# EFFECTS OF FAST TRACK INVESTMENT PROJECT ON HOUSEHOLD INCOME AND ITS IMPLICATION TO CLIMATE CHANGE ADAPTATION; IN GIDAMI DISTRICT, WESTERN, ETHIOPIA

MSc THESIS

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**Approval sheet 1**

This is to certify that thesis of "Effects of fast track investment project on household income and its implication to climate change adaptation; in Gidami district, Western, Ethiopia

Submitted in partial fulfillment of the requirement for the degree of Masters of Science in Climate smart agricultural Land Scape Assessment under Department of Agroforestry has been carried out by Samuel Shiferaw Dasa Id.No MSc/CSAL /R017/2010, under our supervision. Therefore, we recommend that the student has fulfilled the requirements and hence hereby can submit the thesis to the department.

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We the undersigned members of the Board of Examiners of the final open defense by Samuel Shiferaw Dasa "Effects of fast track investment project on household income and its implication to climate change adaptation; in Gidami district, Western, Ethiopia" have read and evaluated his thesis entitled and examined the candidate. Accordingly this is to certify that the thesis has been accepted in partial fulfillment of the requirement for the degree of Master of Science.

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## DEDICATION

This thesis is dedicated to my father Ato Shiferaw Dasa and to my mother Wezero Bizunesh Mekonnin who encouraged me all the way since the beginning of my studies and taught me that education is the key and power to successful future.

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| CCAES | Climate Change Agriculture Food Security |
| CO2 | Carbon Dioxide |
| CRGE | Climate Resilent Green Economy |
| CSA | Climate Smart Agriculture |
| ETB | Ethiopian Birr |
| FAO | Food and Agriculture Organization of united Nations |
| FDRE | Federal Democratic Republic of Ethiopia |
| FGD | Focus Group Discussion |
| FTI | Fast track Investment |
| GTP | Growth and Transformation plan |
| GWP | Global Warming Potential |
| GHG | Green House Gas |
| HH | Household |
| IPCC | Intergovernmental Panel on Climate Change |
| KII | Key Informant Interview |
| NGO | Non-Governmental Organization |
| NMA | National Meteorological Agency |

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EFFECTS OF FAST TRACK INVESTMENT PROJECT ON HOUSEHOLD INCOME AND ITS IMPLICATION TO CLIMATE CHANGE ADAPTATION; IN GIDAMI DISTRICT, WESTERN, ETHIOPIA

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## ABSTRACT

*Agriculture is a science and art of producing crops and rearing animals.It supports the world populations even though highly affected by climate change and variability.Therefore, promoting climate smart agriculture is the solution.CRGE fast track project implemented crops and livestock production climate smart agriculture in the study area. However,no study has evaluated the effect of climate smart agricultural practices or livelihoods of the farmers.This research had the aim of identifying crop and animal production adaptation options and assessing adaptation competence of respondents. In this study,237 sample HHs were selected and stratified by Proportionality allocation to sample into CRGE participant (102HHs) and Non-CRGE group (135HHs).Data was collected from household servey,key informant and focus group discussions and meteorological data also obtained. The results of 20 years trends (1998-2017) of rainfall show that eratic rainfall trends while the temperature was increasing.Crop and animal production income,adaptation level of respondents before and after project and Non-CRGE group mean income in ETB was identified.The mean income of HHs before CRGE project was 5,726.1ETB and after project was12,943 ETB and increased by 7,217.2 ETB.And mean income of None-CRGE group in 2012-2014 and 2015-2017were 5238 ETB and 5502.5 ETB respectively and increased by only 264.5ETB.Therefore,the average mean income due to CRGE fast track investment among CRGE participants increased by 6952.7ETB income mean when compared with Non-CRGE group.Fore the reason, adaptation capacity of CRGE fast track participants also increased.Finally CRGE fast track investment needed for immediate response of adaptation and to diversify source of income. Therefore,promoting CRGE fast track is important since it promotes climate smart agriculture among small holders.*

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*Key words: -* ***Adaptation potential, Climate smart Agriculture, CRGE, Fast track investment***

# 1. INTRODUCTION

## 1.1. Background and Justification

Agriculture is a science and art of activities of producing crops and rearing animals that have greatest potential for poverty reduction. Therefore,it is an economic activity which is highly dependent upon weather and climate in order to produce the food and fiber to sustain life (Tshilidzi,2016). Moreover,it supports world population's livelihoods across the globe. However, climate change and variability are the challenges which affect productivity of agriculture and overall economy of the world especially in developing countries (FAO, 2010). Many sub Saharan countries are severely exposed to the impact of climate change and variability due to the dominance of rain-fed agriculture. Likewise, Ethiopia is also affected by climate change and variability, because the economy of the country primarily depends on rain fed agriculture. Increasing average temperature and fluctuation of rainfall patterns are already moving Ethiopia to drought and food insecurity. One of the main factors driving these systems is the susceptibility of East African countries results unusual weather patterns such as drought and excessive rain fall and storms to the region including Ethiopia (USAID, 2015,

Ethiopia remains highly susceptible to climate shocks cause significant humanitarian consequences in the country (Jirata 2016).Therefore, to solve this problem of climate change and variability, adaptation becomes the instrumental response (Tshilidzi *et.al*, 2016). Adaptations by small holder's farmers have taken as the bench marks for scientific approach (Henderson, *et al.*, 2018). For the reason, adaptation policy designed by considering the knowledge and perceptions of smallholder farmers can bring fruitful and sustainable adaptation response to effects of climate change (Shiferaw 2017).

Depending on the effects of climate change and variability, agriculture requires significant transformation to produce food (Solomon *et al* 2016) and Food and Agriculture Organization (FAO) defines, climate smart agriculture as it integrates the three dimensions of sustainable development such as economic,social and environmental by jointly addressing food security and climate challenges(Jirata 2016). Moreover, climate smart agriculture also includes local knowledge and innovative practices and technologies that promote agricultural productivity and generate income. It includes three major pillars: increasing agricultural productivity, increasing capability at multiple scales and reducing greenhouse gas emissions (Branca, 2012).

Ethiopian government and other development agencies are united and decided on future agriculture development through expansion and investing on climate smart agricultural practices for community adaptation and to ensure sustainable development (FDRE.,2011 ;CRGE.,2014).Depending on this, all regions and sectors work towards effective implementation of climate resilient green economy actions aligned to the growth and transformation plan(GTP) provides as a mechanism for fast tracking high priority. Gidami district is one of the districts found in Kellem Wollega zone of Oromia regional state which was selected for climate resilience green economy fast track investment pilot project. Therefore, climate resilient green economy fast track agricultural investment project was implemented by Oromia Agricultural and Natural resources Bureau since 2016. Major climate smart agricultural practices implemented in the study area were crops,livestock production, natural resource conservation and capacitated farmers on their farm level were types of climate smart agricultural practices to the aim of enhancing livelihoods of farmers in the study area.

However,no study has evaluated the effect of climate smart agricultural practices or livelihoods of the farmers. Therefore, the study seeks to show impact of climate smart agriculture in livelihoods of farmer and their adaptations.

## 1.2. Statement of the Problem

Agriculture is the backbone of rural economies and it has the ability to positively impact on rural livelihoods in which smallholder farmers apply different climate smart agricultural practices on their farm land to adapt the changing climate(Solomon *et.al.*, 2016).

Therefore,to make climate smart agriculture work as a source of income for the poor, assessing and identifying adaptation of climate smart agricultural practices is important (Neufeldt *et.al.*,2011). Because small-scale farmers who are dependent on low input and low output rain-fed mixed farming with traditional agricultural technologies dominate in the study area. Therefore,climate smart agricultural practices has been implemented by fast track investment fund in Gidami district Alchaya Jilo kebele since 2016.These practices are; crop and livestock production,natural resource conservation climate smart agricultural practices and capacity building. However,no study has evaluated the effect of these climate smart agricultural practices or livelihoods of the farmers. For the reason, this study has investigated and identified the adaptation options and effects of climate smart agricultural practices on small holder farmers'livilihoods in the study area and it addressed the selected practices and ways of immediate response to enhance small holder farmers' livelihoods.

## 1.3 Objectives

### 1.3.1. General objective

The general objective of this study was to assess the effects of climate smart agricultural practices on smallholders' livelihoods and their adaptability to changing climate

### 1.3.2. Specific objectives

The specific objectives of the study were:

- ✓ To assess farmer's perception to climate variability and change in the study area
- ✓ To identify the adaptation option of climate smart agricultural practices on crop and livestock production
- ✓ To examine the effects of climate smart agricultural practices on crop and livestock production to enhance smallholders income
- ✓ To make comparative analysis between farmers who applied climate smart agricultural practices in CRGE fast track investment project and NON-CRGE climate smart agricultural practices

## 1.4. Research Questions

The study based on the following research questions:

- What is the trend of climate variability in terms of temperature and rain fall?
- What are the adaptation options of climate smart agricultural practices on crop and livestock production to enhance adaptive capacity of small holder farmers?
- How does the effect of climate smart agricultural practices on crop and livestock production improve adaptive potential of small holder farmers?

- What are the adaptations potential differences between farmers who are included in CRGE fast track investment climate smart agriculture project and NON-CRGE agricultural practices?

## 1.5. Significance of the Study

Assessing of impacts of adaptation strategies and adaptation potential of community in the study area in fast track investment climate resilience green economy (CRGE) project could assists policy makers in designing programs and formulations of polices and use for selecting appropriate climate smart agricultural practices options as solution for changing climate. Additionally the finding can be used to promote climate smart agricultural practice for sustainable development in the communities with similar environment and socio-economic conditions. Development partners such as NGO, researchers who are working on expansion of climate smart agricultural practices for adaptation to climate variability and related aspects can use it as bench mark for supplementary information. More over the result of the study can serve as sources of information about climate smart agricultural practices impacts and adaptation to climate variability to promotion of CRGE fast track investment project.

## 1.6. Scope and Limitations of the study

The study was conducted in Gidami district of Alchaya Jilo kebele. Climate smart agricultural practices effects and their adaptation potential in the study area were assessed. However, from 28 rural kebeles of the district,CRGE fast track investment was implemented only in Alchaya Jilo kebele. Therefore, the research was limited only in Alchaya Jilo kebele even it was limited to only 253 households from out of total 587 households. Therefore, the research limited only to the study area since it is better if it covers some part of the district. But the research limited

only to the study area depending on time and resource allocated for the research.Other limitation is also the two season data was used for identification. Because,CRGE fast track investment implement the climate smart agricultural practices; crop and livestock production for only two years.Therefore,by this research, three years before CRGE project,three years after CRGE project was used to study the effects of climate smart agricultural practices.

# 2. REVIEW OF LITERATURE

## *2.1. Definition and Concept*

**Climate:** According to Ramamasy *et.a.l* (2007), climate is statistical information and weather variation focusing on a specific area for a specified interval. Additionally, according to IPCC (2014) also climate is the long term description of weather in terms of variables such as temperature, rain fall and wind.

**Climate variability:** Climate variability is the fluctuation that occurs from year to year and statistic of extreme conditions and result from natural or internal processes within the climate system and external process of anthropogenic factor and climate variability is cyclical ups and downs over short time scale.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 (Berger,*et.al.*,2015).

**Climate change:** Intergovernmental Panel on Climate Change (IPCC,2014), defines climate Change is any significant change in measures of climate (such as temperature or precipitation) lasting for an extended period of time, three or more decades. Long-term change in global weather patterns, associated especially with increase in temperature and rainfall activity. A change in the state of the climate that can be identified (e.g,by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer (IPCC, 2007).

**Adaption potential is a** relation to climate change impacts and it is the ability of a system to adjust to climate variability, climate change, and extremes to moderate potential damages and to take advantage of opportunities, or to cope with the consequences (Easton *et al.*, 2014).

**Climate smart agriculture (CSA)** is type of agricultural practices; crop production,livestock raring and natural resource conservation technologies implemented for increasing of productivity and enhances resilience,reducing greenhouse gases and contributes to the achievement of sustainable development goals( IPCC 2014)

**Fast track investment (FTIs)** is the immediate implementation of different climate smart agriculiral practices on the ground with an ideal time frame work in climate resilience green economy **(**CRGE 2014).

It is also the process of overlapping sequential activities and it can be measured depending up on cost,time and quality(Alhomadi,*et.al.*,2013).

**Climate resilient green economy (CRGE)** is the green development plan which is responsible to transform identified climate smart agricultural activities for aim of food security,energy,infrastructure development and natural resources management through green development by reducing greenhouse gas emissions to achieve sustainable development (CRGE, 2014).

### 2.2 Farmers' perceptions on climate variability and change

Perception on climate variability and change is the way in which smallholder farmers think and behave in relation to climate variability and change (Wehba *et al.*, 2006). According to (Legesse.,*et.al* 2005), perception on climate variability and change varies with the socio-economic, cultural, gender, environmental and historical context and personal experiences and

the risks are also important in influencing perception.According to study of Vedwan *et.al.,(*2001) also,perceptions help farmers to be more accurate for certain kinds of weather and variations in climate and it is useful to know mechanisms by which weather affects agricultural output.

**2.3 Global cause of climate variability and change**

Since 1900 the global surface temperature of the Earth has risen by about 0.8 $^{0}$C.This temperature increase occurred some greenhouse gases, especially CO2 and CH4, which is known to be mainly due to human emissions and humans have caused more than 90% of global warming (IPCC,2007).

When the concentration of GHG is too high,too much heat is trapped, and the earth's temperature rises outside the range of natural variability. These greenhouse gases are; Carbon dioxide (CO2) and it is the GHG responsible for greatest amount of warming. The majority of CO2 is released from the incomplete combustion of fossil fuels coal,oil, and gases used for electricity production, transportation and industrial processes which accounts more than 80% of the CO2 released into the atmosphere.

Other important GHGs include methane, nitrous oxide emitted in smaller quantities than CO2 and they trap more heat in the atmosphere than CO2 does. The ability to trap heat is measured as Global Warming Potential (GWP). As the most common and abundant greenhouse gas, CO2 has a global warming potential of 1, so all other GHG warming potentials are compared to it. Fluorinated gases, for example, have greater warming potential thousands of times greater than CO2 and these gases have a much stronger impact in occurance of global climate variability and change than CO2 (IPCC 2014).

## 2.4 Cause of climate variability and change in Ethiopia

The majority of Ethiopia's emissions are from livestock (42%) and deforestation (37%); therefore reduction goals are focused on Agriculture, Forestry, and Other Land Use and the country largest contributors to future GHG emissions will be agriculture (emissions are expected to reach 70-160 MtCO2e in 2030) and the industry sector (50-70 MtCO2e in 2030) (World Bank, 2008)

The geographical location and topography, in combination with low adaptive capacity the country high vulnerable to the impacts of climate variability and change.Therefore,too much rainfall in a short amount of time in some areas and not enough in other areas will contribute to both flood and drought conditions flood hazards (Deressa.,T *et.al* 2008)

## 2.5 Evidence of climate variability and change in Ethiopia

Climate change is already taking place now,therefore, past and present changes help to indicate possible future changes. Over the last decades, the temperature in Ethiopia increased at about 0.2° C per decade (World Bank 2008).

