



Addis Ababa University

School of Graduate Studies

College of Social Sciences

Department of Geography and Environmental Studies

**Impact of Climate Variability on Food Security at Rural Household Level: The Case of
*Misrak Badawacho Woreda, SNNPR, Ethiopia***

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Impact of Climate Variability on Food Security at Rural Household Level:

The Case of *Misrak Badawacho Woreda, SNNPR, Ethiopia*

A Thesis Submitted to Department of Geography and Environmental Studies of Addis Ababa University, in Partial Fulfillment of the Requirements for the Degree of Master of Art (Climate Change and Adaptation)

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This is to certify that the thesis is prepared by Kebede Birhanu, entitled: *Impact of Climate Variability on Food Security* and submitted in partial fulfillment of the requirements for the Degree of Master of Arts (Geography and Environmental Studies, Specialization: Climate Change and Adaptation) complies with the regulations of the university and meets the accepted standards with respect to originality and quality.

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Table of contents	Pages
Acknowledgment.....	i
Table of contents.....	ii
List of Tables	v
List of Figures	vi
Acronyms and Abbreviations	vii
<i>ABSTRACT</i>	viii
CHAPTER ONE	1
1. Introduction	1
1.1 Background of the Study	1
1.2 Statement of the Problem.....	3
1.3 Objectives of the Study	4
1.3.1 General Objective	4
1.3.2 Specific Objectives.....	4
1.4 Research Questions.....	5
1.5 Significance of the Study	5
1.6 Scope of the Study	5
1.7 Limitations of the Study.....	6
1.8 Justifications of the study	6
1.9 Organization of the Paper	7
CHAPTERTWO	8
2. Literature Review	8
2.1 Definitions of Key Concepts.....	8
2.2 Theoretical Framework	15
2.2.1 Relationship between Climate Change and Food Security.....	15
2.2.2 Climate Change in Ethiopia.....	16
2.2.3 Agriculture and Vulnerability of Farmers in Ethiopia	18
2.2.4 Adaptation to Impact of Climatic Variability	21
2.5 Conceptual Framework	25
CHAPTER THREE	27
3. Study Area, Design and Methodology.....	27
3.1 Study Area.....	27
3.2 Topography	27
3.3 Population.....	27
3.4 Special Features in the Study Area.....	28

3.5 Climate Condition of the Study Area.....	29
3.6 Research Approach/Research Design	29
3.7 Research Methodology	30
3.7.1 Data Collection Instruments	30
3.7.2 Questionnaire/HHs survey	30
3.7.3 Key Informant Interview and Field Observation	30
3.7.4 Focus Group Discussion	31
3.7.5 Sampling Techniques and Sample Size Determination	32
3.7.6 Data Sources.....	33
3.7.7 Methods of Data Analysis	34
3.8 Socio-Economic Profiles	34
3.8.1 Agriculture	34
3.8.2Crop Cultivation.....	34
3.8.3 Livestock Production.....	35
3.8.4 Safety Net Program	36
3.8.5 Land Use Pattern.....	37
3.9 Social Infrastructures	38
3.9.1 Road Transport	38
3.9.2 Energy sources.....	39
3.9.3 Health.....	39
3.9.4 Education.....	40
3.9.5 Information and Communication.....	40
3.9.6 Market.....	41
CHAPTER FOUR.....	42
4. Result and Discussion	42
4.1 General Demographic Characteristics of Sample Households	42
4.2 Climate Variability and Its Impact in Misrak Badawacho Woreda.....	46
4.3 Rainfall: Amount, Trend and Seasonal Concentration.....	48
4.4 Seasonal Rainfall Pattern in Misrak Badawacho Woreda.....	52
4.5 Temperature Trend in the Study Area	56
4.6 Factors Affecting Crop Production in the study area.....	59
4.7 Analysis of Household Food Insecurity	62
4.7.1 Food Availability and Crop Production in Misrak Badawacho Woreda.....	62
4.7.2 Household Production Over the last ten Years (2006-2015/6).....	63
4.8. Access to Food.....	64

4.8.1 Household Income.....	64
4.8.2 Land use Practice and Holding size	65
4.8.3 Description of Livestock.....	66
4.8.4 Sale of Livestock.....	68
4.9 Aspect of Food Utilization	70
5.10 Vulnerability to Food Insecurity	72
4.11 Summarized Causes and Indicators of Food Insecurity in the Study area.....	75
4.11 Adaptation and Copping Strategies.....	76
4.12 Household Strategies to Copping food Insecurity	80
CHAPTER FIVE	85
5. Conclusions and Recommendations	85
5.1 Conclusions;-	85
5.2 Recommendations	87
REFERENCES	
Appendices	

List of Tables	Pages
Table 1.Distribution of sample households-----	32
Table 2.Distribution of land use-----	37
Table 3.Age and sex of the sample HHs-----	42
Table 4.Marital status and family size of the sample HHs-----	43
Table 5.Educational status and source of the sample HHs-----	44
Table 6.HHs' land holding size-----	45
Table 7.HHs' perception of rainfall trend-----	47
Table 8.Computation of PCI and pluviometric coefficient in the study area-----	50
Table 9.HHs' perception on temperature trend-----	55
Table 10.HHs' perception on factors of crop production-----	59
Table 11.Ten years average annual crop productions in study area-----	61
Table 12.HHs' agro-ecological comparison of average yield production-----	63
Table 13.Average monthly income of the sample HHs-----	63
Table 14.HHs' perception about farm land fertility-----	64
Table 15.Livestock trend-----	65
Table 16.HHs' perception about constraints of livestock rising-----	66
Table 17.HHs' perception of why animal feed declining-----	66
Table 18.HHs' estimated cost of house-----	67
Table 19.HHs' perception of causes of disease-----	68
Table 20.HHs' perception of distance to health center-----	70
Table 21 HHs' perception of distance to water source -----	70
Table 22.HHs' perception of causes of food insecurity-----	71
Table 23.HHs' meals interval per day-----	72
Table 24.HHs' perception of food insecure months per year-----	73
Table 25.Summarized causes and indicators of food insecurity-----	74
Table 26.HHs' perception of coping to livestock forage-----	75
Table 27.HHs' perception of government aid-----	71

