, etal, 2005). Country to findings by they argued that irrigation would been effective adaption of erasure for limiting the harmful effects of climate change is agro-ecological zones specific and therefore that location is very important in dealing with climate change issues(Peressaetal, 2005). Climate change poses huge challenges to the global economy and to social development. Its impacts will disproportionatly affect Sub-Saharan African countries such as Ethiopia because their economies are highly dependent on climate- sensitive activities such as rain-fed agriculture. In Ethiopia, agriculture contributes about 47% of the country's Gross Domestic Product (GDP) and more than 70million people (85% of the Ethiopian population) depend on agriculture directly or indirectly for their livelihoods (Index Mind, 2014). Therefore, any effect on agriculture will significantly affect the Ethiopian economy. It is predicted that changes in climate will lead to recurrent droughts and heavy rainfall in different parts of Ethiopia, reducing the amount of land that can be used for agriculture and decreasing crop productivity. For example, the 2006 flood in Gambela region damaged about 1650 hectares of maize and reduced crop productivity by 20% farm land (Gambela region Disaster Prevention and Preparedness Agency, 2007). This meant a loss of income for the country and also exacerbeted food shortages and malnutrition problems in the region. The impacts of climate change on the environment could also reduce the national income from the export of agricultural products such as coffee, pulses, and flowers. Of particular concern is the possible impact on Ethiopia's famous Arabica coffee, which is exported all over the world. Coffee plants are very sensitive to climate change and there are concerns that Arabica coffee production could become imposible in Ethiopia by the end of this century if the change continues at the current rate (Mac Donald and Simon, 2011). The above proplem is crucial and this gab will tried proved the most important element of vulnerability while using of climate

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change Adaptation and Metegation method at various levels of decision making from the individual up to the regional and national.

3. Methodology of the study

3.1. Description of the Study Area

Mettu woreda was one of the district had a toal area of 68723 hectare which was the 5th largest district in the South Western part at the distance of 575 kms from Capital City of Ethiopia, Addis Ababa. Illubbabor zone oromia region bordering bacho and hurumu in the east, harugure in the west, and bilonopha in the north and Aalle in the south, Mettu was the centeral town of Mettu woreda. The district had rugged land forms dominated by district mainly experience sub_tropical (W\Dega) and temperate (Dega) types of climate condition. The altitude range of this woreda was 1625 m (meters) above sea level. And also average annual rainfall and temperature of this Mettu woreda was 1850 mm, and 16°c-22°c respectively. The rivers in the district area were konori, sori, duqur, and kabar. All were tributaries of the Sor River. The dominant soil types were silt, clay and nito. There were parks, game reserves or sanctuaries for Wilde life conservation such as: buffalo, tiger, hyne, monkey, ape, and pig. Mettu Woreda had estimated population of 91,049 from whom, 40200 were female, and 50849 were male. As agricultural Mettu woreda office (2018) G.C there were 29 kebeles in the Mettu woreda. The farming system of the study area was classified as mixed farming, which means both crop production and livestock production account 78.5% and 30% respectively. Some major cultivated crops were produced in rainy season. The crops produced in the area of food crops such as: maize, sorghum, teff, burly, wheat, and beans. Cash crops such as coffee and root vegetable crops are also produced. The rain fall was evenly distributed and degradation of the resource was high.

3.2. Source of Data

In order to get the data, both primary and secondary source of data were used. The primary data from households by distributing the questionnaire to the respondent's Secondary data from published and unpublished written materials, journals and relevant office report.

3.3. Research Design

For the study the statistical descriptive research design was utilized. For concerning it had to be used both qualitative and quantitative data to facilitate the analysis? Both qualitative and quantitative aspects were focused on impact of climate change on crop production of the government attitude, interest, and observation towards the effective and efficient crop production in Mettu Woreda administration.