According to the IPCC (2007) also, climate change country profile, Ethiopia's mean annual temperature has increased by 1.3°C between 1960 and 2006, an average rate of 0.28°C per decade. The increase in temperature in Ethiopia has been most rapid in July, August and September at a rate of 0.32°C per decade

This 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 (Schneider *et al*. 2008)

Moreover, the observed precipitation and temperature changes in Ethiopia (annual averages) shows that the occurance of climate variability and changes (IPCC,2007). For the reason, Ethiopia has experienced at least five major national droughts since 1980, along with a large number of localized droughts (World Bank 2008) and about half of all rural households in the country experienced at least one major drought from 1999 to 2004 (Dercon 2009).These cycles of drought create poverty traps for many households.

### 2.6 Impacts of climate variability and change on agriculture

Agriculture is the most important economic sector in sub-Saharan Africa, accounting for about 20-30% of GDP and 55% of the total value of exports (Higgins.,*et.al* ,2014).According to IPCC (2007) study also, temperature change and variability impacts international food security and smallholder farmers are the most vulnerable population to the changing climate. Additionally, impacts of climate change on poor rural people in developing countries are increasing their frequency of extreme events with generalized impacts on agriculture and on over all livelihoods.

Climate change in the form of higher temperature, reduced rainfall that results reduces crop yield and threatens food security in low-income and agriculture-based economies. Adverse climate change impacts are considered to be particularly strong in countries located in tropical Africa that depend on rain-fed agriculture as their main source of livelihood and overall impacts of climate change on agriculture especially in the tropics have been highly negative impacts IPCC,(2014).

Changing in climatic conditions (such as temperature and precipitation) affect soil moisture, water availability and increases of distribution of plant and animal pests and pathogens that

resulted reduction of production as well as climate change and variability affect the quality and quantity of animal feeds (Hertel.,*et.al* 2014).

Therefore,Ethiopian agriculture was challenged by many factors of climate-related disasters like drought and flood,insect pest incidence and occurance of plant and animal disease (Deressa 2007). In the time period 1970 to 1996,in Ethiopia, drought and the resultant food shortage and famine were the main killers, accounting for more than 90 % of deaths (Margaret 2003)

Ethiopia had five food crises and 25 droughts and 16 floods occurred in the time period 1970 to 1996 (Desalegn et al. 2006). Moreover, most poor farmers remain poor and vulnerable to future climate shocks (Jayne *et al*. 2003)

**2.7 Impacts of climate variability and change on Ethiopian smallholders**

Agriculture in Ethiopia is heavily dependent on rain-fed and its geographical location and topography, plus a low adaptive capacity, makes the country highly vulnerable to the adverse impacts of climate change. Poverty in Ethiopia is a chronic problem and about two-thirds of its 72 million people live on less than $2 a day (World Bank 2008).

Since, Ethiopia is one of the most food-insecure countries in the world, situation compounded by droughts and famine that cycle in and out. Therefore, over 80 percent of the population of the country derives its livelihood from agriculture were susceptible to the effects of drought and smallholder farmers dominate the sector, generating about 90 percent of agricultural output (Adenew 2006).

For the reason, major effects of climate change on livelihoods include changes in regular crop planting times, length of growing season and shift in crop type or cultivars of crop production

in the country and highly correlated to the rainfall patterns and leading to frequent crop failures and range land degradations, and cause loss of life and property (Deressa.,T *et.al* 2008).According to study by Davies.,*et.al(*2009) climate change and associated environmental degradation have been emerging as big challenge in Ethiopia with 28 million people or 34% of total population earns less than USD 1 per day.

### 2.8 Climate smart agriculture as solution for climate change and variability

Impact of climate change causes temperatures to rise, changing of precipitation patterns these changing reduce global food production (IPCC 2007).Therefore, and transforming climate-smart agriculture (CSA) is solution to overcome the challenge of changing climate. soil conservation to address the infertility problem that is caused by soil erosion, implementation of crop rotation and intercropping to boost the food production at the same time improve soil fertility and capacitating farmers on their farm land (Isaacs *et al.*, 2016).

### 2.9 Climate smart agriculture in Ethiopia

According to FAO (2016), in Ethiopia climate smart agriculture was practiced traditionally in different parts of the country such as: farmers are following traditional soil and water conservation practices as special example in Konso area, practising small-scale water harvesting and river diversion and traditional animal fattening (mixed crop-livestock agriculture) through a cut-and-carry system, traditional agroforestry practices. According to the study, specially Ankober woreda of Amhara Region, farmers traditionally spread animal manure on crop fields, as a result of which significant increases in crop biomass and

yield.Therfore climate smart agricultural practices started by local farmers traditionally in Ethiopia.

Additionally, in 2014, the CRGE Facility has designed and started implementing Fast Track projects which go in line with the CRGE strategy priorities by Ministry of Agriculture and received 6.4 million dollars from the Facility to pilot Fast Track initiatives throughout Ethiopia on identified climate smart agriculture such as crop production improvement, animal production management, restoration of soil fertility, and capacity building (CRGE 2014).

### 2.10 Adaptation potential of climate smart agricultural practices

Climate smart agriculture is a type of agricultural practices; crop production, livestock, and natural resource conservation practices which reduce challenges of changing climate. It is also delivery systems to manage climate risks (Jacob,2015). Therefore, such type of practices are; integrate tree planting, crop production and livestock production as a package of agricultural practices (Belay.,*et.al* 2017).These identified emission reduction potential is to ensure that Ethiopia's 2030 greenhouse gas (GHG) emission levels do not exceed the 2010 level which is 150 million ton CO2e equivalent instead of 400 million ton CO2e under the business as usual path and sixty sectoral initiatives practices are identified and planned to achieve net zero GHG emissions by 2025(CRGE 2014).

### 2.11. Climate smart agricultural practices options

#### 2.11.1 Crop production in climate smart agricultural practice

According to Gebreegziabher *et al.*,(2014) study on crop production, states that introducing new crops varieties are more appropriate to hot and dry areas to support farmers.

Additionally,practices such as;water and soil management,appropriate meteorological information,combining the best performing plant variety,adjusting planting date and plant population,fertilizer rate under current and future climatic conditions is types of climate smart agricultural practices (Bocher., *et.al* 2016).

Because studies by (Perrin,2015) states also, practicing crop production in climate smart agriculture has gratest potential to adapt climate change.Adaptation options of crop production include investing on crop production techinologies such as irrigation,planting drought tolerant and early maturing crop varieties,strengthening institutional set-ups working with research center and educating farmers are the type of climate smart agricultural practices which enhance the livilihoods of small holders ( Bocher.,*et.al* 2016).

### 2.11.2. Livestock production in climate smart agriculture for adaptations

Livestock production in climate smart agriculture is very importance in agriculture and supports over one billion people that accounts for 40% of global agricultural gross domestic product (GDP) and Provides over 33% of the world's protein intake (Verma,2017). According to study of (Perrin,2015) also livestock climate smart agriculture practices need to apply value chain at each level processes,marketing and the processing of animal products.

### 2.11.3. Natural resource conservation related climate smart agricultural practices.

According to Deressa (2007) study on natural resource conservation, reforestation and soil erosion prevention were emphasized as key climate change adaptation and mitigation strategies of climate smart agriculture. According to (Perrin,2015) studies on natural resource

conservation and adaptation which depend natural conservation is the basis for sustainable farming approach through climate smart agricultural practices.

### 2.11.4. Impacts and adaptation potential of climate smart agricultural practices in fast track investment

According to Abraham (2013) and Fisher *et.al.*,(2016) study on adaptation potential of climate smart agriculture can focus on the outcomes of the activities depend on immediate response to adaptation to climate change. Therefore, it needs appropriate fund to promote climate smart agriculture among smallholder farmers at farm level (Thaler.,*et.al.*,2015). However, smallholder farmers have potential to improve their livelihood through building of local adaptation methods, resilience, and promoting climate-smart agriculture. Capacitating farmes on their land is very important (Okumu,2013).

# 3. MATERIALS AND METHODS

## *3.1.* Description of the Study Area

### 3.1.1. Location

The study was conducted in Gidami District, Kellem Wollega Zone Western Oromia Ethiopia. Astronomically the district is located between $8^0$42’00”N to $9^0$3’00”N Latitude and $34^0$12’00”E to $34^0$33’00”E Longitude (Figure 1). Gidami is located approximately at 688km West of Addis Abeba through Addis Ababa-Nekemte main road. Gidami district is 161 km South of the Kelem Wollega capital zone, Dambi Dollo. Gidami district is bordered in the south by Anfilo District, on the west by South Sudan country, in East, Jima Horo district, on the north by Begi District.

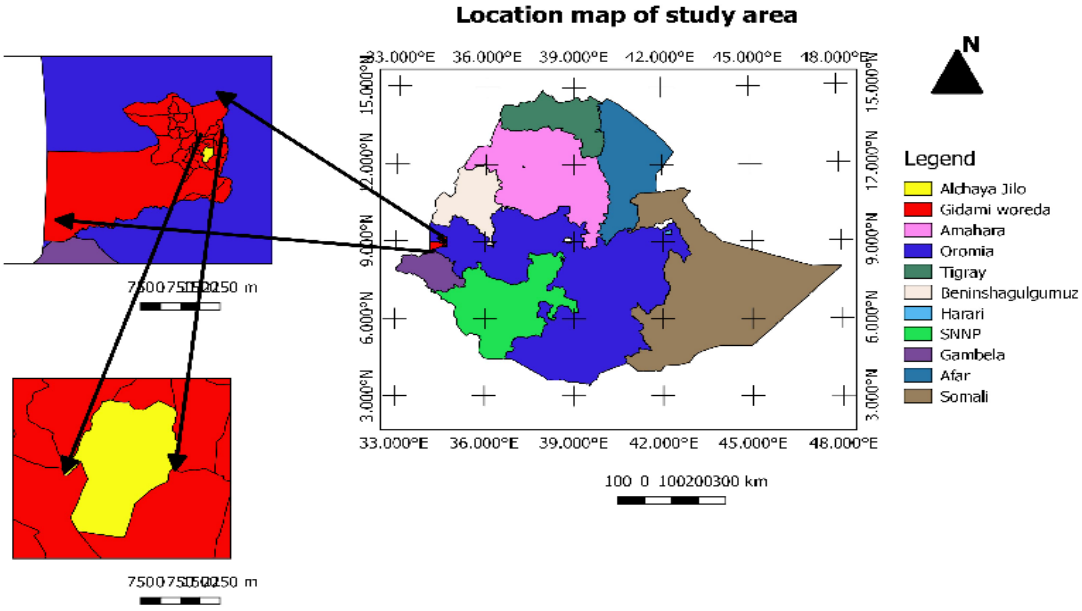



Figure 1: Map of the Study Area
Source**:** QGIS map composer coordinate

### 3.1.2 Climate

According to Gidami woreda agricultural and natural resource office 2018 data, major agro-ecologies are 8% Dega, 75% Wayne Dega and 17% Kola. Rainy seasons in the district include *spring* (March-May), *summer* (June-August) and *autumn* (September-November).Average annual rainfall of the district ranges between 800-1800mm and unimodal rainfall.The temperature ranges from 18-28$^{o}$C with an average annual temperature of 23$^{o}$C(Gidami district agriculture and natural resource office data 2019).

### 3.1.3. Land Use Land Cover

The total area of land 219,031 hectare, from this total area of land 47,004 hectare covered by natural forest, 12,721 plantation forest, 59,872 hectare covered by coffee, 15,283 hectare grazing land, 71,584 hectare crop land and 12,567 hectare of other lands use.

### 3.1.4. Geology and Soil types

According to study (FAO,2014) on world reference base for soil resources,soils are categorized based on materials they formed from and it is used as criteria of soil classifications. Depending on this, geology of west Ethiopia high lands and hilly ridges formed from basaltic rock, sediment rocks and vegetation material with conditioned by topographic influence. Depending on this, the geology of the district is categorized under soil classification of: Andosols, vertisols and Fluvisols.

### 3.1.5. Topography

According to FAO 2014.world reference base for soil resources, West Ethiopia high lands are characterized by terraces and broken foot-hills leading to the Sudanese plains. The altitude of

Gidami district ranges from 1500-2400m asl and topographic feature is characterized by mountains and hills.The dominant mountains in the district are Sonka Mountain,Balo Mountain and Dhaga Roba hills.

### 3.1.6. Socio economic activities

Gidami district is one of the major coffee producers of Kellem Wollega districts. The livelihoods of the farmers depend on mixed farming such as livestock rearing and crop production farming system. Coffee is produced as cash crop and the main food crops produced are; maize, sorghum,teff, millet,Barle,wheat,FebaBean and haricot bean.

### 3.1.7. Population

#### 3.1.7.1. Demographic Characteristics

Gidami district has twenty eight (28) rural and two (2) town administrative Kebeles.The district has an estimated total Demographics population 111,172, (55,890 men and 55,282 Female); 15,884 households (13,903 are men headed and 1,526 are women headed households) 92% live in rural area and 8% of its population are urban dwellers (CSA,2013, projection based on 2007 census)

The largest ethnic group is the Oromo people (98.9%).Afan Oromo is spoken as a first language by 99.25% and 1.69% speak Amharic. The majority of the inhabitants are followers of Ethiopian Orthodox Christianity (70.89%) while 14.99% were Muslim, and 13.6% Protestant

### 3.1.8. Vegetation and Wildlife of the study area

Diversity of trees present in the district as conserved almost for benefit of coffee shade trees. Moreover, Garjeda natural forest and Dhati Walal National park woodlands are covered some parts of the district's serves as conserving site of vegetation. Most common tree species are; *Ficus vasta, Cordia africana, Albizia gummiefera, Millettia ferruginea, Ekebergia capensis* etc.There are also different wildlife animals like lion, buffalos, hippopotamus and different types of birds in Dhati Walal National Park and in all parts of the district(Gidami District agriculture office 2019).

### *3.2.* Sampling Techniques and Sample Size

In this study, a multistage sampling technique was employed in Gidami district of Kellem Wollega zone, Oromia regional state. In Gidami district, Alchaya Jilo Kebele was selected and the kebele has a total 587 households. And the total households of the study area was stratified and divided in to two groups based on households included in CRGE fast track investment project and households that were not included in fast track project. Regarding the sample size, this study was used a simplified formula provided by Yamane (1967) to determine the required sample size at 95% confidence level and ±5% confidence interval.

$\boldsymbol{n} = \frac{\boldsymbol{N}}{\boldsymbol{1+N(e)^2}}$ …… (Yamane 1967)

Where *n* is the sample size, *N* is the population size (total number of households), and *e* is the level of precision (sampling error) at 5% significance level.

$$n = \frac{587}{1+587(0.0025)} = 237$$

According to this formula, from the total 587households, 237sample households were taken for the study. Then,thesample households were proportionally allocated for CRGE households(253) and Non-CRGE group(334 ) households by using probability proportional to the size sampling technique since CRGE fast track project invested on farm level adaptation for CRGE group only and non-CRGE households were not got the investment.