List of Figures	Pages
Figure 1. Conceptual Framework-----	25
Figure 2. Map of the study area -----	28
Figure 3. Focus group discussion-----	31
Figure 4. Affected teff and maize crops by drought and flood in the study area-----	35
Figure 5. Safety net program users and DPPO coordinator (KII) -----	37
Figure 6. Affected land by flood and traditional farming system in the study area-----	38
Figure 7. Total Annual rainfall trend (1991-2015) -----	48
Figure 8. Winter average rainfall trend-----	51
Figure 9. Average belg rainfall trend-----	52
Figure 10. Average summer rainfall trend-----	53
Figure 11. Average autumn rainfall trend-----	54
Figure 12. Winter mean annual temperature trend-----	55
Figure 13. Belg temperature trend-----	56
Figure 14. Summer temperature trend-----	57
Figure 15. Autumn temperature trend-----	58
Figure 16. HHs adaptation strategies-----	76
Figure 17. Soil bund in the study area to adaptation-----	76
Figure 18. Stone bund and check dam for adaptation strategy-----	77
Figure 19. Closure area and water harvesting ponds in the study area-----	77
Figure 20. HHs coping through food consumption-----	80
Figure 21. Helps to HHs in hazard season-----	80

Acronyms and Abbreviations

CSA	Central Statistical Agency
EAS	Ethiopian Academy of Sciences
EIA	Environment Impact Analysis
EPACC	Ethiopia's Program of Adaptation to Climate Change
FAO	Food and Agricultural Organization
FGD	Focus Group Discussion
GHF	Global Humanitarian Forum
GHG	Greenhouse Gases
GPSNP	Governments Productive Safety Net Program
GTP	Growth and Transformation Plan
IPCC	Intergovernmental Panel on Climate Change
KII	Key Informant Interview
MBWANRO	Misrak Badawacho Woreda Agriculture and Natural Resource Office
MBWCTCO	Misrak Badawacho Woreda Culture, Tourism and Communication Office
MBWFEDO	Misrak Badawacho Woreda Finance and Economic Development Office
MBWFEP	Misrak Badawacho Woreda Forest and Environment Protection Office
MoFED	Minister of Finance and Economic Development
NAPA	National Adaptation Program for Action
NMA	National Meteorology Agency
SEA	Strategic Environmental Assessment
SNNPRS	Southern Nations Nationalities and People's Regional States
SPSS	Statistical Package for Social Sciences
UNDP	United Nations Development Program
UNEPA	United Nations Environmental Program
UNESCO	United Nations Educational Scientific and Cultural Organizations
USAID	United States Agency for International Development
WFP	World Food Program
CFSVA	Comprehensive Food Security and Vulnerability Analysis
PCI	Precipitation concentration index
WGII	Working Groups Two.

ABSTRACT

The objective of this study is to assess the impact of climate variability on food security in the study area. To achieve this objective, essential information was gathered from sample kebeles from two agro-ecological zones based on mixed research design. Both quantitative and qualitative data were collected concurrently. The quantitative data includes long-term climatic data (1991-2015) and crop outputs for 10 years (2005-2015) were used for analysis. Multi-stage sampling techniques were employed to select appropriate key informants, discussants and sample households. Based on the relevant information gathered, the status of food insecurity is assessed by their income and food insecurity indicators in the household level. The result of the analysis shows that the rainfall pattern in the study area is highly concentrated in the three months of the summer season. The spring and autumn rains are also found to be determinant factors to agricultural productivity in the study area. Hence, the overall results of the study clearly indicates that both rainfall and temperature attributes significantly determine the annual agricultural outputs causing food insecurity in the study area in addition to socio-economic and technological factors. The study also depicts that the livelihoods of the local people could not sustain the food insecure segments of the population. Landlessness, female headed households, households who didn't have oxen, large family size, patient household heads, and households with less access to diversified sources of income and elders who have no support are the most food insecure segments of the populations. There are four groups of population in the study area. Such as severely food insecure, moderately food insecure, food secure & highly food secure, based on food sufficiency within a year. The study also depicts that, means of adaptation and coping mechanisms of the local people vary. Thus, the local people particularly, those who dwell in kumudo kebele, which is ecologically dry woina dega are significantly affected, and their adaptive capacity is low. Therefore, it is suggested that among other things, enhancing environmental protection (implementing improved soil and water conservation technologies), diversifying off-farm, assuring tenure security, strengthening adaptation and coping strategies, increasing livestock sub-sector productivity and improving irrigation schemes must receive policy attention to enhance agricultural productivity and household food security in the study area.

Key words: Food security, agriculture practices, adaptation, households, climate variability

CHAPTER ONE

1. Introduction

1.1 Background of the Study

Climate change refers to any significant change in the measures of climate lasting for an extended period of time. In other words, climate change includes major changes in temperature, precipitation, or wind patterns, among other effects, that occur over several decades or longer (US EPA, 2016).

Global climate change has potential to damage irreversibly the natural resource base on which agriculture depends, with grave consequences on food security. It also, reduces the productivity of the majority of existing food systems and harms the livelihoods of those already vulnerable to food insecurity (HLPE, 2012). Meeting the dual challenge of achieving food security and other developmental benefits on the one hand and mitigating and adaptation to climate change on the other hand requires political commitment at the highest level (UNEP, 2009).

IPCC concluded that it is very likely during the 21st c that there will be higher maximum temperature and more hot days over nearly all land areas and higher minimum temperature, fewer cold days and frost days over nearly all land areas, and more intense precipitation events. And, it also concluded that increased summer continental drying and drought are likely over most mid-latitude continental interiors (Neil et al., 2001).

Food security is a global challenge closely linked to poverty. The global lobby for Global Development has indicated food security is Goal number one. There has been progress in reducing global hunger (protein-energy malnutrition) from about 1 billion people in 1990-1992 to about 870 million in 2010-2012 (Negatu, 2016).

Agricultural growth remains slow in many countries in Sub-Saharan Africa due to many challenges leading to food-insecurity, malnutrition and high level of poverty. About 70 percent of the world's poorest people live in rural areas in Southern Asia and Sub-Saharan Africa. The challenge of poverty and food insecurity among the world's poor could be addressed through improvement of agricultural performance, improvement in market access, reduction in risks that face farmers and investment in rural infrastructure and enterprise (Negatu, 2016).

The African continent is vulnerable to the impacts of climate change because of several factors like poverty, recurrent drought, population growth and urbanization, inequitable land distribution, over exploitation of resources, subsistence rain-fed agriculture, extreme weather events combined with a low capacity to adapt to the adverse impacts of climate change, aggravate food security risks like decline in productivity, reduced yields, and food insecurity (Aster, 2010). Climate change directly affects food production through change in the agro-ecological conditions and indirectly affects growth and distribution of incomes, and thereby, the demands for agricultural products (NMA, 2007).

Ethiopia is vulnerable to climate change due to its reliance on climate sensitive economic sector which is primary source of livelihoods for the majority of the people in the country due to low level of socio-economic developments, inadequate infrastructure and high dependency on natural resources that make the country more vulnerable to variability of climatic elements and extreme climate events (NMA, 2007). The critical issue of the Ethiopian economy is its laggardness to liberate millions of people entrenched in chronic and seasonal food insecurity-poverty trap. In 2003, about 14.3 million of people faced critical food shortage and crises (Negatu, 2016). Climate related hazards in Ethiopia include; drought, flood, heavy rains, strong winds, frost, heat waves/ high temperature etc.