3.4. Method of Data Collection

Collected the data from both primary and secondary data sources. The primary data was collected from the households by preparing questionnaire and distributing selected respondents from the study area. The Secondary data was collected from different written materials, journals, magazine, and published and unpublished. On the other hand, focus group discussion had been conducted to obtain qualitative data. The personal observation and experience of the study help also to climate change understand the effects in the study area.

3.5. Sampling Techniques and Sample Size

The systematic sampling technique was used by the research to select the sample household in the study Mettu woreda. Since the population was very large, it was impossible to collect data from whole population. Therefore, the research used multistage sampling technique to select sample respondents. Due to the limitation of the and budget to conduct this study, the researcher systematic selected four kebeles (Tulube, Boto, Sardo, and Alebuya) from 29 kebeles of Mettu Woreda local area based on accessibility for the study and where crop production was carried on extensively. Out of (14,117) households from whom, 100 of them were systematic selected. Finally, the study was determined by using the following formula which was developed by Yamane (1967). Because of the households of from these kebeles were homogeneous by margin of error (10%).

$n= N/1+N(e)2$

where, N=Number of target population

n = sample size

e=margin of error, its value is 10%.

e = (10/100)2

= 0.1 × 0.1

= 0.01

So by solving the above formula, sample size was obtained as follows:

N= n1 +n2 +n3 +n4:

Tulube =1125

Alebuya =774

Sardo= 522

Boto =370

N = 1125 + 774 + 522 + 370

N = 2791

n=2791/1+2791×0.01

n= 2791/27.92

n= 99.96 ~100.

And also the number of sample each four kebeles was calculated as followed by using stratified sampling formula.

n1=n1×n/ n1+n2+n3+n4

n1= 1125×100/2791

n1= 40.31

n2 =n2×n/n1+n2+n3+n4

n2= 774×100/2791

n2=27.7

n3 =n3×n/n1+n2+n3+n4

n3 =522×100/2791

n3=18.7

n4 =n4×n/n1+n2+n3+n4

n4=370×100/2791

n4=13.26

Total n =n1+n2+n3+n4

Total n=40.31+27.7+18.7+13.26

Total n=99.97~100

3.6. Method of Data Analysis

The collected data was analyzed by descriptive analysis such as percentages, tables and figurative explanation. Those were chosen to analyze data due to it was easily to understand and interpret data. Also it needs less time and was simple to analyze data. Tabulation was mostly used since it facilitates easy interpretation of data collected.

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4. Data analysis and interpretation

As already studied in the methodology part of this study, primary data has been collected from sample households through questionnaire. The respondents are households from the four kebele of the Mettu woreda area. Thus this chapter covers the analysis data collected.

4.1. Demographic Characteristics

4.1.1. Age Distribution of Sample Respondents

Table 1. Age distribution of sample respondents

Age of respondents	Number of respondents	
	Frequency	Percentage
15-17	19	19%
18-39	27	27%
40-55	30	30%
>56	24	24%
Total	100	100%

Source: Household survey, 2018 G.C.

As of the above table, out of total sample households selected in the study area, 30% and 27% are found between the age group of 40-55 and 18-39 respectively. This implies that according to labor classification the majority of households that reside in the study area of economically active households. While the remaining 15-17 and >56 of the sample households are considered to be economically inactive households. This implies that age of a farm household head plays an important role on decision to produce available crop production and farmer's age also influence the availability of labor that is one of the most determinant factors of production.

4.1.2. Gender Composition of the Respondents

Table 2. Gender composition of the respondents

Sex of respondents	No of respondents	
	Frequency	Percentage
Male	77	77%
Female	23	23%
Total	100	100%

Source: Household survey, 2018 G.C.

Table 2 shows that from the total sample of households 77% of them are male and 23% of them are female. This shows that like other parts of Ethiopia households of Mettu woreda area are predominantly male-headed. Female's participation in agricultural crop production and leading family is less compared to that of males. This is due to cultural barriers which might lead to gender discrimination and this situation discriminate female headed household from participating in agricultural production.