**nh= Nh*n*N$^{-1}$** Where:- **nh**= Proportional allocation

**N=** Total population

**Nh**= Population within stratum

**n**= Total sample size

Depending on this formula:-

1. Proportionality allocation of sample size for CRGE participant household groups was:-

nh= $\frac{253*237}{587}$= 102 households sample was taken from CRGE participant households groups

2. Proportionality allocation sample size for NON- CRGE group households groups was:-

nh= $\frac{334*237}{587}$ =135 households sample were selected from NON-CRGE group of households. Finally,by using simple random sampling technique(lottery system) by using Kebel 237 households were selected from total population of (587 households) for the two stratified groups for the household survey data collection.

Both primary and secondary data were used for this research. The primary data was obtained from primary sources including, household survey, field observation, key informant interviews and focus group discussions. The secondary data was also collected from available sources of information such as published and unpublished documents. This includes data from National Meteorology Agency (NMA),Central Statistical Agency (CSA), CRGE directorate Bureau and Regional bureaus of agriculture and natural resources, Zonal and Gidami district's agricultural office data was used.

### 3.2.1. Household survey

The household survey was carried out after structured questionnaires was prepared and administered from December 2018 to February 2019.Then, survey was carried with total

sample of 237 of this 102 from CRGE participant and 135 from Non-CRGE group sample households drawn from the population of Alchaya Jilo kebele. Both closed and open-ended questions were used to collect the required data and the questionnaire was translated into local languages. The questionnaires were administered with the help of six interviewers who can speak and write the local languages. The data collectors were trained to orient them about the purpose of the research, objective of the survey and to instruct in the business of interviewing. Before the actual data collection, ten households from the study area who were not included in the sample households were selected and pre-test of the questionnaires was conducted.

Therefore,the major parts of the questionnaires prepared for the household survey include household demographic characteristics,socio-economic characteristics,local knowledge about crop and livestock production climate smart agriculture practices and its effects in enhancing smallholders adaptation potential, about income gained from crop and livestock production in CRGE fast track investment projects and Non-CRGE group.

### 3.2.2. Key informant interviews (KII)

Key informant in this study refers a person disposes specific competence/knowledge of climate smart agriculture and its impacts and response due to academic qualifications and many years of work experience.Depending on this,by using snowball sampling approach , Key informant interview was conducted with farmers who had a good knowledge about the biophysical and socio economic conditions of the area such as:-elders, development agents, local leaders, model farmers, and Agriculture and Natural Development Office experts. Therefore, in this research 2(two) of Gidami district agricultural and natural resource office experts, two (2) development agents, and two(2) model farmers totally 6(six) persons were selected and interviews was conducted to cross-check data obtained from household survey

and focus group. Furthermore, the interview with key informant used in this research as additional information which was not raised by household interviews about climate smart agricultural practices, the effect of climate smart agricultural practices for adaptation in CRGE project and None-CRGE and the differences of adaptation potential between farmers of stratified groups.

### 3.2.3 Focus group selection

Focused group discussion helps to generate data at community level and involves a small group of respondents to discuss on issues forwarded by the facilitator who is a skilled focusing on key issues of the research topic. According to Jayasekara, (2012), the focus group discussion was based on theme of study and researchers interest. Accordingly number of participants in FGD and can range from 6 to 12 members. In this study,focus group discussants were selected from representatives of the community including elders, women, and youth groups, totally six (6) focus groups members were organized both from CRGE and Non-CRGE participants.Each FGD consists of eight(8) members/participants. The participants for the focus group discussion (FGD) were selected based on experience and having a better knowledge on the present and past environmental, social and economic status of the study area. The major discussion topics were on climate smart agricultural practices, their impacts and adaptation strategies in CRGE participant and Non-CRGE group

Depending on the selection, each group discussed on key issues of the research topic on which forwarded by facilitator. Therefore, one of the elders' group discussions of the study area showed in the figure below (Figure 2).

Figure 2: Focus group discussion

### 3.2.4. Field observations

Observation was made as supportive or supplementary technique for collected data in this research. During data collection, various observation was occurred through data collection process such as: climate smart agricultural practices and its adaptations on the field including individual farmers land that covers with crop residue, vetiver grass grown on soil bund, apiary sites, hand dug wells, farmers level forge demonstration site, forest plantations by CRGE fast track project and other climate smart agricultural practices actions implemented by farmers of the study area.

### 3.2.5. Methods of Data analysis

Data of the study area were collected via household survey, key informant interviews, focus group discussions and Gidami district's station meteorological data of twenty years (1998-2017) were obtained from NMA(National Meteorological Agency) and analysed by using descriptive statistics. The data were also summarized based on the research objectives and entered into Microsoft excel spreadsheet 2013. Finally imported into Minitab version17. Crop and animal production mean of the before, after and non-CRGE group were analysed and

described by descriptive statistic such mean, standared deviation. The twenty (20) years meteorological data of the district also analysed by calculating the total and the mean of the data and entered in to Microsoft excel line graph and finally the results were interpreted. The implemented climate smart agricultural practices in the study area were; crop production options such as access of improved variety seeds, green manuring, row planting, compost preparation and livestock practices options were; fattening beef cattle and fattening small ruminants, promoting beekeeping,animal forage development,poultry production. Soil and water conservation practices;traces,areaclosure and those practices were socially,economically and environmentally friendly sound to the study area. The amount of income that farmers have been got from crop and animal production before and after CRGE project and Non-CRGE group were asked. Therefore,the relationship of crop and animal production income difference between CRGE and NON-CRGE group were analysed by using ANOVA and descriptive statistical methods. In addition frequencies, percentiles, graphs, tables,histograms were used.

# 4. Results and Discussion

## 4.1. Demographic and socio economic characteristics of sample households

### 4.1.1 Number of surveyed households by sex and their family

A total of 237 households were interviewed for this study, of which 208 (87.8%) were males and 29(12.2%) were females. Out of the 208 male households, 87(42%) were from CRGE participant group, while 121(58%) were from Non-CRGE participant group. Among the 29 female households, 15 females (52%) and 14 females (48%) were from CRGE participant

group and Non-CRGE group respectively. In CRGE participant and Non-CRGE group, male-headed households were dominant in 87.4% representations (Table 1).

Table 1: Number of surveyed households, their family and total populations

| Study area | HHs and their Families | | | | Total population of Sample households | | |
|---|---|---|---|---|---|---|---|
| Alchaya Jilo | Male households | Family number | Female households | Family number | House holds | Family number | Population |
| Total | 208 | 964 | 29 | 102 | 237 | 1066 | 1303 |

Source: Own surveyed(2019)

**4.1.2 Age category of the sample households**

Regarding age of the respondents, out of 237 respondents 143 (60.3%) between 41-50 years 51(21.5%) were between 31-40 years old, 31(13.4%) 21-30 years 12(5.06%) were above 51 years old (Table 2).

Table 2: Age category of sample households

| S/N | Age category | Total | Percent (%) |
|---|---|---|---|
| 1 | 20 – 30 | 31 | 13.14 |
| 2 | 31 – 40 | 51 | 21.5 |
| 3 | 41 – 50 | 143 | 60.3 |
| 4 | Above 50 | 12 | 5.06 |
| | Total | 237 | 100 |

Source: Own surveyed (2019

### 4.1.3 Marital status of the sample households

When considering the marital status, out of 237 respondents, 222 (93.7%) reported that that they were married, while 5(2.1%) were divorced, where, 4(1.7%) were widowed and 6(2.53%) were unmarried (Figure 3).

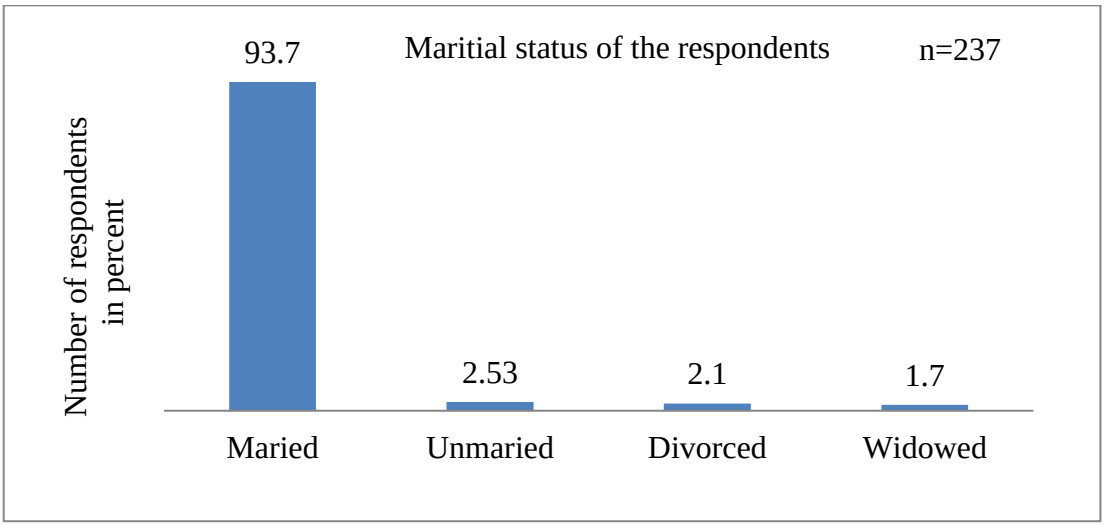



Figure 3: Martial statuses of the sample households

### 4.1.4 Family size of the surveyed households

Concerning the family size of the surveyed households, 119(50.2%) had 5-7 families where 104(43.88%) had less than 5 and 13(5.5%) family size of 8-10 and 1(0.42 %) had 11-13 family size. More family size was indicated in age category of 5-7 family size as shown below (Table 3).

Table 3:Family size of the sample households

| Family members | Total | (%) |
|---|---|---|
| < 5 families | 104 | 43.88 |
| 5 – 7 | 119 | 50.2 |
| 8 -10 | 13 | 5.5 |
| 11-13 | 1 | 0.42 |
| Total | 237 | 100 |

Source: Own surveyed (2019)

### 4.1.5 Educational level of the sample households

In terms of educational level of the sample households, out of 237 households 99 (41.8 %) can read and write 65(27.4 %) were illiterates and 47(19.8%) were 1-4 grade,47 (9.7% ) were 5-8 grade finally,3 (1.3%) were grade 9-12 (Table 4).

**Table 4: Education level of sample households**

| **Education level** | **Total** | **(%)** |
|---|---|---|
| Illiterate | 65 | 27.4 |
| Read & write | 99 | 41.8 |
| Grade1-4 | 47 | 19.8 |
| Grade 5-8 | 23 | 9.7 |
| Grade 9-12 | 3 | 1.3 |
| Total | 237 | 100 |

Source: Own field surveyed (2019)

### 4.1.6 Land holding size of the sample households

Regarding of land holding, the land holding of interviewed households were small and lies between 0.5.1(ha) up to1(ha) were 121(51.5%) households while 46(19.4%)of households had 0.5(ha). And 45(18.6%) had 1.1-2(ha) where, 20(8.4%) had 2.1-3 (ha )and 5(2.1%) represents households with land holding of 3.1-4 (ha) (Table 5).

Table 5: Land holding size of sample households

| Amount of land size in (ha) | Total | % |
|---|---|---|
| 0-5 ha. | 46 | 19.4% |
| 0.5.1 -1 ha. | 121 | 51.5% |
| 1.1-2 ha. | 45 | 18.6% |
| 2.1-3 ha. | 20 | 8.4% |
| 3.1-4 ha. | 5 | 2.1% |
| Total | 237 | 100 |

Source: Own survey data (2019)

### 4.2. Farmers' perception of climate variability and change in Gidami district

Sample households indicated that they have observed variability in the climate in in terms of increasing temperature, winds and declining precipitation over the past 20 years. Extreme climatic events like floods were observed to have increased in the past 20 years. Such perceptions and understanding of climate change have significant importance in their livelihood for adaptations to climate change. Farmers of the study area were asked whether they perceived long-term climate changes in temperature and rainfall. Accordingly, out of 237 households,(90.7%) were agreed and (5.9%) disagreed while (3.4%) indicated no change on Long-term climate change and (94%) were agreed,(3.8%)were disagree and (2 %) respondents

replied no change on Long-term temperature change and (93%) of respondents agreed,(5.5%)disagreed and (1.7%) replied no change on long term change in rain fall and perceived changes in rainfall in terms of its irregularity ,uneven distributions and late or early on-set of rainfall are common feature of climate change evidences(Figure 4).

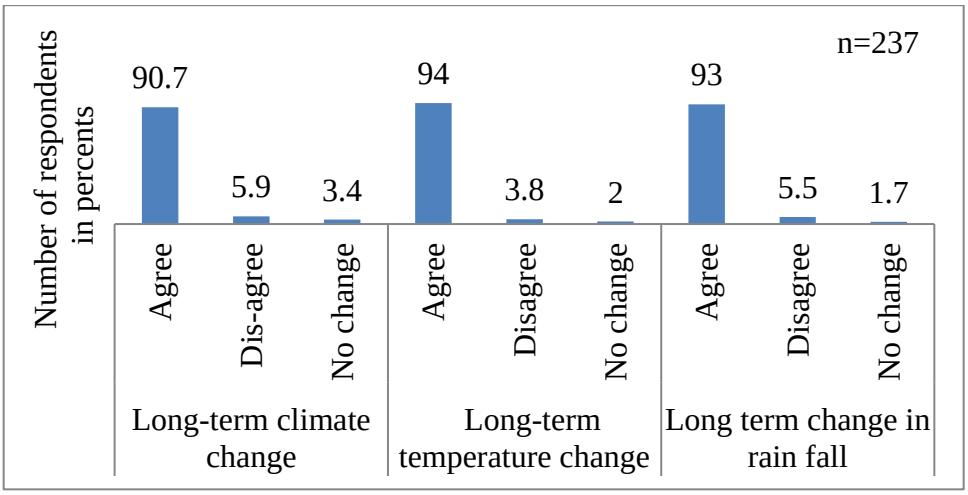



Figure 4: Respondents perceptions to climate change in the study area

As shown in the Table 10 below, respondents were also asked how they knew and learned regarding changes in rainfall. In this regard, 91(38.4%) were informed about climate change from extension workers and media mainly radio while 57(24%) from training and workshops, that organized for the target community 56(23.3%) were informed from extension worker only, 33(13.9%) were informed from media (radio) (Table 6). The result was in lines with study of FAO,(2013) which noted that, climate smart agricultural practices needs awareness to expand among farmers and it needs the involvement of researchers with farmers, land managers, agro foresters, livestock keepers, fishers, resource managers and policy makers (stakeholders) to empower them by means of accessing information for palatable choices to involve to adaptive capacity and resilience on the ground.