The overall results of the study clearly indicates that both rainfall and temperature attributes significantly determine the annual agricultural outputs causing food insecurity in the study area. There are four groups of population in the study area. Such as severely food insecure, moderately food insecure, food secure & highly food secure, based on food sufficiency within a year.

According to Negatu (2016), in developed and developing countries all over the world, farmers and indigenous and local communities have traditional knowledge, expertise, skills, and practices related to food security, agricultural production, diversity and adaptation. The study also depicts that, means of adaptation and coping mechanisms of the local people vary. Thus, the local people particularly, those who dwell in kumudo kebele, which is ecologically dry woina dega are significantly affected, and their adaptive capacity is low than moist woina dega even though they used various adaptive and coping strategies. Therefore, this study values for policy makers to adjust additional remedies to problem and helps as baseline for those interested to study on similar issues in Misrak Badawacho Woreda.

1.2 Statement of the Problem

Food insecurity and undernourishment is the most acute challenge in Sub-Saharan Africa. These challenges have been compounded by effects of climate change that result either in heavy flooding or drought that destroy farm produce and causes crop failure respectively(Negatu, 2016).

Agricultural productivity is highly dependent on weather, climate and water availability, and is adversely affected by weather and climate related disasters. Failure of rains and occurrence of natural disasters such as floods and droughts could lead to crop failures, food insecurity, famine, loss of property and life, mass migration, and negative national economic growth (Sivakumar, 2005).Crop failure and food shortage can result from what appears to be a minor and much localized decrease in annual precipitation (Hassan, 2002). Among the many challenges constraining Ethiopian agriculture, none is more severe than that caused by its overwhelming dependence on weather and climate (EPCC, 2015).

Farmers are the most susceptible to climate change that it affects directly or indirectly their productivity especially precipitation and temperature. They have direct impact on agricultural productivity and indirect impact through by pests on crops, reducing water availability and increasing natural resources degradation (Edward,2011).Agriculture-based livelihood systems that are already vulnerable to food insecurity face immediate risk of increased crop failure, new patterns of pests and diseases, lack of appropriate seeds and planting material, and loss of livestock.

According to Killmann (2008), it will also affect all four dimensions of food security: food availability, food accessibility, food utilization and food systems stability. Food insecurity is a condition that put impact on population that usually experience food shortage. It must be analyzed in the context of climate variability, climate change and uncertainty in order to minimize its future impact (WFP 2009).

Climate variability has an impact on human health, livelihood assets, food production and distribution channels, as well as changing purchasing power and market flows. Its impacts can be categorized in to both short term, resulting from more frequent and more intense extreme weather events, and long term, caused by changing temperatures and precipitation patterns. People who are already vulnerable and food insecure are likely to be the first affected (Killmann, 2008).

From my long experience and as different reports the problem of food insecurity has been challenging the livelihoods of the rural households in the study area whose existence is largely dependent on agriculture. According to Disaster Prevention and Preparedness work Unit head of *Misrak Badawacho Woreda* Agriculture Office; in 2000 year 56,020, in 2015 year 32,324 and in 2016 up to May 27, 226,475 households were registered to be victims of food shortage and famine and food aid was provided to sustain their life. This obviously verifies that food shortage and famine is prevalent in the study area. Actually, *East Badawacho Woreda* Agriculture Officers indicated that rainfall variability and temperature fluctuation are major causes for food insecurity and famines frequently observed in the area. However, no study has been found that upholds or denies the views of the Agriculture Officers. And, the study conducted by Addise (2014) reveals only land degradation dimension without showing such climate variability hazard/flood with food security. Taking this in to consideration, this study aimed to fill this gap by assessing and investigating the vulnerability of households to food insecurity and its causes and coping mechanism of households' to food insecurity in *Misrak Badawacho Woreda*.

1.3 Objectives of the Study

1.3.1 General Objective

The main objective of the study is to investigate the vulnerability of households to food insecurity at rural household level in *Misrak Badawacho Woreda, Hadiya Zone, SNNPR*, and Ethiopia.

1.3.2 Specific Objectives

The specific objectives of the study are:

- To assess the rainfall and temperature trend using meteorological data in the study area.
- To determine the status of food security in the study area.
- To examine the impact of climate variability on agricultural productivity and food security.
- To identify the causes of food insecurity in the study area.
- To differentiate local adaptation and coping strategies at the HH level in the study area.

1.4 Research Questions

Based on the Objectives of the study and relevant literature, the following research questions were posed.

Research questions are;-

1. What looks like the trend of rainfall and temperature in the study area?
2. What is the status of food insecurity in the study area?
3. To what extent does climate variability affect the agricultural productivity and food security?
4. What are the causes of food insecurity in the study area?
5. What are the local adaptation and coping strategies to impacts in the study area?

1.5 Significance of the Study

The study provides important information about patterns of climate variability and provides options for the impact induced to vulnerability by climate variability. It contributes a better understanding of predicted impacts of climate variability on agricultural products and food security. It also serves as base line information to facilitate and exchange of ideas among local community, researchers, policy makers, development actors etc. at different institutional level by creating awareness on how to keep up local knowledge and use it as input for further studies on the area under threat of climatic variability.

1.6 Scope of the Study

The study focused on assessing the impact of climatic variability on food security in rural households on selected two sample kebeles from *Misrak Badawacho Woreda in Hadiya zone, SNNPR*. These two sample kebeles are selected from *dry woina dega -Kumudo and from moist woina dega-Ajaba chalfo* from both agro-ecological zones of the Woreda. And, study focused more on farming dependent segment of population rather than engaged in various works. The study area is selected purposely based on the researcher's previous and current knowledge for the *woreda* and the sample kebeles were selected randomly.

1.7 Limitations of the Study

However, challenges had occurred while conducting the study. The first and the most challenging event was the limitation of time and money.

The other challenge was frustration of meteorological data in the study area because it is not allowed to put such data at woreda level. Thus, the researcher forced to travel about 120 km of distance from study area to Hawassa, NMA branch, 2-3 times. The other problems that the researcher faced was clash of programs held with developmental agents to use the enumerators and key informants with that of *woredas* seasonal trainings and works. However, it adjusted by postponing the held program to appropriate days. In all this ups and downs, the aforementioned money constraint played a great role in travelling and buying stationaries even the regular salary in the study area stayed for more than a month (up to 34/35 days) due to budget deficit in *woreda*. Even though there is unmentioned lot of challenges, to be a fruitful in the work, the researcher tried to overcome it using different means.