4.1.3. Marital status of the respondents

Table 3. Marital status of the respondents

Marital status	Frequency	Percentage
Single	2	20%
Married	6	60%
Divorced	1	15%
Widowed	5	5%
Total	10	100%

Source: Household survey, 2018 G.C.

Table 3, shows that out of sample households 60% of them were married, while the other 20%, 15%, and 5% were single, divorced, and widowed respectively. Thus, the most the sample households marital status of respondents was married.

4.1.4. Family size of the respondents

Table 4. Family size of the respondents

Family size	Frequency	Percentage
<4	25	25%
4-7	42	42%
>7	33	33%
Total	100	100%

Source: Household survey, 2018 G.C.

Family size is the demographic variable that affects the social and economic wellbeing of the household's member. In view of this fact, average household size can sometimes use to reflect its implication to health and housing problems. As of table 3 the total average family size of the households in the study area is between the intervals of 4-7 which accounts for 42% out of the total sample households. This implies that households of the study area have averagely 4-7 household members. This implication is that the large family size is a typical feature of rapidly growing population.

4.1.5. Educational status of the respondents

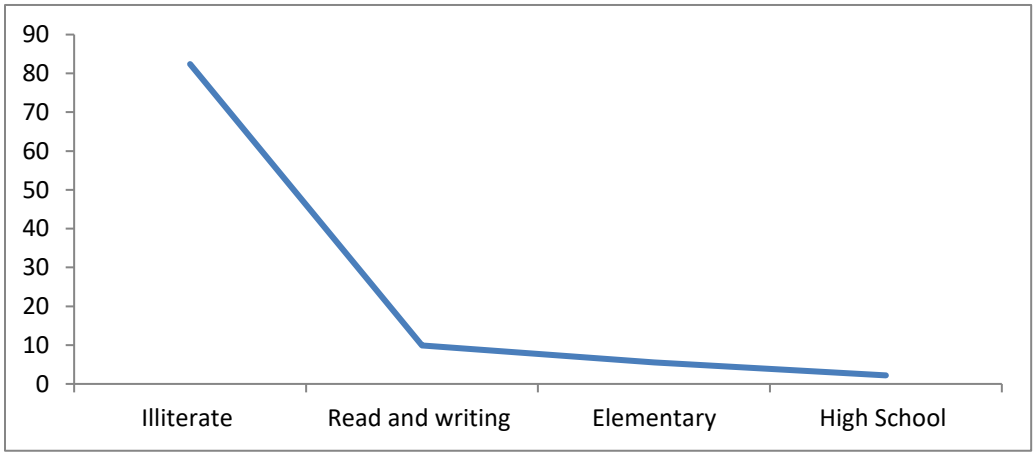

Figure 1. Educational status of the respondents

Source: Household survey, 2018 G.C.

Figure 1, which represents educational background of the respondents, 84,84% of the sampled households are illiterate while 9,9% are able write and read only. The remaining 5,5% and 2,2% of the respondents attends elementary and high school respectively. This implies that literacy level is very low in the study area. The reason of low literacy is that in the previous time there was no such expanded educational service. Moreover, in the area person is considered to be literate if he or she can read with understanding and write a short statement at least in one language. Otherwise a person is considered to be illiterate.

4.1.6. Occupational of the respondents

Table 5. Occupational of the respondents

Occupation	Frequency	Percentage
Self-employed	-	-
Agriculture	75	75%
Landless labor	10	10%
Service	15	15%
Total	100	100%

Source: Household survey, 2018 G.C.

Table 5, which shows that occupational of the respondents, 75% of the sample households were more engaged in agriculture, while remaining 10% and 15% of them were, landless labour and service respectively. Those were also, have no self employed out of sampled households. Thus inorder to live they participate occupational of the most in agriculture and also absence of the self employed is the problem of affected adversely the life

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of some households in study Mettu woreda.