Other studies conducted by Smit.,*et.al(*2001;Nkonya *et al*.,(2008),households with access to formal agricultural extension,farmer-to -farmer extension and information about future climate change are more likely used to adjust their farming practices in response to climate change(Table 6)

Table 6: Number of households and their source of information

| S. N | Stratified group | Number of respondents and source of information from | | | | Total |
|---|---|---|---|---|---|---|
| | | Extension workers | Media (radio)only | Extension worker and radio | Training | |
| 1 | CRGE group | 25(24.5%) | 6 (5.9%) | 33 (32.4%) | 38 (37.3%) | 102 |
| 2 | Non–CRGE | 31(30.4%) | 27 (23%) | 58 (43%) | 19 (14%) | 135 |
| | Total | 56(23.6%) | 33 (13.9%) | 91 (38.4%) | 57 (24%) | 237 |

Source: Own field survey 2019

### 4.3 Time series meteorological information on rainfall and temperature

#### 4.3.1 Rainfall data analyses over Gidami district, study area

Meteorological data of rain fall and temperature was obtained from National Meteorology Agency (NMA) and it was analyzed by using Microsoft Excel by line graph and results interpreted.The analyzed 20 years (1998-2017) climate data results showed that highest annual average rainfall of the district was 1634.4 mm while the lowest annual average rain fall was 941.5mm.Therefore, Similar to the respondent's perception to climate variability, the rain fal1 trend of the area indicated shows eratic rainfall trend and fluctuations was observed from the analyzed data in the year of 2001,2003,2008,2009, 2014 and 2015 and (Figure 5).

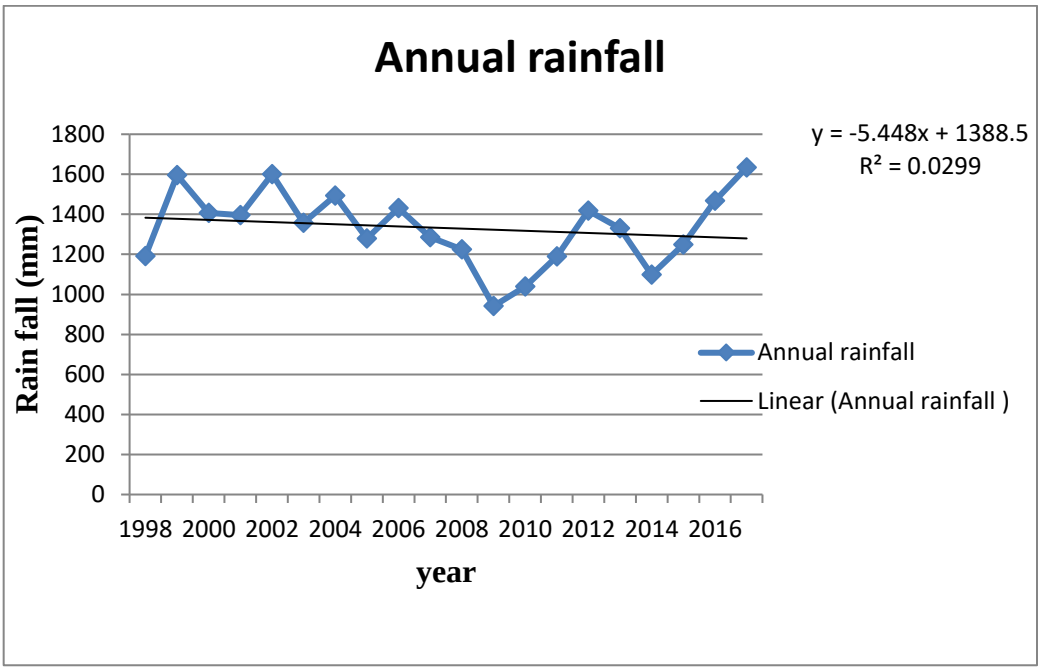
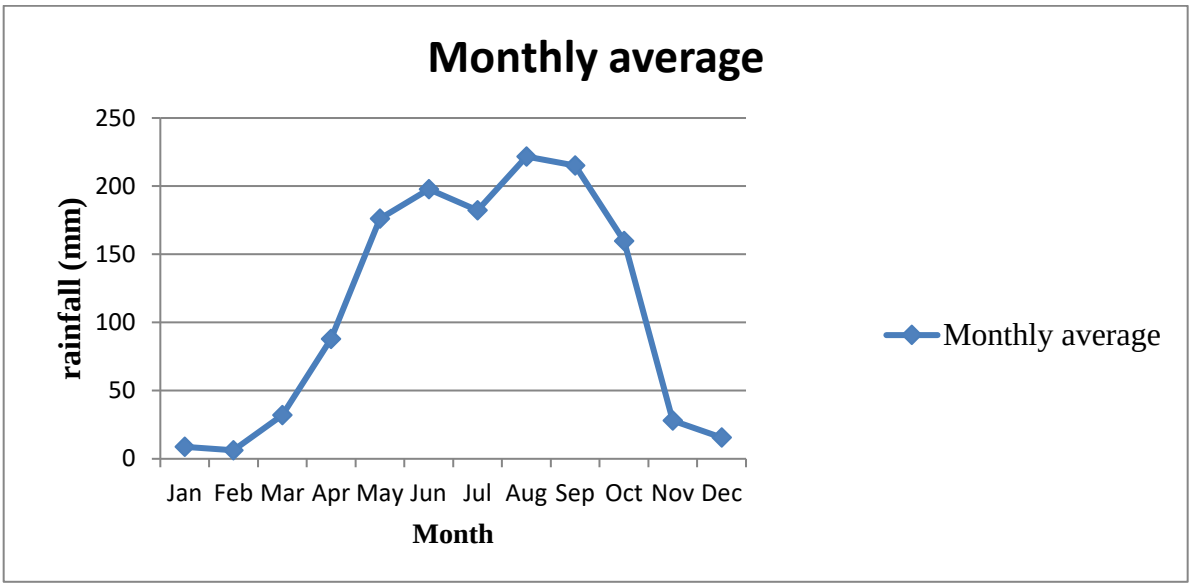



Figure 5: Annual trend of mean total precipitation (mm) of the study area

The longest rainy season of the district is from June to August locally called *"Kiremt"* had received the highest amount of monthly average rainfall 222mm (Figure 6) especially on the month of July and August which is used for agricultural crop production. But "Bega" (dry) season of the district is from December to February which received 6.25mm of average monthly rain fall especially in February and it is the lowest monthly mean of the rainfall in the district.Therefoe, the climate change was observed in terms of the late on set of rain fall early or late cessation and as well as less and high intensity was observed as similar to the farmers' perception of the study area.

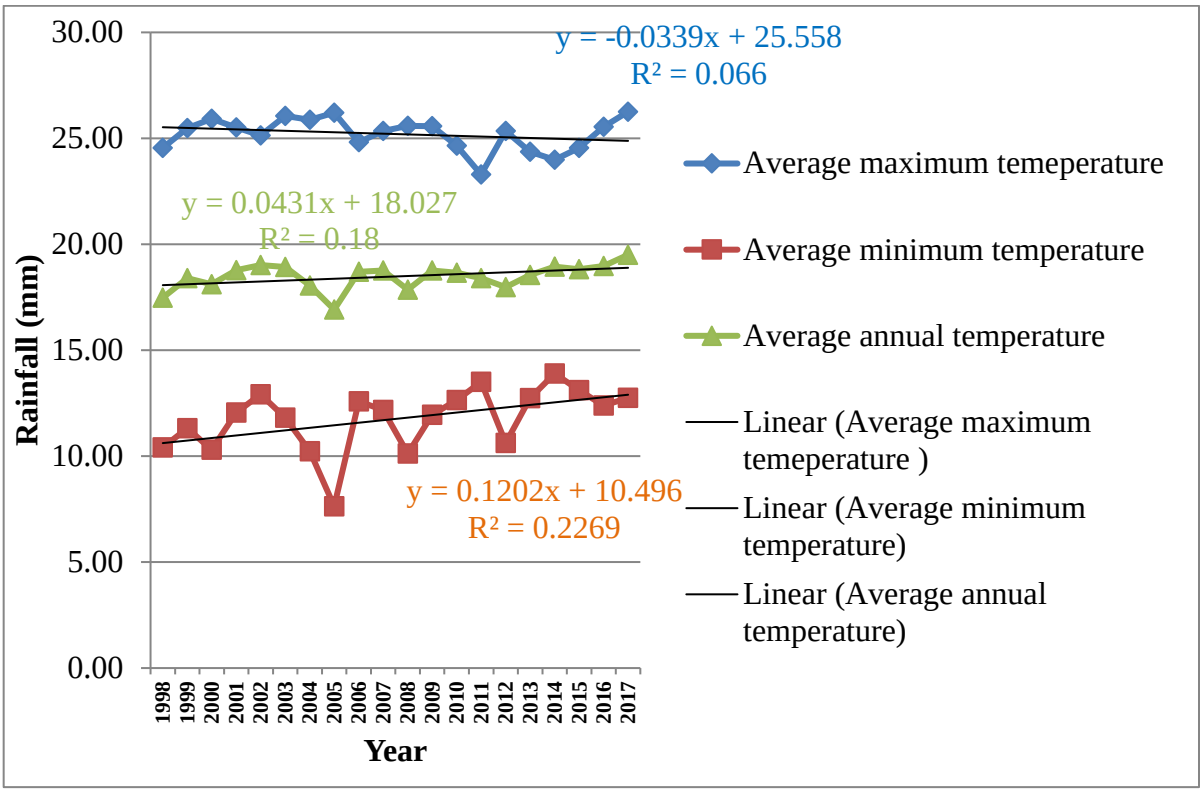



**Source:** NMA 2019

Figure 6: Average Monthly rain-falls (mm) of the study area

### 4.3.2 Temperature data analysis over Gidami district, study area

The highest maximum temperature from the data was 26.25 $^{0}$c while the lowest maximum temperature was 23.3$^{0}$c. The maximum temperature of the study area is increasing trends in the year of 2000, 2005,2009,2012,2015, 2016, and 2017 from the data (Figure 7).The highest minimum temperature was 13.5$^{0}$c and lowest temperature shows that 7.63$^{0}$c.Therefore, the average minimum temperature indicated the increasing of temperature. Finally the local perception of farmers in case of increasing temperature and eratic and fluctuation of rain fall is the same to the meteorological data results in the study area.




Source NMA, 2019

Figure 7: Trends of maximum,minimum and average annual temperature of the study area

### 4.4. Effects of climate resilence green economy fast track investment project on farmers livilihoodds and adaptation in the study area.

#### 4.4.1 Crop production trends and adaptation options

Sample households were interviewed about their income of crop production. Therefore, out of total 237 interviewed respondents (70.4%) of households in Non-CRGE used inorganic fertilizer,(5.2%) used organic fertilizer,(13.3%) used both organic and in organic while 11(%) were not used both fertilizers. And (60%) of CRGE participant used both fertilizers,(24.5%)

used organic fertilizers,(12.7%) used inorganic fertilizers while (3%)not used both fertilizers (Figure 8).

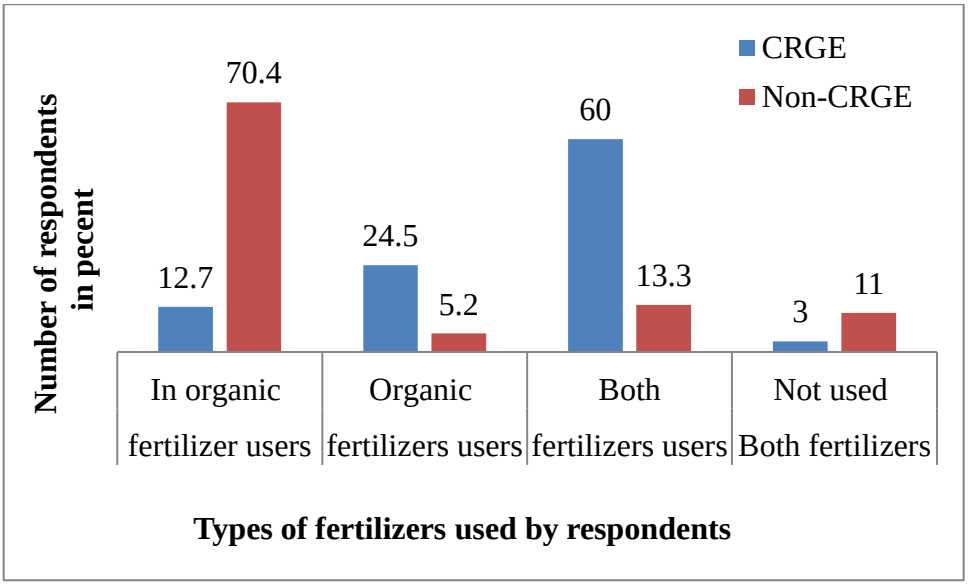



Figure 8: Respondents' category in used fertilizers

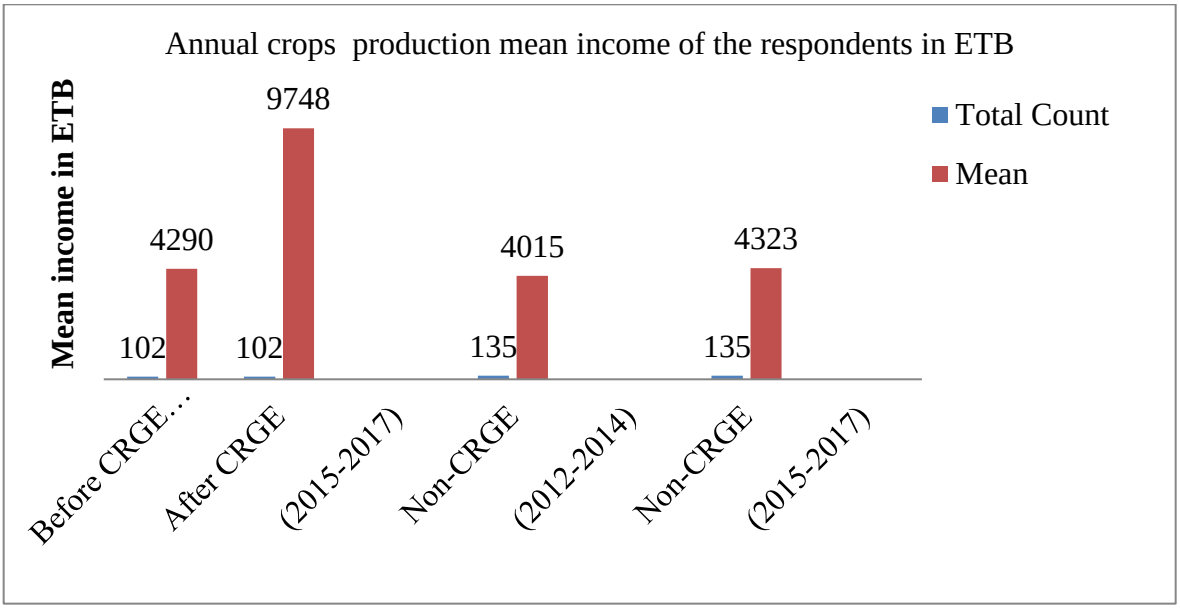
The result shows that the respondents in CRGE participant shifts from inorganic fertilizer to using both fertilizers together and finally to organic fertilizers because CRGE fast track project aim was to reduce the use of chemical fertilizer by increasing compost preparation to make environmentally friendly to conserve soil micro-organisms, improve soil nutrient, improve organic matter and improve soil moisture. The impacts of inorganic fertilizers on soil are not as organic since it is chemicals it harm soil micro-organisms. And it is costive to use and needs more capital to buy the fertilizers.capital it is chemical The result related with study of Parr *et al.*,1994 who stated that, soil microorganisms need organic carbon to live; they get this from eating wood chips,leaves,manures and other organic matter,they creates humus which increases soil structure, good for root penetration and development.