1.8 Justifications of the study

The rationale of food security by Ethiopian government within national as well as local priorities is very important. These is analyzed within the consent of the current, policy frameworks, such as Growth and Transformation Plan (GTP) of (2010-2015), Agriculture sector Policy and Investment Framework (PIF), Food Security Program (FSP) of (2010-2014), and National Nutritional Strategy, (NNS) of (2008). In line with this, DPPO reports and *Woreda* agriculture and natural resource development office reveals the study area is over dependent on rain-fed agriculture so that the vulnerable segment were relied on different Governmental and Non-Governmental aids. The study area faces several food insecurity challenges which, coupled with environmental degradation, have accelerated decline in land productivity resulting in deteriorating livelihood. Therefore, this study values for policy makers to adjust additional remedies to problem and helps as baseline for those interested to study on similar issues in Misrak Badawacho Woreda.

1.9 Organization of the Paper

This paper is organized in five chapters. The first chapter deals with the introductory part that comprises background of the study, statement of the problem, objectives, research questions, significance and limitation of the study, Chapter two includes reviews of some relevant literature. The third chapter describes the research methodology and sampling techniques, fourth chapter deals about data analysis/ discussions and results. Then the last chapter contains conclusion and recommendation. The data collection tools and other information attached as appendices.

CHAPTER TWO

2. Literature Review

2.1 Definitions of Key Concepts

Climate change refers to any significant change in the measures of climate lasting for an extended period of time. In other words, climate change includes major changes in temperature, precipitation, or wind patterns, among other effects, that occur over several decades or longer (US EPA, 2016). As free encyclopedia it is a change in the statistical distribution of weather patterns when that change lasts for an extended period of time (i.e., decades to millions of years). Climate change may refer to a change in average weather conditions, or in the time variation of weather around longer-term average conditions (i.e., more or fewer extreme weather events). It is a large-scale, long-term shift in the planet's weather patterns or average temperatures (US EPA, 2016).

It also believed to be the main cause of hunger and malnutrition affecting 45million people as a result of lower crop yields and fewer livestock and livestock products (Haakansson, 2009).

Climate change and development are highly intertwined: The risks of global warming could jeopardize decades of development efforts, particularly in the poorest regions of our planet. It is therefore vital to ensure that development projects strengthen their beneficiaries' capacities to confront climate change (Keller, 2009). It also will have an effect on the frequency, intensity and duration of extreme weather events which could negatively affect food security in some of the most vulnerable areas (Krishnamurthy et. al., 2013).Its impacts are undermining a whole range of human rights: rights to food, safe water and health and education (Willis, 2015).It also by increasing hazard at the same time as it erodes resilience, and has a magnifying effect on disaster risk. In particular, climate change will magnify the uneven distribution of risk, skewing disaster impacts even further towards poor communities in developing countries (UN, 2009).

In addition its impact on crop production would be mainly through change in temperature, rainfall, which collectively influence the length of growing period, time of critical growth rate, increased evapo-transpiration and hence seriously reduced and in some cases causes complete crop failure. At a global scale, pests and diseases attribute to an average yield loss of 18% and 16%, respectively in major crop species.

Additionally it affects food and nutrition security and further undermines current efforts to reduce hunger and protect and promote nutrition. Consequently, under nutrition in turn undermines the resilience to shocks and the coping mechanisms of vulnerable populations, lessening their capacities to resist and adapt to the consequences of climate change. It directly affects food and nutrition security of millions of people, undermining current efforts to address under nutrition, one of the world's most serious, but least addressed socioeconomic and health problems (EPCC, 2015).

It further will alter potential losses to many pests and diseases as changes in temperature can result in geographic shift through changes in seasonal extremes (EPCC, 2015). Also, with increased variability and extremes, it puts an extra constraint on food security (Liniger, et al., 2011).

Climate; -is average state of the atmosphere observed over a long period of time. It represents the accumulation of daily and seasonal weather events over a long period of time (Ahrens, 2007).

Weather; - is a condition of the atmosphere at a particular place and time. It is a day to day state of atmosphere (Ahrens, 2012: Muluneh, 2010).

Global warming refers to the recent and ongoing rise in global average temperature near Earth's surface. It is caused mostly by increasing concentrations of greenhouse gases in the atmosphere. Global warming is causing climate patterns to change. However, global warming itself represents only one aspect of climate change (US EPA, 2016). To a scientist, global warming describes the average global surface temperature increase from human emissions of greenhouse gases (Watanabe, 2008).

Vulnerability;- is defined as the degree to which a system is susceptible and unable to cope with adverse effects of climate change including climate variability and extremes (IPCC, 2001).It is also defined as the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt (WGII, 2014).

Limited national scientific, technological, financial and institutional capacity and arrangements and poor infrastructure collectively heightened Ethiopia's vulnerability to the impacts of climate change. Major floods occurred in different parts of the country in 1988, 1993, 1994, 1995, 1996, and 2006 and overall, periodic drought in Ethiopia causes severe reductions in food availability,

putting government expenditures on food aid and emergency drought relief to swell during these periods.

In recent years, the Ethiopian government has maintained records of expenditures on vulnerability and food security, which have typically increased during extreme drought (e.g., 1999–2000 and 2003–2004), (EPCC, 2015).

Impacts: Effects on natural and human systems. It is generally refers to effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services, and infrastructure due to the interaction of climate changes or hazardous climate events occurring within a specific time period and the vulnerability of an exposed society or system. This is also referred to as consequences and outcomes.

The impacts of climate change on geophysical systems, including floods, droughts, and sea-level rise, are a subset of impacts called physical impacts (WGII, 2014).

Risk: The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values.

Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability, exposure, and hazard. In this study, the term *risk* is used primarily to refer to the risks of climate-change impacts (WGII, 2014).

Hazard: The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources. In this study, the term *hazard* usually refers to climate-related physical events or trends or their physical impacts (WGII, 2014).

El Niño –is irregularity in weather/climate caused by reversal in pressure and air circulation between east pacific and west pacific. It is a part of large scale ocean- atmosphere interaction that can take several years to run its course. This condition frequently occurs around Christmas, local residents called itEl Niño, (Spanish for boy child) referring to the Christ child (Muluneh, 2010). It also defined by technical brief as following is a warming of the central Pacific leading to high pressure weather systems. The term was first used by fishermen in the 1600s along the coasts of Ecuador and Peru to describe an unusually warm ocean current, typically observed around Christmas time and lasting for several months (Technical Brief, 2015).

La Niña- (the girl child) is the cold water episode which is the opposite El Niño condition (Muluneh, 2010). Technical brief puts it as follows the opposite of El Niño warming is a colder sea surface temperature leading to low pressure weather systems. For example, the Horn of Africa drought of 2011 was triggered by a deep and prolonged *La Niña* episode and resulted in a severe food security and nutrition crisis that affected the lives and livelihoods of more than 12.5 million people living in the region's dry lands (Technical Brief, 2015).