4.2.0. Land holding of respondents

4.2.1. Percentage Land holding of the respondents

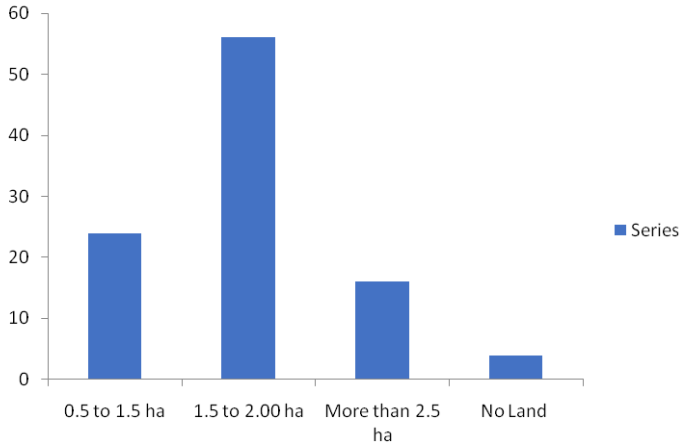

Figure 2. Percentage Land holding of the respondents

Source: Household survey, 2018 G.C.

The figure above shows out of total sampled households, 56% of them have land size 1.5-2.0 hectare while 24% of them have land size of 0.5-1.5 hectare. The remaining 16% and 4% of them have land size of greater than 2.5 hectare and no land respectively. This implies that the majority of land holding size of the sampled household is averagely found between the interval of 1.5-2.0. The study also signifies that the average total land holding is lower specially due to rapid growing population. There are also farmers who have no land which accounts for 4% out of sampled house-holds. Thus in order to live they participate in daily labor work and trading activities. The unbalanced land distribution is also another problem affecting adversely the life of some households in study area.

4.2.2. Amount of Land Used for Crop Production

Figure 3. Land used for crop production by respondents

Source: Household survey, 2018 G.C.

The figure 3 shows that most households use ½ of their land for crop production which accounts for 68% out of sampled households. While remaining 21% and 11% of them use ¾ and ¼ of their land for crop production respectively. The study shows that household in the study area use a half of their land for crop production such as sorghum and maize are predominantly produced. The remaining portion of land is kept for livestock grassing product and saved from repetitive crop production on the same plot of land in order to keep land's fertility and quality.

4.2.3. The Income Source of Households

Table 6. The income source of households

No	Farm activities	No of respondents	
		Frequency	Percentage
1	Crop production	33	33%
2	Cattle	26	26%
3	Both	19	19%
4	Nonfarm activities	-	-
5	Daily labor	16	16%
6	Trade	6	6%
	Total	100	100%

Source: Household survey, 2018 G.C.

Table 6 shows that out of sampled households 33% of them engaged in crop production while 19% of them are engaged in crop production and cattle. The remaining 26% of them are cattle production. There are farmers who are participate in nonfarm activities i.e. trade and daily laborer which accounts for 6% and 16% of the sampled households, respectively. The study implies that the majority of households of study area participation in the production of crop. Thus farmers are excessively relied on crop production, which is climate sensitive production. Thus, the most crop production, and cattle respectively was impacted by impact of climate change.

4.2.4. Crops grown in one year of the respondents

Table 7. Crops grown in one year of the respondents

Crops grown	No of respondent frequency	No of respondent percentage
Three-months	55	55%
Five-months	20	20%
Six-months	15	15%
Seven-months	10	10%
Total	100	100%

Source: Household survey, 2018 G.C.

Table 7 shows that out of the sample household 55% of the sample households engaged to the grown crops three-months. While, the other 20%, 15%, and 10% were five-months, six-months and seven-months respectively crops grown in one year area of mettu woreda.