The challenges to adapt the different adaptation measures such as lack of preceptation,cash shortage lack of awareness on the adaptation technology were some challenge of adaptation in the study area.

### 4.4.2. Crop production income of households in the study area

By classifying the crop production year of the study area, in to:-

Before CRGE project (2012-2014), after CRGE project (2015-2017) and Non-CRGE (2012-2017). Respondents were asked their income of crop production.Accordingly crop production income mean of the respondents of CRGE participant after project was 9,748 ETB while income before CRGE was 4,290 ETB and the increment difference of 5,458 ETB. The income of Non-CRGE group (2012-2014) was 4015 ETB while income of None-CRGE (2015-2017) was 4323 ETB while the increment is only 308 ETB (Figure 9)

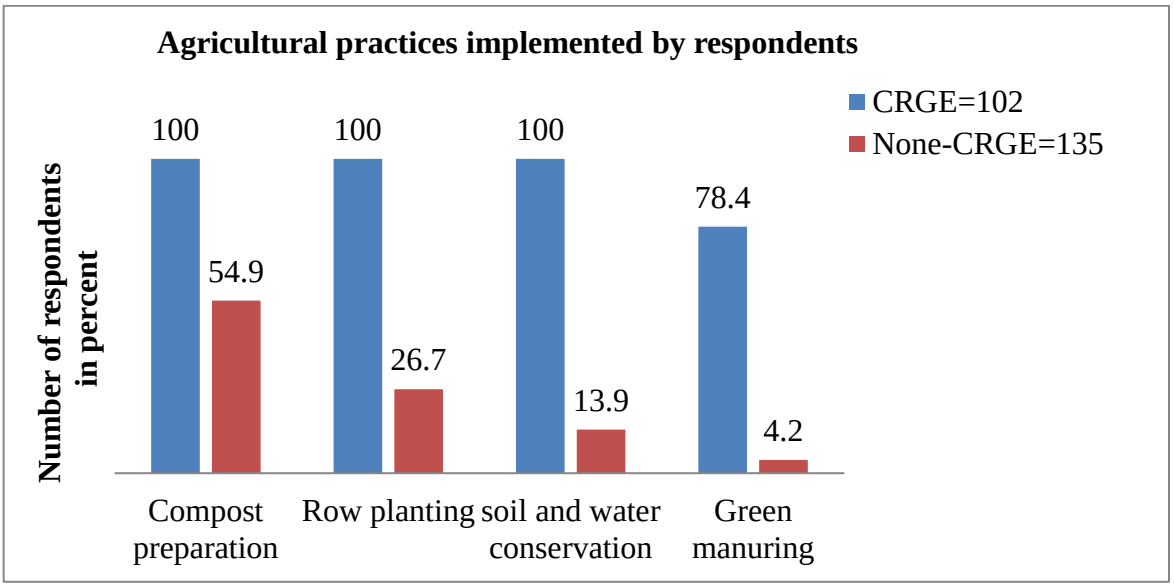



**Source: Own field surveyed (2019)**

Figure 9: Crop production mean income of the respondents in (ETB)

### 4.4.3 Climate smart agricultural options that increased crop production in the study area

Climate resilience green economy (CRGE) invested on identified options of crop production in fast track investment project for CRGE participant. Respondents were asked how many of them practiced crop production increasing options Accordingly, out of 102 CRGE participants households 102(100%) prepared compost,102(100%),practice row planting,102(100%) of respondents practices soil and water conservation practices, 80(78.4%) practiced green manuring by CRGE fast track investment project fund. But out of total 135 of None-CRGE group of respondents 56(54.9%) practices compost,36(26.7%) practiced row planting, respondents 33(13.9%) practiced soil and water conservation 10(4.2%) practices green manuring(Figure10).Non-CRGE group practiced climate smart agriculture from their experience not from CRGE fund but they also use inorganic fertilizers in small amount and soil conservation practices was not properly done as the CRGE group. So that soil erosion was one of the main problems that decreased crop production of Non-CRGE. But CRGE group used both organic and inorganic together and soil conservation practices was done properly on their own land by fast tracking fund. That results increament of their income.Therefore, the implemented climate smart agricultural practices increased cereal crops production among CRGE fast track project participant. The results also lines with the research conducted by (Smith P.*et.al*.,2007) who stated that, soil fertility improvement, agronomic practices, overall management of farm helps to reduce nutrient loss,and used to promote sustainable agriculture.



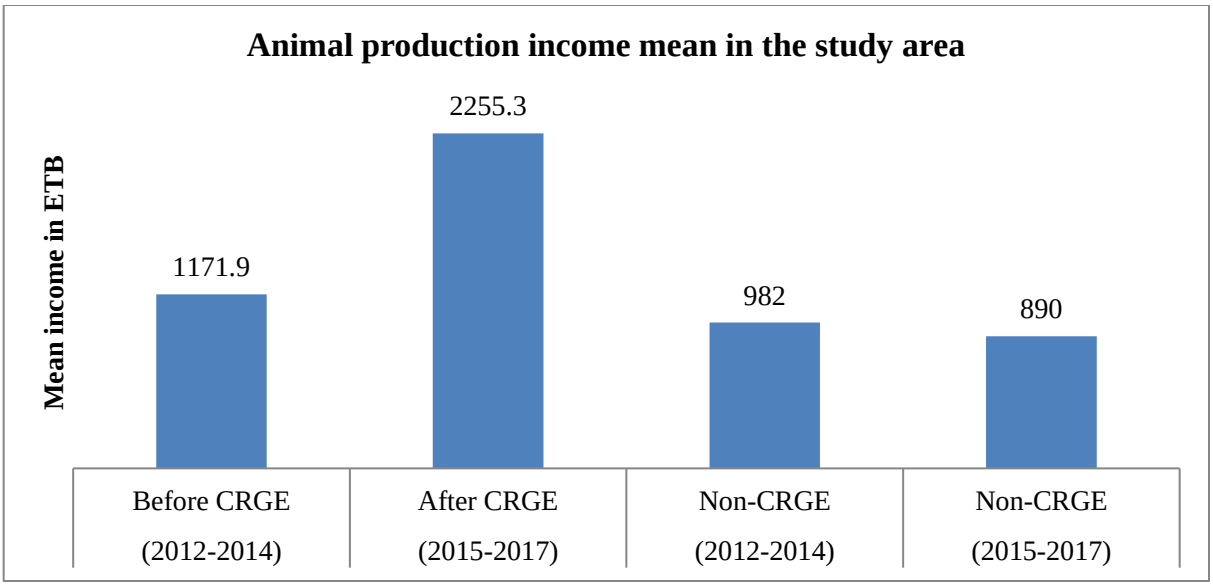

Source: Own survey (2019)

Figure 10: Climate smart agriculture practiced used by respondent

### 4.4.4 Animal production income of the study area

Respondents were asked their three years duration of income from;cattle,sheep and goat, poultry production, hive product(honey and wax) and each respondent's income was calculated and the mean income CRGE and Non-CRGE was compared.Therefore,mean income of animal production income of after CRGE project was 2255.3 ETB. Because the inputs that increased livestock production were access of modern hives, improved poultry breeds, access of beef cattle,access of sheep and goat for women animal forage development, in CRGE participant, while mean income of respondents from animal production before CRGE project was 1171.9 ETB. The result implies the increment of respondents' income was 1083.4 ETB. Mean income of animal production in None-CRGE group (2015-2017) was 890.9 ETB while, mean of animal production income of (2012-2014) was 982.0 ETB (Figure 11).The animal production increament in the study area were due to accessing of animal production inputs by fast track investment and capacitating farmers on their farm by CRGE

fund as well as housing beef cattel,introducig apiary site and provision of water resource at households level in the study area.




Source: Own field surveyed (2019)

Figure 11: Animal production mean income of households in the study area in ETB

**4.4.5. Analysis of income from Hive product (honey and wax) in the study area**

Sample households interviewed about their income of hive product of before CRGE project, after CRGE project and None CRGE group. Accordingly honey production income of after CRGE project (2015-2017) was 940 ETB mean and income before CRGE fast track project (2012-2014) was 264.20 ETB. Therefore, 675 ETB increment was observed.

But income from hive product of None CRGE group of (2015-2017) was 288.60 ETB while (2012-2014) 241 ETB.

The result showed that mean income of honey production of None-CRGE group was decreasing due to limited access of modern hives and with accessories as well as lack of training on beekeeping technology for Non-CRGE group and lack appropriate fund to invest on hive product for Non-CRGE group.(Table 7).

Table 7: Sample households' income from Hive product (honey and wax) in ETB

| Variable | Total Count | Mean |
|---|---|---|
| Before CRGE 2012-2014 | 102 | 264.2 |
| After CRGE 2015-217 | 102 | 940 |
| Non-CRGE 2012-214 | 135 | 241 |
| Non-CRGE 2015-2017 | 135 | 288.6 |

Source: Own surveyed (2019)

### 4.4.6. **Factors for crop and animal production reduction in the study area**

Respondents were asked about crop animal production reduction of the study area. Accordingly out total 237 respondents 70(29.5%) states that late-onset and abnormal distribution of rain fall is one of the major decreasing crop and animal production and 53(22.36%) states sever erosion caused crop production reductions,35(14.8%) respondents also replied that soil fertility problem for reduction while 24(10.21%) were replied that insect pest problem 21(8.9%) states that lack of land, and 18(7.6%) replied lack of improved crop variety and animal breeds and of the 16(6.8%) replied that lack of income(Table 8)

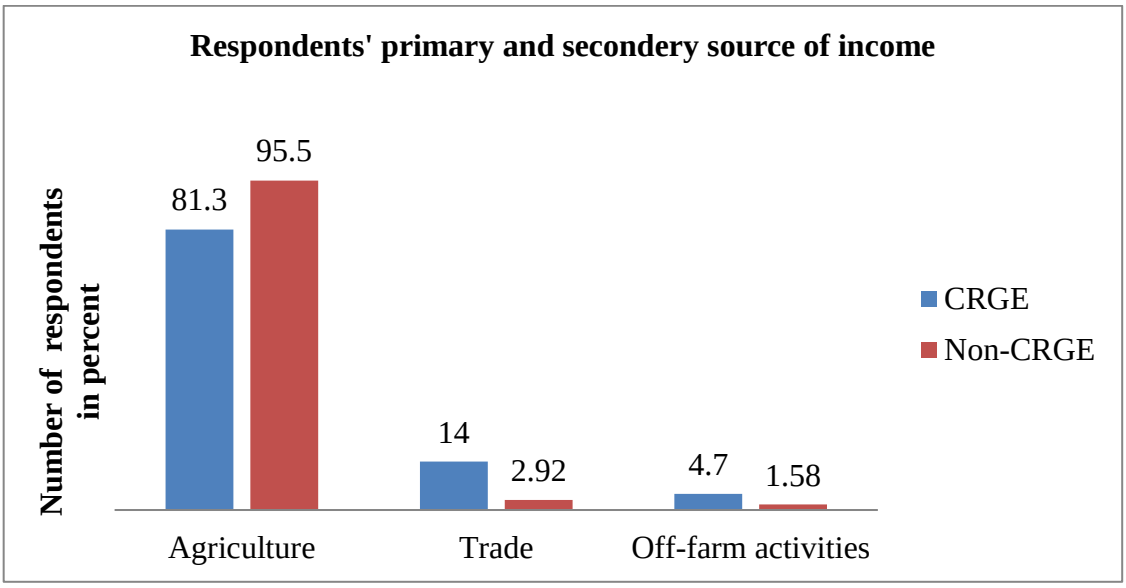
Table 8: Factors of reduction of crop and animal production in the study area

| Crop production Problem of the area | Respondents groups | | | | Total | Percent (%) |
|---|---|---|---|---|---|---|
| | CRGE participant | Percent (%) | None-CRGE group | Percent (%) | | |
| Sever erosion | 17 | 16.7 % | 36 | 26.7 | 53 | 22.36% |
| Lack of land | 10 | 9.8 % | 11 | 13.3 | 21 | 8.9% |
| Soil fertility problem | 13 | 27.4 % | 22 | 35.6 | 35 | 14.8% |
| Late-onset and abnormal distribution of rain fall | 35 | 24.5 % | 35 | 26 | 70 | 29.5% |
| Lack of income | 6 | 13.7 % | 10 | 14.07 | 16 | 6.8% |
| Insect pest | 17 | 8.8 % | 7 | 10.4 | 24 | 10.21% |
| Lack of improved variety | 4 | 3.9 % | 14 | 11.9 | 18 | 7.6% |
| Total | 102 | 100 | 135 | | 237 | 100 |

Source: Own surveyed data 2019

### 4.4.7 Respondents' sources of income and their adaptation potential

Respondents' source of income was analyzed based on their performance of adaptation. Accordingly out 237 respondents, 212(89.63% )were still depend on agriculture as primary source of income, 19 (8.01%) shift their primary sources of income from agriculture to trade due to CRGE fast track investment project while 6(2.36 %) shifts their primary source other off farm activities such as wood work and metal work. Because after they got income from the fast track project,the CRGE participant motivated to shift their primary source of income to secondery source income to improve their livelihoods (Figure 12).




**Source: Own surveyed (2019)**

Figure 12: Source of income of respondents

Therefore the CRGE participant respondents adaptation impacts shows that, out of 102 respondents 15(fifteen) respondents shift their primary source of income from agriculture to trade by 15(14.7%)which accounts 6.3% of the 237 respondents total sample.While the None-CRGE group shifts their primary source of income to trade by only 4(3%).Therefore, the CRGE fast track project impacts double win impact (resilience and income gain)to adapt the changing climate since the participants promoting their life .Therefore,(19)nineteen farmers from Alchaya Jilo kebele shits from agriculture to trade because of the fast track investment project help them financial capital and social capital.

The result shows that the utilization of production inputs such as modern hives with accessories, access of improved crop variety seeds, providing water sources, access to credit and capacity building by capacitating farmers and investing on farmers' farm level practices were improve their income and enhance their adaptation potential. Therefore, the findings of this study in line with the study of (Hunter *et al.*,1998) who states that, differential impacts on

the livelihoods of human population vary and are largely determined by the location of settlement and levels of income, education and awareness and access to production inputs. Other studies conducted by Easterling *et al*.,(2004) states that, adaptive capacity of households and communities is determined by their socio-economic characteristics such as access to financial, technological and information resources,the institutional efficiency within which adaptations occur, human capital, political influence, and kinship networks.