Climate variability: refers to the year to year variations of atmospheric conditions around the mean states (WMO, 1992). It is natural climate variation on astronomical/ geological time scales as distinct from human-induced climate change (Killmann, 2008).

Key weather variables for crop prediction are rainfall, temperature, solar radiation, humidity and wind speed that play great role. Its shocks directly impact house hold economies, but also often aggravate other stresses such as disease burden (Sivakumar, 2005). Climate change, and increasing climate variability, as well as other environmental issues, such as land degradation, loss of biological diversity and stratospheric ozone depletion, threatens our ability to meet the basic human needs inadequate food, water and energy, safe shelter and a healthy environment (Sivakumar, 2005).

Adaptation: refers to a response to climate related disasters that are not prevented by mitigation efforts. It is coping with those climate change effects that we cannot, will not; prevent. It is already happening as a response to climate change along with climate variability and other non-climate factors. It is the principal way to deal with the impacts of a changing climate. It involves taking practical actions to manage risks from climate impacts, protect communities and strengthen the resilience of the economy (Goodwin, 2008; Burton et al., 1993; SERA, 2000; IPCC 2015).

Mitigation: refers to efforts to prevent climate change. It is an action or a series of actions taken to reverse or to stop an adverse situation. It comprises conservation and, the development and employment of alternative energy sources. It consists of a component of technology and behavior change (Goodwin, 2008).

Livelihoods: can be defined as the bundle of different types of assets, abilities and activities that enable a person or household to survive. These assets include physical assets such as infrastructure and household items; financial assets such as stocks of money, savings and pensions; natural assets such as natural resources; social assets, which are based on the

cohesiveness of people and societies; and human assets, which depend on the status of individuals and can involve education and skill (Killmann, 2008).

Resilience: The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation (WGII, 2014).

It also understood here to mean the ability of individuals, households, and/or communities to withstand and respond to droughts and other shocks and it determined by Exposure, Sensitivity and Coping capacity.

Exposure can be defined as the nature and degree to which the income generating assets of a household are located in places where they are subject to droughts and other shocks.

A household whose assets are located in an area in which severe droughts occur once in every 5 years on average is more exposed than a household whose assets are located in an area in which severe droughts occur once in every 15 years on average.

Exposure is an exogenous dimension of vulnerability, that is, it is beyond the control of the household in the short run (Cervigni et al., 2016).

Sensitivity is the degree to which a household is affected by droughts and other shocks. For a given level of exposure, a household that derives a large share of its income from drought-affected activities (e.g., rain fed cropping, pasture-based livestock production) will have a higher sensitivity to droughts, other things equal, than a household that derives a small share of its income from drought-affected activities. Sensitivity is determined in large part by past decisions made by the household regarding the nature and mix of its assets and by its livelihood strategy. Changing the nature and mix of assets, as well as the livelihood strategy, is one of the main avenues the household can follow to enhance its resilience (Cervigni et al., 2016).

Coping capacity refers to the ability of a household to mitigate the impact of drought and other shocks after they occur. Access to financial resources (from its own savings, from friends or relatives, or from social safety nets) can help the household make up for an income shortfall resulting from, for example, a drop in production following a drought. Liquidating productive assets to mitigate the negative impacts of current droughts may reduce the ability of the household to mitigate the impacts of future droughts, that is, it will reduce the household's resilience (Cervigni et al., 2016).

Food: is any substance consumed to provide nutritional support for the body. It is usually of plant or animal origin, and contains essential nutrients, such as fats, proteins, vitamins, or minerals. The substance is ingested by an organism and assimilated by the organism's cells to provide energy, maintain life, or stimulate growth. (<https://en.wikipedia.org/wiki/Food>.)

Food security: is the state at which all people at all times has physical and economic access to sufficient , safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (world food summit,1996). It also defined as follows by Ethiopian academy of sciences “Food security exists when people have sustainable physical and economic access to enough, safe, nutritious, and socially acceptable food for an active, healthy and productive life” (EPCC, 2015; Negra, 2013).

The above definition connotes various elements that condition food security. These include food availability through domestic production or imports and economic capacity to access food, which in itself must be adequate in terms of quantity and quality to provide enough calories, proteins and minerals adequate for sustained health and productive performance.

Thus, climate variability or change has a direct effect on food security. Food security vulnerability to climate change begins with biophysical effects at the level of individual farms on plants and animals and the systems in which they are managed. These effects alter livelihoods in rural areas directly and urban areas indirectly. International markets transmit the effects of climate change elsewhere and can affect local food security, both for better and worse, by altering domestic prices and influencing livelihoods. The poor and other vulnerable groups are likely to be at high risk to food insecurity brought by climate change (HLPE, 2012).

Food insecurity: is defined as lack of access by people to enough food for an active and healthy life. It describes the phenomenon of food deficit in the household and the community level (Balcha, 2001).Risk of food insecurity and the breakdown of food systems linked to warming, drought, flooding, and precipitation variability and extremes, particularly for poorer populations in urban and rural settings, (WGII, 2014; Tagel, 2008).It also can be described clearly by concepts such as hunger, under nutrition and famine.

Hunger: is defined as the condition resulting from an individual’s inability to eat sufficient food to lead a healthy and active life (Balcha, (2001).

Whereas **under nutrition** is defined as the measurable nutrient deficiency in a diet that can lead to illness (lack of energy, retardation, blindness) or even deaths. Undernutrition can be classified into acute and chronic undernutrition (Balcha, (2001).

Acute undernutrition is a short-term inadequacy of food intake, in cases such as famine or war. In such case the person under acute undernutrition can be recovered from it when the causes are improved or ended.

Nevertheless, the term chronic undernutrition refers to long-term inadequacies. Chronic undernutrition may have physical effect in height, weight and intellect and the term **famine** describes a widespread and extreme hunger that results for individuals in a drastic loss of body weight and an increase in morbidity. At the community level it describes the rise in the death rate and massive social dysfunction and dislocation (Balcha, 2001).

Food measured in four dimensions such as;-

Food availability: the physical presence of food through domestic production, commercial imports or food aid. Indicators of changes in food availability might include crop and livestock production trends (*sufficient quantity of food for consumption*) (Killmann, 2008; WFP, 2014).

Food access: a household's ability to acquire adequate amounts of food, through a combination of home production and stocks, purchases, gifts, borrowing and aid. Indicators of food access changes might include food price trends and market flows (*ability to obtain food regularly through own production or purchase*) (Killmann, 2008; WFP, 2014).