4.2.5. Bases of cropping production pattern of the study area

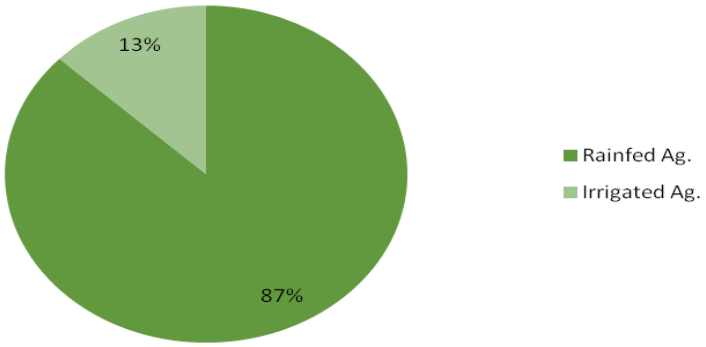

Figure 4. The bases of cropping production pattern of the study area

Source: Household survey, 2018 G.C.

From the above figure, 87% of the total households relied on rainfed agriculture agricultural production while the remaining 13% of them on both rainfed and irrigation system. This implies that irrigation system is not well practiced in the study area. This especially due to the lack of the irrigation system on available revers unavailability of revers suitable for irrigation activity. For this reason most of the households of study area engaged in rained agricultural production and thus they could able to harvest only once a year. Thus heavily depend on rain fed and traditional practice is state which renders households of the study area highly vulnerable to climate change then affected by its adverse impact.

4.2.6. Terminology of climate change in study area

Table 8. Terminology of climate change in study area

No	Question	Option	No of respondents	
			Frequency	Percentage
1	Do you familiar with the terminology of climate change?	Yes	76	76%
		No	24	24%
		Total	100	100%
2	If your answer for question no 1 yes, how do the pattern of rainfed variability in your area reveals compared to the last year?	Increasing	25	25%
		Decreasing	42	42%
		No change	21	21%
		Indeterminate	12	12%

		Total	100	100%

Table 8 (cont.). Terminology of climate change in study area

No	Question	Option	No of respondents	
			Frequency	Percentage
3	Is there any change noticed by you in temperature change if no 1 yes?	Increasing	49	49%
		Decreasing	19	19%
		No change	21	21%
		Indeterminate	11	11%
		Total	100	100%

Source: Household survey, 2018 G.C.

From the table above, question number one; which asks weather the household have heard about climate change and its impact or not. Out of the total sampled house holds 76% of them replied that they have heard about climate change and its impacts. While 24% of them have not heard. Farmers differ in their level of access to climate change information its impact from extension service and other source such as media so that they could not hear about climate change and its impacts. Regarding the second question about the pattern of climate variability 42% of total sampled households replied that annual rain fall decreased from year to year; this implies that rain fall variability is one of the challenges of crop as well as livestock production. Farmers maintained that late rain, early cessations insufficient rains are rain fall related problems affecting their crop production. Regarding the third question about the pattern of temperature can cause impact on health of human beings and livestock as well as crop production. In view of this fact; households of the study area are exposed to the risk of several climates related hazards.

4.2.7. Observe of respondents due to change in pattern of local climate

Table 9. Observation of respondents due to change in pattern of local climate

No	Option	No of respondent frequency	No of respondent percentage
1	Decrease in agricultural productivity	50	50%
2	Shortage of food and making environment more vulnerable	25	25%
3	Loss of plant species	20	20%
4	Shortage of drinking water	5	5%
	Total	100	100%

Source: Household survey, 2018 G.C.

Table 9 shows that out of sample households 50% of their agricultural productivity were decreased by the impact of climate change, while the other, 25%, 20%, and 5% were shortage of food and making environment more vulnerable, loss of plant species, and shortage of drinking water respectively impacted by impact of climate change.

4.2.8. Impact of climate change on crop productivities

Table 10. The impact of climate change on crop productivities

Degree of climate change	No of respondent frequency	No of respondent percentage
High	50	50%
Low	4	4%
Medium	46	46%
Total	100	100%

Source: Household survey, 2018 G.C.