# 5. CONCLUSIONS AND RECOMMENDATION

## 5.1 CONCLUSION

In the study area' mixed farming: crop and livestock production were dominant practices on which the livelihoods population depends. In the study area, Alchaya Jilo kebele, Gidami district, impacts and adaptation potential of respondents were identified in this research.The respondents were categorized into CRGE (Before and after interventions) non-CRGE participants. The result indicated that respondents perceived that temperature was increasing and rainfall was decreasing was observed from the data (1998-2017).Respondent**s** also experienced with eratic rain fall with high intensity which cause hazards. This finding was also in line with the findings of the meteorological results data.

The study resulted also crop and animal production in the after CRGE fast track investment was increased while the production before CRGE and Non-CRGE groups increment was small. Because, in the after CRGE fast track project different crop and animal production climate smart agriculture were invested on the CRGE participant farmers' farm by CRGE fast track project investment and capacitate them by training and awareness of about climate smart agriculture immediate response .But Non-CRGE group were not get such kind of investment. More over CRGE fast track investment accessed agricultural inputs for participants.Therefore, identified climate smart agricultural high priority options (crop production, animal production and capacitating farmers on their farm) were increased small holders'adaptation potentials and their adaptive capacity. Therefore, CRGE participant income was increased by the mean of

7,217 ETB income and Non-CRGE group increased by only264.5 ETB.Therefore,the,CRGE group shows 6952.7 ETB increament when compared with Non-CRGE group.

### 5.2. Recommendations

- Farmers' perceptions to climate variability and change should use as supplementary source of data in any work regarding residence of climate change.
- Climate smart agricultural practices such as crop and livestock production options should be practiced by small holder farmers on their own farm land to adapt the changing climate.
- Accessing and promoting adaptable and affordable technologies of crop production disease resistant,early maturing varieties improve smallholder farmers' income
- Introducing exotic livestock breeds and management is important to increase income of smallholders
- It is important to build up the collaboration and network with smallholder farmers and other stakeholders to minimize production problems
- Establishing weather station and community level early warning is important for adaptations
- Government should aware, create policy, and implement the climate smart agriculture as solution of climate change.
- Government should promote crop and animal production climate smart agricultural practices on farmers' farm level

## REFERANCES


Abraham, E.2013. What Factors Impact the Effectiveness of International Non Governmental adaptation in the United States. adaptation to climate change and determinants of their adaptation decisions in the *Africa: The Case of Uganda.* IFPRI Research Report No. 00159. International Food

Adenew,B. 2006. Effective Aid for Small Farmers in Sub-Saharan Africa: Southern Civil Society Perspectives. Addis Ababa, Ethiopia: Canadian Food Security Policy Group

Alhomadi, A. A., R. Dehghan & J.Y. Ruwanpura. 2001.Time, cost and quality predictability and Long-Term Impacts of Climate on Crop Production cause of Climate Change. Argentina. AIACC working paper no. 39. USA.

Belay,A.,J.W.Recha, T.Woldeamanuel and J.F. Morton. 2017.Smallholder farmers' adaptation to climate change and determinants of their adaptation decisions in the Central Rift Valley of Ethiopia', Agriculture & Food Security. BioMed Central, pp. 1–13. doi: 10.1186/s40066-017-0100-1.

Berger, T. Wossen, T., Troost, C., Latynskiy, E., Tesfaye, K., & Gbegbelegbe, S. (2015). Adaptation of farm-households to increasing climate variability in Ethiopia: Bioeconomic modeling of innovation diffusion and policy interventions. International Association ofAgricultural Economists: 2015 Conference. Retrieved from http://purl.umn.edu/229062

Bocher, T. F. 2016. 'Modeling Crop Yield and Farmer Adaptation to Rainfall Variability The The case of Southern Ethiopia

Branca, G.,T.Tennigkeit, W.Mann,and L. Lipper. 2012. *Identifying opportunities for* Cambridge University Press. Pp. 869-883. case of Southern Ethiopia Central Rift Valley of Ethiopia. *Agriculture & Food Security*, *6*(1), p.24.classification system for Namingsoils and creating legends for soil maps. *World Soil climate-smart m Agriculture investment in Africa* (p. 132). Rome: Food and Agriculture CON-203-1 to CON-203-9. https://doi.org/10.1016/j.evalprogplan.2015.01.002

CRGE. (2014). Government of the Federal Democratic Republic of Ethiopia Climate Resilient Green Economy (CRGE) facility operations manual, (May)

CSA (2013) 'Population Projection of Ethiopia for All Regions At Wereda Level from 2014 – 2017. Federal Democratic Republic of Ethiopia Central Statistical Agency, Addis Ababa, Ethiopia. http://www.csa.gov.et/images/general/news/pop_pro_wer_2014-2017_final accessed 0', (August 2013). Available at: www.csa.gov.et

Davies, M., B. Guenther, J. Leavy, T. Mitchell and T. Tanner. 2009. Climate change adaptation, disaster risk reduction and social protection: complementary roles in agriculture and rural growth?. IDS Working Papers, 2009(320), pp.01-37

Dercon, S. 2009. Risk, Poverty, and Insurance. Focus 17, Brief 3. In Innovations in Insuring the Poor. IFPRI 2020 Vision. Washington, DC: International Food Policy Research Institute. http://www.ifpri.org/sites/default/files/publications/focus17_03.pdf. Accessed September 2010.

Deressa,T.2007.*Measuring the economic impact of climate change on Ethiopian agriculture: Ricardian approach*, World Bank Policy Research Paper No. 4342. World Bank, Washington, DC

Deressa,T.2008 R.M.Hassan and C. Ringler. 2008. Measuring Ethiopian farmers' vulnerability to climate change across regional states. Intl Food Policy Res Inst.

Desalegn,C. E., M. S. Babel, A. D. Gupta, B. A. Seleshi and M. Douglas. 2006. *Farmer`s perception of Water Management under Drought Conditions in the Uppar Awash Basin, Ethiopia,* URL *Development and Equity.* In: McCarthy, J. J.,O. F. Canziani,N. A. Leary, D. diverse cropping systems under a new agricultural policy environment in Energy Economics, 46,pp.562-575

Easterling,W.E., B. Hurd and J.Smith. 2004. Coping with global climate change: the role of Adaptation in the United States.Pew Centre on Global Climate Change.

Easton, Z. M. 2014 'Climate Change Adaptation for Agriculture : Mitigating Short- and Long-Term Impacts of Climate on Crop Production cause of Climate Change.

FAO (Food and Agriculture Organization of the United Nations) . 2013. Climate-

FAO. 2014 World reference base for soil resources, update 2015: International soil

FDRE. (2011). CRGE Vision, 1–28. Retrieved from http://www.undp-aap.org/sites/undp-aap.org/files/Ethiopia_Climate Resilient Green Economy Vision.pdfe.

Fisher, P.A., K.G. Beauchamp, L.E. Roos, L.K. Noll, J. Flannery and B.C. Delker. 2016. The neurobiology of intervention and prevention in early adversity.*Annual review of clinical psychology, 12*, pp.331-357food and fertilizer technology center, Taipei, Taiwan.91

Gebreegziabher, Z.E.N.E.B.E., A.L.E.M.U. Mekonnen, R.A.H.E.L. Deribe, S.A.M.U.E.L. Abera, M.M. Kassahun. 2014. Climate change can have significant negative impacts on Ethiopia's agriculture. *Research Brief. Addis Ababa, Ethiopia. EDRI, EfD.*

Henderson, R. M., S. A. Reinert, P. Dekhttar & A. Migdal. 2018. Climate Change in 2018:

Hertel, T.W. and D. B. Lobell. 2014. Agricultural adaptation to climate change 2014.

Higgins, P.A.and J.V. Steinbuc. 2014. A conceptual tool for climate change risk assessment.*Earth Interactions, 18*(21), pp.1-15 *holder income and land distribution in Africa: Implications for poverty reduction.*

Hunter, D.,J. Salzman and D.Zaelke. 2007. *International environmental law and policy* (Vol. 4).NewYork:Foundation,PresImplications,forBusiness,(Mba2016),317032.https://doi.org/10.1016/j.qref.2006.12.021infast-track projects.4th Construction Specialty Conference, 2(May 29 to June 1), India: a study of local perception and response. Vol. 19: 109–117.University Intergovernmental Panel on Climate Change. Cambridge: Cambridge University.

IPCC,Climate Change 2007: Impacts, Adaptation and Vulnerability.Contribution of Working Group II to the Fourth Assessment Report of the IPPC. Cambridge: Cambridge University Press. Pp. 869-883

IPCC. 2014. 'What Causes Climate Change ? So , What Causes Climate Change ? What Is Climate Change ? Is Human-Induced Climate', p. 4.

Isaacs,K.B., S.S. Snapp, K. Chung and K.B. Waldman. 2016. Assessing the value of

J.Dokken & K S. White (eds.): Climate Change: Impacts, Adaptation.

Jacob, J. M. 2015. 'Climate-Smart Agriculture : Farmer ' s Bane Or Boon.

Jayasekara, R. S. 2012. Focus groups in nursing research: Methodological perspective. *Nursing Outlook* 60 (6): 411-6.

Jayne,T. S., T. Yamano, M. Weber, D. Tschirley, R. Benfica, A. Chapato and B. Zulu. 2003.

Jirata, M., S. Grey and E. Kilawe. 2016. Ethiopia climate-smart agriculture scoping.

Legesse, B. and L. Drake. 2005. Determinants of smallholder farmers' perceptionsof risk in *Linkages Between Land Management, Land Degradation, and Poverty in Sub-Saharan* Ltd. UK.

Margaret, F. M. 2003. Planning for the Next Drought, Ethiopia Case Study.

NMA (National meteorology agency)Gidami district Station data 2019

Neufeldt, H., P. Kristjanson, T. Thorlakson, A. Gassner, M. Norton-Griffiths, F. Place & K. Langford. 2011. Making climate-smart agriculture work for the poor. *ICRAF Policy Brief 12*,6.Retrieved from https://ccafs.cgiar.org/publications/making-climate-smart-agriculture-work-poor#.WW54XYQrLm4.

Nkonya, E. J. Pender, C. Kaizzi, E. Kato, S. Mugarura, H. Sali, & J. Muwonge. 2008. of Georgia Department of Anthropology, USA of the Drought Response 1999–2000 and Current Preparedness, Washington DC, USAID.

Okumu, O. F. 2013 'Small-Scale Farmers' Perceptions and Adaptation Measures To Climate Change in Kitui County, Kenya Organization of the United Nations.

Organizations (INGOs) in Ethiopia.

Parr, J., S. Hornick and D. Kaufmman.1994. Use of microbial inoculants and organicfrtilizers.

Perine, C. 2015. Climate Variability and Change in Ethiopia Summary of Findings, perspectives on adaptation to Climate change: Lessons from Mexico and Policy Research Institute,Wasington D.C poor countries: Current modeling practice and potential for empirical contributions.

Ramamasy, S. and S. Bass. 2007.*Climate variability and change: adaptation to drought in Bangladesh, A resource book and training guide, Food and Agricultural Organization of the United Nations, Rome*.ISBN 978-92-5-105782-7.*Resources Reports No. 106*, p.192 Rwanda. *Food Security, 8*(3), pp.491-506.

Schneider et al. 2008: Global precipitation analysis products of the GPCC. Technical report, Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst.

Shiferaw Bekele. 2017. Productive Capacity and Economic Growth in Ethiopia. *DepartmentofEconomic&SocialAffairs*,(34).Retrievedfromhttps://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/publication/CDP-bp-2017-34.pdf

Smart Agriculture Sourcebook. Rome: FAO; 2013.

Smit, B. & P. Olga. 2001. *Adaptation to Climate Change in the Context of Sustainable agriculture.*

Smith P, D. Martino, Z. Cai, D. Gwary, H. Janzen, P. Kumar, B. McCarl, S. Ogle, F. O'Mara. 2007. Agriculture In Climate Change.

Solomon Asfawu and Lipper. 2018. *Climate Smart Agriculture Building Resilience strategies,* Food Policy 28 (3), 253 – 275 study. *FAO, Rome*).

Thaler, K., C. Kien, B. Nussbaumer, M.G. Van Noord, U. Griebler, I. Klerings, G. Gartlehner and UNCOVER Project Consortium. 2015. Inadequate use and regulation of interventions against publication bias decreases their effectiveness: a systematic review. *Journal of clinical epidemiology*, *68*(7), pp.792-80 the Eastern Highlands of Ethiopia. *Journal of Risk Research*.Routledge Informa *to Climate Change, Natural Resource Management and Policy*. doi: 10.1007/978-3-319

Tshilidzi Madzivhandila Sibanda & F. A. Gwelo. 2016. Africa Agriculture Status Report2016.*AfricaAgricultureStatusReport2016*,19.https://doi.org/http://hdl.handle.net/10568/42343.

United States Environmental Protection Agency (2016). Inventory of US greenhouse gas emissionsandsinks19902014(DRAFT).Availableahttps://www3.epa.gov/climatechange/ghgemissions/gases.html

USAID. 2015. 'El Niño in Ethiopia: Uncertainities, impacts and decision-making', *Agriculture Knowledge, Learning Documentation and Policy (AKLDP) Project*, (September), p. 2. Available at: http://www.agri learning -ethiopia.org/wpcontent/uploads/2015/09/AKLDP-El-Ninbrief-Sept-2015.pdf.

use of Microbial and Organic Fertilizers in Agricultural Production, Published by the

Vedwan, N. and R. E. Rhoades. 2001. Climate change in the Western Himalayas

Verma,S. K. 2017. A Study on Awareness and Adaptation Strategies of Climate Smart Agriculture in Sultanpur District of Uttar Pradesh, (377343).

Vulnerability- Contribution of Working Group II to the Third Assessment Report of

Wehbe, M., H. Eakin, R. Seiler, M.Vinocour, C. Avila and C. Marutto. 2006. Local

*Working Group II to the Fourth Assessment Report of the IPPC.* Cambridge:

World Bank. (2008). Ethiopia: A Country Study on the Economic Impacts of Climate Change. Development Prospects Group, Report Number 46946-ET.