Food utilization: a household's consumption of the food it has access to and the individuals' ability to absorb and metabolize the nutrients. Indicators could include physiological development (*quality and safety of food, including nutrition aspects*) (Killmann, 2008; WFP, 2014).

Food stability: the condition where food is regularly and periodically available and affordable so that it contributes to nutritional security. Indicators of stability include the impact of shocks such as floods and droughts on crop production. Changes in climate and increases in some extreme weather events, such as floods and droughts, could disrupt stability in the supply of food and people's livelihoods making it more difficult for them to earn a stable income to purchase food (*risk of losing access to resources required to consume food*)(Killmann, 2008;WFP, 2014).

Food systems: encompass (i) activities related to the production, processing, distribution, preparation and consumption of food; and (ii) the outcomes of these activities contributing to

food security (food availability, with elements related to production, distribution and exchange; food access, with elements related to affordability, allocation and preference; and food use, with elements related to nutritional value, social value and food safety). The outcomes also contribute to environmental and other securities (e.g. income). Interactions between and within biogeophysical and human environments influence both the activities and the outcomes (Killmann, 2008).

2.2 Theoretical Framework

2.2.1 Relationship between Climate Change and Food Security

Climate variability and food availability are highly interlinked being climate variability is a primary controlling factor of agricultural productivity. It is expected to negatively influence crop production, livestock rearing and water cycle. It also affects food security together with overpopulation, poor land and poor water management causing hunger and malnutrition. A significant proportion of people in the crop dependent highlands are chronically food insecure. Moreover, climate change places more pressure on the food security of millions by reducing crop yields, increasing land degradation, and lowering water availability (EPCC, 2015).

Some 45mil people affected worldwide as a result of reduced yield of cereals, fruits, vegetables, cash crops and livestock's (GHF, 2009). So ,climate change make shrinking of yield rates, arable land shocks to natural calamity creating less favorable growth conditions. Extreme weather events under climate change, the frequency and intensity of some disasters such as droughts, floods and storms could increase, with an adverse impact on livelihoods and food security.

And, climate-related disasters have the potential to destroy crops, critical infrastructure, and key community assets therefore deteriorating livelihoods and exacerbating-poverty. (<http://documents.wfp.org/stellent/groups/public/documents/communications/wfp258981.pdf>).

Understanding the specific impacts of climate change on food security is challenging because vulnerabilities are unevenly spread across the world and ultimately depend on the ability of communities and countries to cope with risks. In the context of food security, some regions of the world might experience gains under climate change, but developing countries are likely to be negatively affected. Changes in climatic conditions have already affected the production of some staple crops, and future climate change threatens to exacerbate this.

Higher temperatures will have an impact on yields while changes in rainfall could affect both crop quality and quantity. (<http://documents.wfp.org/stellent/groups/public/documents/communications/wfp258981.pdf>).

Drought, flood, heat wave, and rainfall failure can have devastating consequences for agricultural production and the impacts could be immediately transmitted to food security and human livelihoods (Ferede et al., 2013).

If agricultural production in the low-income developing countries of Asia and Africa is adversely affected by climate change, the livelihoods of large numbers of the rural poor will be put at risk and their vulnerability to food insecurity increased (Killmann, 2008).

Among the most significant impacts of climate change is the potential increase of food insecurity and malnutrition (Krishnamurthy, 2013). Climate change affects plants, animals and natural systems in many ways. It will result in multiple stresses for animals and plants in many agricultural and aquatic systems in the coming decades. Irregular precipitation that already affects the livelihood and production of a large number of rural families is expected to become more serious in the face of climate change (HLPE, 2012). Households that rely on herding or farming as principal livelihood sources will continue to be exposed to droughts and other shocks, which depending on their frequency and severity can negatively affect incomes and plunge large numbers of people into poverty (Cervigni et al., 2016).

2.2.2 Climate Change in Ethiopia

Ethiopia is highly vulnerable to the impacts of climate variability. Its agriculture is heavily dependent on natural rainfall, with irrigation agriculture accounting for less than 1% of the total cultivated land. Thus, temperature, the amount and temporal distribution of rainfall and other climatic factors during the growing season are key determinants to the crop yields and, in turn, food shortages, malnutrition and famine. Small scale farmers and pastoralists are already feeling these impacts in their food security and livelihood opportunities (Oxfam, 2010; 2014).

Ethiopia ranks 10th in the list of countries most at risk of climate change in 2014, according to the Climate Change Vulnerability Index, prepared. The low-level of development and dependence on agriculture are the main reasons for this vulnerability (Weldegebriel, 2014).

Climate variability and extreme events (drought and heavy rains) are causing significant damage to life, property, natural resources and economy in Ethiopia; making the most important

economic systems highly vulnerable (EPCC, 2015). Food security is highly sensitive to climate risks in Ethiopia.

This is because 90% of rural households rely on agricultural activities (livestock, crop production, or a combination of the two) as the main occupation of their household head and irrigation coverage levels are very low (WFP, 2014).

The Ethiopian population is experiencing climate change and its impacts on the environment and natural resources. A decrease in seasonal rainfall has devastating implications on agricultural production leading to food insecurity, malnutrition and famine. The frequency and intensity of drought is likely to increase over the coming decades, which will present a serious threat to biodiversity, ecosystems, water, agricultural and human health. Impacts of increased climate variability and change include (i) increased food insecurity; (ii) outbreaks of diseases such as malaria, dengue fever and water borne diseases such as cholera and dysentery due to floods, and (iii) respiratory diseases associated with droughts; (iv) heavy rainfalls which tend to accelerate land degradation and damage to communication infrastructure (César et al., 2013; EPCC, 2015).

Effects of climate change e.g. changed rainfall patterns and also extreme weather events such as droughts negatively affect agricultural production and food security. In Ethiopia, food insecurity is widespread due to chronic drought and flooding (César, et al., 2013). Dependence on unreliable and low-productivity rain fed agriculture may well be the primary determinant of household food insecurity in Ethiopia (Devereux, 2000).

A significant proportion of people in the crop dependent highlands are chronically food insecure. Moreover, climate change places more pressure on the food security of millions by reducing crop yields, increasing land degradation, and lowering water availability.

For example, a bio economic analysis using maize crop as a case study indicate that the number of food insecure people in Ethiopia would increase by up to 2.4 million by 2050 as a result of the impact of climate change not only on production but also on global agricultural import and export trade and prices (EPCC, 2015).

Also it is making things even worse for the poor countries like Ethiopia. The rains no longer fall; rainy seasons are shorter and more intense. In some places, the rain doesn't come at all, or arrives in very small quantities. The changing climate is resulting in an even more vulnerable population, and an even greater risk of hunger crises (Haakansson, 2009).

The estimated number of people affected by food shortages in Ethiopia varies from year to year and from region to region.