Table 10 shows that about the impact level of climate change 50% of the sample household replied that the degree of climate change on crop production is high while nearly half 4% and 46% of them replied that is the impact of the climate change on crop production is low and medium level impact, respectively. In this study there is an ultimate change in temperature and rainfall variability according to the farmer's response to the

previous questions from table 5 and thus it could cause higher degree of climate change on crop production. However, in this case only half 50% of total sampled household replied that climate change has high impact on crop production. This is due to the reason that majority of the households have carelessly replied or they unwillingness to reply appropriate response to the question provided. More over farmers in the study area are characterized by high illiteracy rate which might be one reason for replying in appropriate response.

4.2.9. Impact of climate change on crop production

Table 11. The impact of climate change on crop production

No	Question	Option	No of respondents	
			Frequency	Percentage
1	Do you observe any impact of climate change on your crop production?	Yes	57	57%
		No	43	43%
		Total	100	100%
2	If your answer for question 1 is yes, what impacts did you observe?	Crops are sometimes failing	13	13%
		Crops are totally failing	27	27%
		Increasing the problem of drought and flooding	7	7%
		Production per hectare is decreasing	53	53%
		Total	100	100%

Source: Household survey, 2018 G.C.

Based on the table above 57% of the sampled households replied that climate change have indeed affected their crop production while 43% of them have not observed any impact of climate change. Regarding the second question about climate change impacts 53% of the sampled households observed that climate change causes crop production per hectares to decrease while 27% of them replied that it causes crop production totally to decrease. The remaining 7% and 13% of them replied that climate change causes to increasing the problems of flooding and drought and crop production sometimes to fall respectively. Farmers in the study are also mentioned that floods caused by climate change destroyed several villages, infrastructures, human life and agricultural fields during the last years. This indicates that climate change had serious impacts on crop and livestock production and cause agricultural productivity to decrease significantly.

4.2.10. Adaptation Strategies Taken to Climate Change

Table 12. Adaptation strategies taken to climate change

No	Question	Option	No of respondents	
			Frequency	Percentage
1	Is possible to adopt strategies to cope up with climate change?	Adaptation	81	81%
		Mitigation	19	19%
		Total	100	100%
2	If your answer for question no 1 adaptation, what type of adaptation strategies have you been practiced?	Crop diversification	49	49%
		Temporary Migration	18	18%
		Use of fertilizers and manure application	32	32%
		If Other specify	1	1%
		Totally	100	100%

Source: Household survey, 2018 G.C.

Table above shows about climate change adaptation under taking in the study area. It's known that adaptation to climate change is the process through which people could reduce the negative effects of climate on their health and wellbeing and adjust their life styles to the new situations around them. From the table above 81% of total sampled of households replied that it is possible to adopt strategies while 19% of them replied mitigation. Regarding the second question about types of adaptation strategies, it shows that 49%of the sampled household has practiced crop diversification as the strategy while 18% and 32% of them have practiced temporarily migration and use of fertilizer and manure application respectively.The remaining 1% of them has

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practiced other strategies to climate change adaptation. This includes changing the timing of planting based on the rainfall situation.

4.2.11. Change cultivated area of crops due to climate change

Table 13. The change cultivated area of crops due to climate change

No	Question	Option	No of respondents	
			Frequency	Percentage
1	Is there any change in cultivated area of crops due to climate change?	Yes	55	55%
		No	45	45%
2	If your answer no 1 yes, what are the crops and its magnitude of change?	Increasing	35	35%
		Decreasing	65	65%
		Intermediate	0	0%
		Totally	100	100%

Source: Household survey, 2018 G.C.

Table 13 shows that the first question 55% of the sample households of cultivated area of crops was impacted by the impact of climate change . regarding the second question, out of sample households 65% cultivated area of crops decreased by impact of climate change. Thus, the most cultivated area of crops households of respondents was impacted by impact of climate change.