Yamne,T. 1967. Elementary sampling theory

# APPENDICE

**Apedix1: Survey Questionnaire for Rural Households**

**Location**

1. Name of Kebele _____
2. Name of Sub Kebele/Dev.t Group _____
3. District_____ Zone _____ Region _____
4. Stratified group
   a) CRGE participant group
   b) NONE-CRGE participant group
5. Name the house holder _____

**Part I:**

1. Demographic and socio-economic characteristics of the respondent household
   1. Age of household head: ___ 2. Sex of households head: 1. Male___1.2. Female_
   _ 1). Married 2) Unmarried 3) Divorced 4) Widowed 5) Widower
   3. Language: _____
   4. How long have you lived in the Kebele? _____Years _____
   5. Total family size? Female_____Male_____Total _____
   6. Age group of family members:a. < 10 years of age: Male _____ Female _____
      b. 10-14 years of age: Male _____ Female _____
      c. 15-50 Years of age: Male _____ Female_____
      d. > 51 years of age : Male _____ Female_____

**2. Household literacy assessment; Please exclude the respondent. Please fill the following** table

| Literacy level | Number of family members | Rem ark |
|---|---|---|
| Non-literate | | |
| Read and write | | |
| Primary-level education (grade1-8) | | |
| High school education (grade 9-12) | | |
| College Diploma | | |
| University graduate | | |

3. Family members able to read and write: 1 Female_____ 2. Male_____3. Total: ____
4. What are your occupation (list them in order of importance)-_____
5. Household sources of livelihoods and climate change impact
6. What does your family sources of livelihoods from? (Multiple responses are possible). Please put this marks (√ )
   A. Animal husbandry _____
   B. Crop cultivation _____
   C. Trade (Livestock ….) _____
   D. Sale of fire wood and charcoal _____
   E. Animal husbandry and crop production_____

| Type of occupation | Rank | | | |
|---|---|---|---|---|
| | 1st | 2nd | 3rd | Etc |
| Agriculture | | | | |
| Trader | | | | |
| Trader and Agriculture | | | | |
| Wage Labor | | | | |
| Wage Labor and Agriculture | | | | |
| Other (specify) | | | | |

8. What are the major challenges/problems that you face in your crop production? Please indicate them in order of importance

| Challenge | Rank | | | |
|---|---|---|---|---|
| | 1st | 2nd | 3rd | Etc |
| Moisture stress | | | | |
| Lack of oxen | | | | |
| Lack of labor | | | | |
| Soil fertility, | | | | |
| Insect pest | | | | |
| Weed | | | | |
| Lack of land | | | | |

9. Do any member of your family practice seasonal migration 1. Yes 2. No
10. If yes who is migrating from the family members 1.Father 2. Children
11. If yes for how long they migrate? 1. Less than three months 2.Up to six months 3. More than six months
12. What other skill do you have other than farming?
1. Weaving 2. Blacksmithing 3. Pottery 4. Wood works 5 .Other.

**Appedix2: Survey of Climate smart agriculture practices**

**Part I**: **Land holding and Crop Production**
1. What is the size of your land holding? _____ ha
2. Do you cultivate all of your land? 1. Yes_____ 2. No_____
3. If no how do you benefit from your land? 1. Share cropping 2. Rent it for money 3. Other _____
4. Do you feel that your land holding is adequate to produce enough for your subsistence?
1. Yes _____ 2. No_____
6. How sloppy is your farm land? 1.Plain 2. Medium 3.Very steep slope?
7. Have you constructed water harvesting structure on your land holding? 1. Yes 2. No
8. Have you constructed soil and water conservation structure on your land holdings?
1. Yes_____ 2. No_____
9. Do you have a pair of oxen to plough you land? 1. Yes_____ 2. No_____Others
10. In which category do you classify your soil on basis of its fertility?

1. Low fertility 2. Medium fertile 3. Highly fertile

11. How productive is your land without fertilizer? 1. High 2.Medium 3. Low

12 Are you use fertilizer? 1. YES 2 NO

13. What type of fertilizer did you use? 1. Inorganic 2 .organic

14. What type of agriculture do you practice? 1. Rain-fed 2.Irrigated 3. Mixed

15. Does your annual production cover the annual food need of your family?

1. Yes__ 2No__

16 How many quintals do you produce by crop type during good rainy season on average?

| Crop Type | Yield /ha in qt | Crop Type | Yield /ha in qt | Crop Type | Yield /ha in qt |
|---|---|---|---|---|---|
| Teff | | Sorghum | | Field Peas | |
| Barley | | Maize | | Millet | |
| Wheat | | FebaBean beans | | | |

15. How many income you gain from crop production per year before and after project?

16. How do you perceive your crop production?

Increasing _____ decreasing _____

17. If no enough crop production, how do you satisfy your food needs?

a. Purchase by selling livestock or other products

b. Sell lab our to generate income c. Practice petty trade

18. What are the major challenges/problems that you face in your crop production? Please indicate them in order of importance

| Challenge | Rank | | | |
|---|---|---|---|---|
| | 1st | 2nd | 3rd | Etc |
| Drought | | | | |
| Erratic rainfall/uneven distribution of rainfall | | | | |
| Lack of oxen | | | | |
| Lack of labor | | | | |
| Soil fertility, | | | | |
| Soil erosion | | | | |
| Insect pest | | | | |
| Weed | | | | |
| Land shortage/small land size | | | | |
| Lack of improved seed | | | | |

**PART II: Livestock Husbandry**

**1. Animal Production**

1. How many heads of the following livestock do you have before and after project?

| Livestock | Number | Livestock | Number | Livestock | Number |
|---|---|---|---|---|---|
| Cows | | Calf | | Honey bees | |
| Oxen and bulls | | Sheep and goats | | Poultry | |

| | | | | | |
|---|---|---|---|---|---|
| Heifers | | Equines | | | |

2. Is there any change on your livestock number, composition, and feeding of your village?
Increasing ____ Decreasing____
3. Is increased animal production?
4. How many income you gain from animal production per year before and after project? How do you perceive animal production? Increasing _____ decreasing _____

**2. Animal Fodder**

1. Type of fodder production _____, _____, _____, _____

2. What is the dominant grazing system you practice in your village?

1. Free grazing
2. Stall (cut and carry)

3. Do you have private grazing land? 1. Yes 2. No
4. Do you have produce animal forage? 1. Yes 2. No
5. How many income you gain from forage production in project? _____

**3. Honey Production**

1. How many hives of the following do you have before and after project?

| Hives | Number |
|---|---|
| Traditional back yard hive | |
| Transitional hive | |
| Improved (Modern) hive | |

2. How many kilogram of honey and beeswax you produce per production cycle?
3. How many income you gain from selling of honey and bees wax per production cycle
4. How many total income you got from honey selling?

**PART III: Natural Resource Management**

**1. Growing seedling on Nursery**

1. Do you produce forest seedling?_____
2. Type of forest seedling production _____, _____, _____, _____

**2. Forest Plantation**

1. Do you plant tree?_____
2. Type of tree you plant _____, _____, _____, _____

**PART IV: Land Use Land Cover Change Issues**

1. Is the grazing land area cover in your locality changing in size? 1. Yes 2. No
2.. If there is change in the area of grazing land is it decreasing or increasing in size?
1. Increasing 2. Decreasing
3. If you answer that the woodland is decreasing what are the major reasons behind deforestation, please give the rank (1st, 2nd, 3rd, etc.) in its severity_____
4. What type of tree species are grown in your farm land or around the homestead or elsewhere in your locality list the major trees you are planted? (list them) _____, _____, _____,_____
7. Do you grow trees? 1. Yes 2. No
8. Ifyes,how many trees have you grown? _____
9. List the major trees/shrub found in your locality_____
What problems have you faced due to climatic variability?

| Problems | Yes | Yes | Problems | Yes | Yes |
|---|---|---|---|---|---|
| crop failure | | | Increases flood disaster | | |
| Poor livestock productivity | | | Loss of income | | |
| Loss of pasture land | | | increase deforestation) | | |
| Loss of agricultural land | | | High intensity wind | | |
| Severe soil erosion | | | Drying of vegetation | | |
| Shortage of water | | | Drying of streams and rivers | | |

8. Which local indicators do you use to evaluate the temperature trend in the area? (Please support your choice with example).9. Observation of physical structures and societal clothing styles (disappearance of ice cover in mountain peaks, frost damage become uncommon, drying up of rivers, streams, swampy areas ,lakes, dressing light cloths etc.

**Appendix 3.Assessment of Adaptation option to climate change and barriers faced**

1. What adjustments by CRGE or NONE-CRGE in your farming have you made to the long-term shifts in the rainfall?

a. Enhance traditional irrigation schemes: _____ YES/NO
b. Used drought resistant crop varieties: _____ YES/NO
c. Using improved crop varieties: _____ YES/NO
d. Shifting from crop producing to planting vegetation ___ YES/NO
e. Adopt crop rotation and mixed cropping: _____ YES/NO
f. Enhancing animal rearing practice : YES/NO
g. If there are others list them: _____

2. Do you think the adaptive mechanism(s) you employed for the temperature problem is the best and viable one in current and future climate change and variability? 1. Yes 2. No

**Assessment of coping option to climate change and barriers faced**

1. In time of crop failure what do most households do to generate income for the family?

| Adaptation strategy | Yes | No | Reason |
|---|---|---|---|
| Migrate to urban area | | | |
| Reduce daily food intake | | | |
| Collect wild food | | | |
| Look for daily work | | | |
| Collect fuel wood for sale | | | |
| Sell assets: livestock, etc | | | |
| Borrow food from others | | | |
| Borrow money | | | |
| Purchase of food on credit | | | |

2. What support do you get from the government and non-government to complement your food needs in times of climate shocks?

1) Direct food aid: YES/NO 2) Provide cash: YES/NO
3) Food for work: YES/NO 4) Credit service: YES/NO

DED

what do u think causes climate variability?

| **Cause of climate variability** | **5=highly Agree** | **4=Agree** | **3=Average** | **2=Disagree** | **1=Highly Disagree** |
|---|---|---|---|---|---|
| a) Natural Variability | | | | | |
| b) Deforestation | | | | | |
| c) Overgrazing | | | | | |
| d) Population growth | | | | | |
| e) Urbanization | | | | | |
| f) Wetland degradation | | | | | |

| No | **Type of agricultural practices or climate smart agricultural practices** | **Amount in hector.** | **Remarks** |
|---|---|---|---|
| 1 | Do you produce food crops? How many hector. | | |
| 1.1 | Do you practices crop variety improvement? How many? | | |
| 1.2 | Do you practice Inter cropping? How many? | | |
| 1.3<br>1.4 | Do you practices crop diversification? How many?<br>Do you practices irrigation on your farm? How many? | | |
| 1.5 | Are you practices mulching? How many? | | |
| 1.5 | Are you practices crop protection? How many? | | |
| 1.6 | Are you practices compost preparation? How many? | | |
| 1.7 | Are you practices row planting? How many? | | |

ces did you practices through your experience?

15. For what purpose you employed the overall agricultural product?

1. for househ
2. for earning income from se
3. for both (1 and 2

**A. Farmers' perception in climate variability**

1- Do you think that for the past 20 years climate is variability?

1. = Yes ☐ 0. = No ☐

18. What are the indicators (impacts) of climate variability?

| Evidence of climate change | 5=Highly Agree | 4=Agree | 3=Average | 2=Disagree | 1=Highly Disagree |
|---|---|---|---|---|---|
| 1.a) Rise in Temperature | | | | | |
| b) decrease in Temperature | | | | | |
| c) No change in Temperature | | | | | |
| 2.a) Increase in Precipitation | | | | | |
| b) Decline in precipitation | | | | | |
| c) No change in precipitation at all | | | | | |
| 3.Changes in seasonal patterns | | | | | |
| 4.Changes in the timing of rainfall | | | | | |
| 5.Reduced crop yields (crop failure) | | | | | |
| 6.Limited availability of water | | | | | |
| 7.Increased incidence of pest/disease attack | | | | | |
| 8.Frequent occurrence of droughts | | | | | |
| 9.Reduction in soil fertility | | | | | |
| 10.Occurrence of floods | | | | | |
| 11.Reduced indigenous biodiversity | | | | | |
| 12.Death of livestock | | | | | |
| 13. Increased hunger and famine | | | | | |
| 14. Loss of cultivable land | | | | | |
| 15. Increased food prices | | | | | |
| 16. Loss of farm household income | | | | | |
| Others..... | | | | | |

**B.** Effect of climate resilience green economy (CRGE)fast track investment project agricultural piracies on livelihoods of the study area.

17. Do you thing the CRGE fast track investment have value effect on your livelihoods?
1=yes ☐ 0= no ☐

**Adaptation practices to climate variability**

18. Do you practice any climate change adaptation option on your own farm land?
1= Yes ☐ o =NO ☐
19. If "Yes", to Q#21, answer the following questions.

20. What are the different adaptation practices you did on your farm?

| **Adaptation practices** | **1=YES** | **0=NO** | **Year of starting the practice** |
|---|---|---|---|
| **1.Crop options of adaptations** | | | |
| Timely cultivating and sowing | | | |
| Crop diversifications | | | |

| | | | |
|---|---|---|---|
| Suitable agronomic practices | | | |
| Crop protection local knowledge | | | |
| **2.livestock production adaption options** | | | |
| Provision supplementary feeds | | | |
| Diversifying animal raring | | | |
| Promotion of using manual tractor instead of draft power | | | |
| Use of hybrid animals and drought resistance | | | |
| Promotion of raring proein-effecency small animals to reduce emission | | | |
| **3.Natural resource conservation related adaptation options.** | | | |
| Soil conservation practices per house hold | | | |
| Bund constructions on individual farm | | | |
| Promotion of biological conservations | | | |
| Erosion control traditional knowledge | | | |

21. What are the opportunities/benefits of applying the above-mentioned adaptation options?
…….....

22. Do you have access to climate data and information? 1= Yes ☐ 0 = No ☐

23. What is your source of information?

1. Television 2. Radio 3. Personal observatio 4. Development agents 5. Farmer Association6. Others …….

24. Do you get any assistance from extension office? 1= Yes ☐ 0 = No

25.. Do you get any loan (credit) for your farm activities? 1= Yes ☐ 0 = No ☐

26.. How far (distance in Km) do you have to travel to the Main Market?

.....

**D. Barriers /Constraints faced by small farmers in the adoption of various adaptation practices**

27. What challenges (constraints) do you face in using the various adaptation practices?

a) …….....……
b) …….....….....……
c) …….....……
d) .....
e) .....
f) .....

30. Do you think climate change can be tackled? 1= Yes ☐ 0 = No ☐

31. If "Yes", what do you think needs to be done to address climate change?

**Interview for Focus Group Discussants (FGD)**

**1.** What are the types of previous conditions of agricultural practices in the Kebele?

_____
_____
_____

**2.** What is the cause of climate change in the area?

_____

_____

_____

3. What type of adaptation strategies are commonly used in your locality to reduce climate change?

_____

_____

_____

3.1 Are there any opportunities that help farmers to cope climate variably in your area?

_____

_____

_____

1. Is there any support (financial, technical etc) from concerned bodies for farmers in order to help their effort during the use of adaptation mechanisms?

_____

_____

2. What will be the contribution of farm associations in using appropriate adaptation mechanisms?

_____

_____

_____

**Questionaries' for Key informants Interviewer (KII)**

1 What are the impacts of agricultural practices that small holder farmer practices?

_____

_____

2.What are the effect of climate change and variability on small holder farmers? And what is its current trend of changing climate ?

_____

_____

3.What are the measures of taken by small holder farmer to adapt the changing climate in the study area? And what are local knowledge climate smart agriculture previously previously known?