Reports indicated that the Ethiopian droughts of 1974 and 1984 were among the most severe events affecting over 8.3 million people (MOA, 2010). However, poverty is still a big obstacle to overcome in Ethiopia. Nearly one third of the population lives below the poverty line, and a vast majority depends on subsistence agriculture. Chronic and acute food insecurity is prevalent, especially among rural populations and smallholder farmers. About 10 percent of Ethiopia's citizens are chronically food insecure, and this figure rises to more than 15 percent during frequent drought years (CARE, 2014).

It also repeated by Ethiopian Academy of Science as follows, the number of people needing food assistance can be categorized into two broad groups, i.e., those categorized as chronically food insecure and those categorized as transitory food insecure. This means that the former category of people are permanently in a state of food insecurity under the prevailing environmental and socio-economic conditions and can be corrected if and when these constraining conditions are improved. Those under the second category are vulnerable when environmental and socio-economic shocks are beyond their means. Various estimates indicate that chronic food insecurity affects between 5-6 million people in the country on the average on annual basis while the remaining are classified under the second category (EPCC, 2015).

The climate of Ethiopia is characterized by extreme events, such as drought and floods which made the country often affected by famine and food shortage in the world (UNDP; 2010; NMA 2007). The problem of famine and food shortage traced back to 250B.C in the country consistent with the history of drought which has occurred in various parts of the country in different times. Since the 19thc about 30 major episodes have been recorded about 13 of which covered the whole country and reported to be a severe. The rest affected mainly Wolo and Tigray (UNESCO, 2004). The frequency and spatial coverage of drought has increased over the past few decades.

The last two decades have been marked by wide spread drought and famines occurring every two to three years as compared to every 7 to 10 years over the previous decades (NMA, 2007; UNESCO, 2004).

2.2.3 Agriculture and Vulnerability of Farmers in Ethiopia

Agriculture remains by far the most important economic sector in the Ethiopian economy for the following reasons: (i) it directly supports about 85% of the population in terms of employment and livelihood; (ii) it contributes about 50% of the country's gross domestic product (GDP); (iii) it generates about 88% of the export earnings; and (iv) it supplies around 73% of the raw material requirement of agro-based domestic industries. It is also the major source of food for the population and hence the prime contributing sector to food security. In addition, agriculture is expected to play a key role in generating surplus capital to speed up the country's overall socio-economic development (Deressa, 2007; MoFED, 2007; Haile, et al. 2005).

Although crop area, yield and productivity are increasing at a national level, currently, climate change is expected to have significant effects on crop production in the medium to long term period if the present rates of global warming continue unabated (EPCC, 2015).

Ethiopia's agriculture is heavily dependent on natural rainfall, with irrigation agriculture accounting for less than 1% of the total cultivated land. Thus, temperature, the amount and temporal distribution of rainfall and other climatic factors during the growing season are key determinants to the crop yields and, in turn, food shortages, malnutrition and famine (César et al., 2013; Killmann, 2008; Mahlet, 2013; MoFED, 2007).

Ethiopia's dependency on agriculture and low adaptive capacity make the country highly vulnerable to the adverse impact of climate variability. Many farmers die of hungers and depend on foreign food aid during extreme drought periods. For instance, by 1983/84 drought year a million people died due to drought that leads to famine. Several households have also been affected during drought periods over different years (UNESCO, 2004). The current climatic variability is already imposing a significant challenge to Ethiopia by affecting food security, water and energy supply, sustainable development efforts by causing natural resource degradation and natural disasters (Haakansson, 2009).

In animal resources: Ethiopia is said to have the largest number of domestic animals in Africa, estimated at 55.03 million cattle, 27.4 million sheep and 28.2 million goats in addition to a large number of poultry, camels and equines (pack animals). Climate affects animal production in three major ways: (a) the direct effects of weather and extreme events on herd body conditions and dynamics (b) indirectly, impacts on pastures and forage crop production and quality; (c) changes in the distribution of livestock diseases and pests could be substantial.

The direct effects include temperature and other climate factors such as shift in rainfall amount and patterns on animal growth, reproduction and milk production. The indirect effects include climatic influences on availability of water, the quantity and quality of animal feed such as pasture, forage, crop yield and the severity and distribution of livestock diseases and parasite (EPCC, 2015).

Ethiopia has the largest livestock population in Africa and the tenth largest in the world. Livestock is an integral part of the farming systems in the country. It is the source of many social and economic values such as food, power, fuel, cash income, security and investment in both the highland and the lowland pastoral farming systems. The livestock sector contributes approximately 12 to 15% to total GDP and about 25 to 30% to the agricultural GDP.

It is also a major source of foreign exchange, second only to coffee. In general the country's livestock resources are characterized by low productivity.

Average yields per animal slaughtered or milked are estimated at 110kg of beef, 10kg of mutton and 213kg of cow's milk. At present the per capita consumption of milk and meat is estimated to be 16 kg and 10 kg per annum respectively (Deressa, 2007).

In Water resources: - Ethiopia is considered as the “water tower” of East and Northeast Africa as many rivers flow out of the country because of its high altitude that forces such outflows to the surrounding countries. It is estimated that the country's irrigation potential is close to 5.4 million hectares, comprising of over 3.7 million hectares from surface water sources (rivers and lakes), over 1.16 million hectares from ground water sources and about 0.5 million hectares from rain water harvesting (EPCC, 2015).

The decrease in rainfall amount will cause decrease in ground water recharge, flow of streams and rivers thereby resulting in a declining amount of water available for irrigation. In other places, total rainfall may increase but will fall within a short period with greater intensity so that dry spells are longer (EPCC, 2015). These include, among others;-

Climatic: Since Ethiopia's agriculture is overwhelmingly rainfall-dependent; it suffers greatly from the risks associated with high rainfall variability. Long term records indicate that there have been severe and repeated rainfall failures resulting in severe food/feed insecurity, including famines, on the Ethiopian population due to significant loss of crops and livestock. Needless to say, such shocks result not only in hardships to human and animal populations but also thwart seriously economic development efforts (EPCC, 2015).

Technology: - the Ethiopian farming and herding communities have been, and still are, largely dependent on traditional crop “land races”, indigenous animal stocks as well as poor management practices and poorly organized value chains, particularly marketing systems. This state of affairs results not only in low crop and animal productivity but also in inadequate incentives to encourage greater production and productivity (EPCC, 2015).

Socio-cultural:-it can be said that the overwhelming majority of the Ethiopian agricultural communities, be they sedentary or nomadic, are highly traditional and prefer to live by traditional values and norms considered appropriate to their respective communities. This is further aggravated by the high level of poverty and food insecurity leading to risk aversion by way of being reluctant to adopt new technologies and new ways of doing things (EPCC, 2015). Thus, farmers’/herders’ responses to natural shocks remain largely traditional and poorly developed to withstand shocks due to climate variability and, indeed, climate change (EPCC, 2015).