5. Conclusion and recommendation

5.1. Conclusion

This study aimed at analyzing the impact of climate change on crop production the case of area Mettu Woreda and thus the following result have been concluded.As a result of demographic analyzes of the house-hold shows most of house-holds who engaged in crop production are males and their age group is between 40 and 53. The majority of house-holds who engaged in this activity found to be illiterate and have an average family size between 4 and 7. Thus this large house-hold size caused them health, housing and other problem. The analyses of study on climate change revealed that socio economic related to possible solution in controlling climate impacts plays a vital role for betterment of agricultural practice of house-holds. The size of larger land area enables them to spread their risk from adverse climate change and thereby to reduce impacts. Larger crop land area may provide better opportunities to have sufficient crop production and the possibility of growing different types of crop. Since most of the house-holds engaged in rainfed agricultural production, they would they could harvest only once a year and this can be the major reason for their crop failure. Thus the dependency of their agricultural production heavily on rainfall exposed them to induced climate change. The survey of household revealed that here has been increased rainfall variability's and temperature raise over the years. Late rain, early cessation and house-holds in study area. Due to change flooding has destroyed several villages infrastructure and agricultural fields. The majority of the house-holds have replied that the degree of climate change in crop production is quit medium. Climate change causes crop production per hectare to decrease significantly. Furthermore, it causes the problem of drought and flood to increase.The main strategies of farmers to climate change identified in study area were crop diversification, temporarily migration. Manures, fertilizers and other applications. Analyzing the different adaptation together made by all respondents that mixed farming system is considered to be one of the most important adaptation responses to climate change.

5.2 Recommendations

On the bases this study, the following recommendations have been drawn to reduce the impact of climate change on crop production of study area.

1. There is a need to support farmer's adaptation capacity and improving their crop production efficiently to overcome climate change impacts. So, the agricultural and rural development needs to support them.
2. Focus on raising awareness, knowledge management and information dissemination. The study reveals that climate change is already occurring and affecting significantly the crop and livestock production, thus their strong need to raise awareness and disseminate relevant information in order to have the understanding of multi faced impacts of climate change. This also include promote activities to enhance farmers participation on awareness creation activities as it is highly needed in the field of climate change. So the

government or private responsible institutions should be able to work on the promotional through media and others.

3. Irrigation activities are implemented in study area to overcome hazard created on agricultural sector. Thus the government or concerned body should give awareness and support them to enable to use irrigation system.
4. There were strengthened intensive natural resource conservation and rehabilitation activities. Particularly measures that conserve the environment and at the same time can generate income to support farmers were essential.
5. The majority of sampled house-holds have large family size found between 4 and 7 this shows rapidly growing population. Therefore, measures against the prevailing high population growth should be targeted strongly.