_____

_____

4.What are the serves is given to small holder farmers by Government,NGO, and others for adaptation of climate change?

_____

5.What are different known climate smart agriculture to adapt climate change and variability in the study area?

_____

_____

6. What are the crop production related climate smart agriculture practiced before and after CRGE project and how their impacts measured in relation to small holder adaptation criteria?_____

___

7. What are the livestock related climate smart agriculture practiced before and after CRGE project and how their impacts measured in relation to small holder adaptation criteria?

___

8. What are the livestock related climate smart agriculture practiced before and after CRGE project and how their impacts measured in relation to small holder adaptation criteria?

___

9. What are the natural resource related climate smart agriculture practiced before and after CRGE project and how their impacts measured in relation to small holder adaptation criteria?

___

10. What are the comparative criteria of small holders farmers of the study area for adaptation and potential of reducing climate change depend on their income when they are compete to each other?

___

11.What are the effect of CRGE fast track investment project on the small holder farmer of the study area ?And how their income estimated before CRGE fast track project ,after CRGE fast track project among small holder farmers?

12.How climate smart agriculture in the fast track investment affect livelihoods of the study area ?

___

**Appendix 4.Institutional Factors**

1. Do you get agricultural extension services in your area? 1. Yes 2. No
2. Do you have market access nearby? 1. Yes 2. No
3. Are there roads that connect the Kebele you with nearby towns or cities? 1. Yes 2. No
4. Do you have access and use improved production inputs and technologies? 1. Yes 2. No
5. Do you have access and use improved production inputs and technologies? 1. Yes 2. No

## Appendix 5: Meteorological Data

**Rain fall data in mm for the year (1998-2017) of Gidami district**

| year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total | mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1998 | 0 | 0 | 0 | 0 | 0 | 235.6 | 229.6 | 190 | 241.6 | 225 | 52.9 | 16.2 | 1190.9 | 99.24 |
| 1999 | 26.7 | 22.9 | 0 | 168 | 280.9 | 260.1 | 193.2 | 209 | 229.3 | 159 | 36.4 | 9.8 | 1595.4 | 132.95 |
| 2000 | 14.9 | 11.2 | 0 | 149 | 215.4 | 229.2 | 176.8 | 206 | 208.6 | 182 | 14.2 | 0 | 1406.8 | 117.23 |
| 2001 | 0 | 0 | 78.8 | 36.8 | 304 | 193.4 | 221.7 | 208 | 143.9 | 182 | 7.4 | 19.5 | 1395.5 | 116.29 |
| 2002 | 4 | 0 | 78.6 | 89.9 | 147 | 342.4 | 135.1 | 351 | 282.7 | 109 | 11.2 | 48.9 | 1599.8 | 133.32 |
| 2003 | 0 | 1.6 | 15.4 | 36.5 | 237.4 | 192.9 | 244.7 | 180 | 243.5 | 184 | 20.7 | 0 | 1356.7 | 113.06 |
| 2004 | 3.5 | 19 | 8.2 | 121 | 186.9 | 212.7 | 161.7 | 271 | 253.1 | 165 | 45.8 | 45.1 | 1493 | 124.42 |
| 2005 | 0 | 0 | 7.3 | 43.5 | 173.6 | 304.7 | 126.6 | 237 | 187.1 | 181 | 7.8 | 9.8 | 1278.4 | 106.53 |
| 2006 | 3.5 | 0 | 0 | 36.4 | 208.5 | 160.3 | 231.3 | 178 | 320.8 | 225 | 52.1 | 15.3 | 1431.2 | 119.27 |
| 2007 | 3.2 | 8.7 | 45.6 | 116 | 131.3 | 178.9 | 163 | 223 | 258.5 | 96 | 41.4 | 19.4 | 1285 | 107.08 |
| 2008 | 41 | 0 | 49.1 | 228 | 258.9 | 122.5 | 145.4 | 133 | 117.4 | 108 | 18.3 | 4.1 | 1225.3 | 102.11 |
| 2009 | 0 | 2 | 54.3 | 47.1 | 93 | 131 | 132.1 | 146 | 175.5 | 121 | 39.5 | 0 | 941.5 | 78.46 |
| 2010 | 3.5 | 0 | 0 | 0 | 14.7 | 176.2 | 178.9 | 193 | 262.8 | 159 | 36.2 | 14.7 | 1039 | 86.58 |
| 2011 | 4 | 1.6 | 12 | 39.3 | 131.2 | 212 | 134 | 270 | 187.3 | 97 | 53.4 | 48.2 | 1190 | 99.17 |
| 2012 | 14.8 | 8.3 | 14.1 | 145 | 208.5 | 160.3 | 221 | 207 | 253.1 | 158 | 11.8 | 16.4 | 1418.6 | 118.22 |
| 2013 | 4 | 11.2 | 15.4 | 173 | 130.6 | 192 | 211.4 | 136 | 187.1 | 225 | 45.2 | 0 | 1331 | 110.92 |
| 2014 | 0 | 19 | 78 | 43.2 | 130.3 | 135 | 132.4 | 209 | 160 | 164 | 7.8 | 19.4 | 1098.1 | 91.51 |
| 2015 | 0 | 8.3 | 49.5 | 32.3 | 304 | 193 | 132 | 180 | 164.3 | 132 | 36.3 | 16.3 | 1248 | 104.00 |
| 2016 | 49.6 | 11.2 | 79.9 | 122 | 131 | 143 | 143 | 350 | 190.2 | 225 | 14.3 | 7.8 | 1467.3 | 122.28 |
| 2017 | 4 | 0 | 54.3 | 132 | 237.8 | 180 | 331.7 | 357 | 234.1 | 96 | 7.4 | 0 | 1634.4 | 136.20 |
| Total | 176.7 | 125 | 640.5 | 1759 | 3525 | 3955 | 3646 | 4434 | 4300.9 | 3193 | 560 | 311 | 26626 | 2218.8 |
| Month | 8.835 | 6.25 | 32.03 | 88 | 176.3 | 197.8 | 182.3 | 222 | 215.05 | 160 | 28 | 15.5 | | |

Maximum temperature data 0C for the year of (1998-2017) of Gidami district

| YEAR | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1998 | 27 | 23 | 28 | 29 | 21 | 24.4 | 22 | 22.1 | 22.9 | 23 | 25.3 | 26.8 | 294.5 | 24.54 |
| 1999 | 28 | 26.1 | 29.2 | 28.7 | 26.1 | 23.3 | 21.9 | 22 | 23.2 | 25 | 25.9 | 26.4 | 305.8 | 25.48 |
| 2000 | 27.6 | 28.4 | 28.6 | 27.2 | 27.2 | 25.2 | 23.4 | 23.3 | 24 | 25 | 25 | 26.2 | 311.1 | 25.93 |
| 2001 | 27.3 | 28.3 | 21 | 29.4 | 27.7 | 24.3 | 23.2 | 22.8 | 24.2 | 29 | 28 | 21 | 306.2 | 25.52 |
| 2002 | 27 | 21 | 30.3 | 21 | 26.4 | 25.4 | 23.4 | 24.2 | 23.9 | 24 | 28 | 27 | 301.6 | 25.13 |
| 2003 | 27.2 | 29 | 29.2 | 27.3 | 25.9 | 24.5 | 24.1 | 23.6 | 24.1 | 25 | 25.7 | 27 | 312.6 | 26.05 |
| 2004 | 27 | 28.4 | 29.3 | 25.6 | 25.3 | 23.8 | 27 | 23.7 | 24.1 | 25 | 25.1 | 26.2 | 310.5 | 25.88 |
| 2005 | 27 | 27.6 | 29 | 29.4 | 26.7 | 25.1 | 22.9 | 23.5 | 24.7 | 25 | 25.8 | 27.7 | 314.4 | 26.20 |
| 2006 | 25.1 | 28.9 | 29.8 | 28.6 | 30.8 | 25.1 | 20.6 | 21.3 | 21.6 | 22 | 21 | 23 | 297.8 | 24.82 |
| 2007 | 27.3 | 27.3 | 28.5 | 27.5 | 27.8 | 25 | 22.7 | 22.4 | 22.7 | 24 | 24.3 | 24.7 | 304.2 | 25.35 |
| 2008 | 27.3 | 26.5 | 29.1 | 27.9 | 28.1 | 25.3 | 23 | 23.1 | 22.8 | 24 | 24.5 | 25.4 | 307 | 25.58 |
| 2009 | 23 | 28.3 | 29.8 | 28.8 | 27.8 | 26.7 | 23.5 | 22.2 | 22.4 | 24 | 25 | 25.4 | 306.9 | 25.58 |
| 2010 | 19.8 | 23 | 21.4 | 23.7 | 25 | 24 | 25 | 27 | 28 | 28 | 28 | 23 | 295.9 | 24.66 |
| 2011 | 21 | 21 | 29 | 21 | 24.6 | 23.3 | 22.2 | 21.2 | 21 | 23 | 25.9 | 26.3 | 279.5 | 23.29 |
| 2012 | 28 | 28.8 | 28 | 26.9 | 24.6 | 22.7 | 23.1 | 22.8 | 24.2 | 24 | 24.6 | 26.5 | 304.2 | 25.35 |
| 2013 | 26.9 | 27.6 | 28.5 | 26.8 | 23.9 | 22.5 | 20.7 | 20.9 | 22.2 | 23 | 23.9 | 25.4 | 292.3 | 24.36 |
| 2014 | 26.5 | 27 | 26.1 | 25.5 | 23.1 | 22 | 21.1 | 21.4 | 22.5 | 24 | 24.2 | 24.5 | 287.9 | 23.99 |
| 2015 | 26.2 | 26.6 | 27.8 | 27 | 24.3 | 22.6 | 21.3 | 21.7 | 22.4 | 24 | 24.7 | 25.9 | 294.5 | 24.54 |
| 2016 | 26.5 | 28.3 | 27.4 | 25.4 | 24 | 29 | 26 | 21.9 | 23.6 | 24 | 24.4 | 26 | 306.5 | 25.54 |
| 2017 | 26.6 | 27.4 | 28.5 | 29 | 25.1 | 26 | 29 | 21.2 | 23.6 | 24 | 29 | 25.7 | 315.1 | 26.26 |
| SUM | 522.3 | 532.5 | 558.5 | 536 | 515.4 | 490.2 | 466.1 | 452 | 468.1 | 489 | 508 | 510 | | |
| AVERA | 26.12 | 26.63 | 27.93 | 26.8 | 25.77 | 24.51 | 23.31 | 22.6 | 23.405 | 24.5 | 25.4 | 25.5 | | |

**Minimum temperature data in $^0$C for the year of (1998-2017) of Gidami district**

| YEAR | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1998 | 10.7 | 11.4 | 12.5 | 12.3 | 10.5 | 9.6 | 10 | 9.4 | 9.6 | 9 | 9.3 | 10.7 | 125 | 10.42 |
| 1999 | 10.1 | 12.2 | 13.2 | 13.6 | 12 | 11.2 | 10.7 | 11 | 10.4 | 10 | 11.4 | 10 | 135.8 | 11.32 |
| 2000 | 11.8 | 10.9 | 10.8 | 12.1 | 10.3 | 10.2 | 9.7 | 8.7 | 10.4 | 11 | 11 | 6.8 | 123.7 | 10.31 |
| 2001 | 7.8 | 9.2 | 9.9 | 15.9 | 14.7 | 11.3 | 12.5 | 12.2 | 13.1 | 13 | 12.3 | 12.7 | 144.6 | 12.05 |
| 2002 | 12.3 | 12.8 | 12.4 | 15.2 | 15.4 | 13.5 | 12.4 | 12.9 | 12.5 | 12 | 12.4 | 11.2 | 155 | 12.92 |
| 2003 | 10.7 | 12.5 | 13 | 14.3 | 12.1 | 10.8 | 10.7 | 10.6 | 10.5 | 10.6 | 13 | 13 | 141.8 | 11.82 |
| 2004 | 10.7 | 12 | 11 | 11 | 10.1 | 9.9 | 9.1 | 8.8 | 8.5 | 8.5 | 13 | 10.2 | 122.8 | 10.23 |
| 2005 | 5.3 | 7.3 | 8.5 | 8.8 | 8.2 | 6.9 | 7.1 | 6.5 | 6.1 | 5.9 | 8 | 13 | 91.6 | 7.63 |
| 2006 | 12.9 | 13 | 14.9 | 13.2 | 13.8 | 12.7 | 10.6 | 12.3 | 12.2 | 12 | 11.4 | 12 | 151 | 12.58 |
| 2007 | 12.2 | 13.6 | 14.1 | 14.2 | 13.5 | 12.2 | 12.2 | 12 | 11.5 | 11 | 10.8 | 8.8 | 146.1 | 12.18 |
| 2008 | 10.1 | 10.3 | 10.2 | 8.5 | 11.4 | 10.1 | 9.4 | 9.1 | 8.8 | 8.5 | 13 | 12 | 121.4 | 10.12 |
| 2009 | 13.1 | 15 | 13 | 11 | 5.8 | 12 | 13 | 12 | 13 | 11 | 10.5 | 14 | 143.4 | 11.95 |
| 2010 | 13.1 | 12 | 14.4 | 13.8 | 13.5 | 13.3 | 13 | 11.9 | 10.8 | 11 | 12 | 13 | 151.8 | 12.65 |
| 2011 | 11 | 12.5 | 13 | 14.9 | 14.8 | 15 | 14.3 | 14.5 | 11 | 13 | 15 | 13 | 162 | 13.50 |
| 2012 | 7.3 | 13 | 9.3 | 11.8 | 12 | 8 | 13 | 10,2 | 13 | 13 | 12 | 15 | 127.4 | 10.62 |
| 2013 | 14 | 12 | 12 | 13 | 5.8 | 12 | 13 | 12.9 | 13 | 13 | 15.7 | 16.4 | 152.8 | 12.73 |
| 2014 | 13.2 | 15.2 | 15 | 15.3 | 14.7 | 14.1 | 13.9 | 14.2 | 14 | 14 | 11.8 | 11.4 | 166.8 | 13.90 |
| 2015 | 11.4 | 13.3 | 13.5 | 15 | 14.7 | 14.1 | 13.5 | 13.4 | 13.9 | 13 | 11.1 | 10.4 | 157.3 | 13.11 |
| 2016 | 9.3 | 10.3 | 13.6 | 13.4 | 13.9 | 13.3 | 13.5 | 13 | 13 | 12 | 11.7 | 11.7 | 148.7 | 12.39 |
| 2017 | 11.3 | 11.9 | 12.5 | 14 | 14.7 | 13.8 | 13.3 | 13.5 | 13.5 | 12 | 11.6 | 10.9 | 153 | 12.75 |
| Annual | 218.3 | 240.4 | 246.8 | 261 | 241.9 | 234 | 234.9 | 219 | 228.8 | 224 | 237 | 236 | | |
| Av. Mi | 10.92 | 12.02 | 12.34 | 13.1 | 12.1 | 11.7 | 11.75 | 10.9 | 11.44 | 11.2 | 11.9 | 11.8 | | |