References

1. Aschalew, A. (2007).Climate change detection and attribution in tropical Africa. *Thesis submitted for the partial fulfillment of the requirement for the degree of masters Addis Ababa University*, Ethiopia.
2. Befekadu Degefe and Berhanu Nega (eds.) (2000). *Annual Report on the Ethiopian Economy*, *1*,. The Ethiopian Economic Association. Addis Ababa: United Printers.
3. Brohan et al. (2006). Uncertainty estimates in regional and global observed temperature changes: A new data set from 1850. *Journal of Geophysical Research Atmospheres*, 111, D12106.
4. Central statistical agency (CSA) (2011). Agricultural sample survey, *Report on Land Utilization Vol. IV*. Addis Ababa.
5. Derresa, T. and Hussen, R. (2005). Measuring the impact of climate change on South African Agriculture: the case of sugarcane growing regions, *Agrekon*, *44* (4).
6. G. A. Gbetibouo, Rashid M. Hassan (2004). Measuring the economic impact of climate change on major South African field crops: a Ricardian approach, *Global and Platenary Change, 47*, 143-152. DOI:10.1016/j.gloplacha.2004.10.009
7. Guush, B, (2011). Evaluation of Ethiopia's Food Security Program: Documenting Progress in the Implementation of the Productive Safety Nets Programme and the Household Asset Building Programme. Washington, DC: IFPRI.
8. Haile, T. (2005). Weather pattern food security and humanitarian response in sub-Sahara Africa, *Philos Trans R Soc Lond B Biol Sci*., *360*(1463), 2169–2182.
9. Jones, P.G., Thornton, P.K. (2003). The potential impacts of climate change on maize production in Africa and Latin America in 2055. *Global Environ Change*, *13*(1), 51-59.
10. The Intergovernmental Panel on Climate Change (IPCC 2000). Migration climate change the Working group III contribution to the IPCC fourth assessment report Cambridge University Press.
11. The Intergovernmental Panel on Climate Change (IPCC 2008). Climate change impact adaptation of vulnerability contribution of working group II to fourth assessment report of IPCC Cambridge University press.
12. Kalkidan, E.(2012). Source of risk and impact of climate change adaptation strategy on crop production. *Proceedings of the eleventh international conference on the Ethiopian economy*, vol. II.
13. Kasperson, R.E. & Kasperson, J.X. & Dow, Kirstin (2001). Vulnerability, equity, and global environmental change. *Global Environmental Risk*, 247-272.
14. Mendelssohn (2008). A Ricardian analysis of the impact of climate change on African cropland. *AfJARE, 2*(1).
15. Millennium Development Goal's (MDGS 2007). *The report of millennium development goals*. United Nations, New York.
16. National Bank of Ethiopia (2011). Annual Report VII Investment.
17. National Meteorology Agency (2007). Climate Change National Adaptation Programme of Action (NAPA) of Ethiopia, The Federal Democratic Republic of Ethiopia, Ministry of Water Resources, National Metrological Agency, Addis Ababa; Ethiopia.
18. Oxfam international (2010). The rain doesn't come on time anymore. Poverty, vulnerability, and climate variability in Ethiopia. *Oxfam International Research Report*.
19. Pender, J. and B. Gebremedhin (2007). Determinants of Agricultural and Land Management Practices and Impacts on Crop Production and Household Income in the Highlands of Tigray, Ethiopia, *Journal of African Economies*, *17*, 395–450.

20. Shanahan, M., Shubert, W., Scherer, C. and Corcoran, T. (2013). Climate Change in Africa: A Guidebook for Journalists. Fackson Banda (ed). *UNESCO Series on Journalism Education*.
21. Tadesse, M. and K. Belay (2004). Factors influencing Adoption of soil conservation measures in Southern Ethiopia: The case of Gununo Area. *Journal of Agriculture and Rural Development in the Tropics and Subtropics*, 105, 49-62.
22. United Nations Environment Programme, Sudan: post-conflict environmental assessment (Nairobi: UNEP, 2007).
23. UNDP Climate Change Country Profiles Ethiopia [Web page]. School of Geography and the Environment, Oxford University. Accessed Feb. 27, 2012 at http://country-profiles.geog.ox.ac.uk.
24. United Nation Framework Convention on Climate Change (UNFCCC, 2007a). Vulnerability and adaptation to climate change in small island developing states – Background paper for the expert meeting on adaptation for small island developing States. UNFCCC Secretariat. Bonn, Germany.<http://unfccc.int/files/adaptation/adverse_effects_and_response_measures_art_48/application/pdf/ 200702_sids_adaptation_bg.pdf> UNFCCC.
25. Wassie, B. and Fekadu, B. (2014). The impact of climate change on pastoral production systems. A study of climate variability and household adaptation strategies in southern Ethiopian rangelands. *WIDER Working Paper 2014/028*.
26. World Bank (2007). *The Economics of Adaptation to Climate Change: Synthesis Report*. Washington, DC: The World Bank Group.
27. World Food Programme (WFP) (2009). *Summary of food security and vulnerability in selected urban centers of Ethiopia*. Addis Ababa, Ethiopia.
28. World Food program (2011). Country program Ethiopia 2000253. Agenda item 8. Rome, Italy..
29. Yusuf, Arief Anshory, and Arief Ramayandi (2008). Reducing fuel subsidy or taxing carbon: comparing the two instruments from the economy, environment, and equity perspective for Indonesia. Working Paper in Economics and Development Studies, Padjadjaran University, Bandung, Indonesia.