Institutions: - one glaring gap in relation to climate variability and climate change has been, and still is, failure to establish a national institution with the necessary legal power and resources to deal with the climate issues at national level. Although the current Government of Ethiopia has recently formulated a major policy document that sets out action plans to deal with climate issues, responsibilities are diffused across many public organizations (i.e., MoFED; and NMO) which make effective handling of the issue difficult. Recently, the Ethiopian Academy of Sciences (EAS) is also playing an active role in setting up EPCC to deal with the same issue (Abebe, 2007; World Bank, 2016).

2.2.4 Adaptation to Impact of Climatic Variability

Adaptation strategies are methods that local people used to adjust themselves with the existing change to minimize and adapt the impact of climate change (Negatu, 2016).

Adaptation is adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (Killmann, 2008). Change management focuses on modifying behaviors over the medium-to-long term to avoid disruptions or declines in global and local food supplies due to changes in temperature and precipitation regimes, and to protect ecosystems through providing environmental services.

Adapting to climate change involves managing risk by improving the quality of information and its use, providing insurance against climate change risk, adopting known good practices to strengthen the resilience of vulnerable livelihood systems, and finding new institutional and technological solutions (Killmann, 2008).

As agriculture is directly affected by climate change; adaptive strategies and technological practices are becoming increasingly important issues for promoting development (UNEP, 2011). Ethiopia is on its way to setting up a national panel on climate change with functions more or less similar to that of the Intergovernmental Panel on Climate Change (Wondwossen, 2014). Despite the challenges, Ethiopia hopes to capitalize on its current economic growth by becoming more resilient to the impacts of climate change while developing its economy in a carbon neutral way (Nanki-Kaur, 2013).

Over the last two decades, the Ethiopian government has put in place a number of policies, strategies and laws that are designed to support sustainable development. The country has developed and implemented a wide range of legal, policy and institutional frameworks on environment, water, forests, climate change, and biodiversity. Under the Plan for Accelerated and Sustained Development to End Poverty (PASDEP), implemented from 2005/06 to 2009/10, Ethiopia achieved rapid economic growth and laid a foundation for future growth by e.g. investments in infrastructure and human capital (EPCC, 2015; César et al, 2013).

Ethiopia's new five year plan, the Growth and Transformation Plan (GTP) for 2010/11–2014/15, sets even higher growth and investment targets, including achievement of all Millennium Development Goals. Key goals include: - Rapid economic growth with GDP per capita expected to reach US\$698 by 2015 (almost doubled compared to current GDP per capita US\$350); - Increase agricultural production is to double, to ensure food security in Ethiopia for the first time; etc. The Environmental Policy of Ethiopia was approved in 1997 and is the first key document that captured environmental sustainable development principles. Environment Impact Analysis (EIA) procedures should be applied to plans according to the EIA proclamation No: 299/ 2002. Strategic Environmental Assessment (SEA) has been introduced to Ethiopia quite recently. Ethiopia's Program of Adaptation to Climate Change (EPACC) is a program of action to build a climate resilient economy through adaptation at sectorial, regional and local community levels. The EPACC updates and replaces Ethiopia's National Adaptation Program of Action (NAPA) (César et al., 2013).

Ethiopia also has an overarching framework and a national strategy towards a green economy, the “Climate Resilient Green Economy” (CRGE) 2011. The Climate Resilient Green Economy (CRGE) Strategy offers a promising attempt at ensuring an economic development which mitigates greenhouse gas emissions, adjust to climate change and promote projects and investments which prevent/minimize environmental impacts. It Coordinated by EPA, and with strong political support from the Prime Minister’s Office and the Ministry of Finance and Economic Development (MoFED) and line ministries, the Green Economy Strategy provides an opportunity to promote sustainable development in Ethiopia (César et al., 2013).

The major programs that have been and still are under implementation to combat food insecurity include the Productive Safety Net Program, Household Asset Building Program, Complementary Community Investment project and Voluntary Resettlement Program (EPCC, 2015).

Policies and programs designed to respond to climate change should be complementary to, not independent of, those needed for sustainable food security. Interventions designed to increase general food system resilience are highly likely to contribute to climate change adaptation as well. Efforts to increase expenditure just on adaptation would be better directed toward increasing overall expenditures on sustainable food security with particular attention being paid to the unique and uncertain threats from climate change that require action today (public, private and other sectors) (EPCC, 2015).

The Ethiopian government mitigation part is aimed at promoting conditions that reduce the greenhouse gases emissions due to various types of development activities. The focus in this respect concerns 1) improvement of crop and animal production practices, 2) development of forestry and agro-forestry activities, 3) development of electric power generation through renewable energy sources and 4) expanding the use of modern and energy efficient technologies. In case of adaptation, the climate resilience strategy is aimed at developing strategies that enhance the capacity to withstand the negative effects of climate change through various activities in various sectors of the national economy.

Coping options like farm production adjustment ; such as diversification and intensification of crop and livestock production, changing land use and irrigation, development and promotion of new crop varieties, improvement in water and soil management, improved animals health technology, weather and climate forecasting and early warnings are vital(Nanki-Kaur, 2013).

Strategies for community based adaptation include improving water management practices such as building infrastructure for more efficient irrigation systems and small-scale water capture, storage and use, adopting practices to conserving soil moisture, organic matter and nutrients, using short-cycle varieties and setting up community-based seeds and grain banks (HLPE, 2012). Implementing a variety of management activities on the land could greatly increase its capacity to absorb carbon dioxide from the atmosphere. These activities include afforestation and reforestation, sustainable forestry practices, the implementation of conservation tillage on existing crop land, increased harvest rotations, and selective thinning.

If employed effectively, such land management practices would serve to maintain and possibly expand carbon sink capacity over the next 50 to 100 years (Streck, 2008).

Land degradation is the major environmental problem resulting in low and declining agricultural productivity in the country. Ethiopia has experienced food security problems due to land degradation (EPA, 2012).

As our climate changes in response to rising temperature, adaptation will be vital to reduce the impact of climate change that is key to food security and livelihoods (Aster, 2010). Adaptation of the food system will require complex social, economic and biophysical adjustments to food production, processing and consumption. Such changes will be most difficult for the poorest and most vulnerable regions and populations. Many of the poorest countries are found in tropics regions and hence the nations least able to adapt may be the most affected (HLPE, Report-3; Vidaurre, 2012)

Lack of sustainability in food production is a key threat to resilience and needs to be addressed by changes in the way we produce food, by moderating demand for foods such as ruminant products whose production generates especially large contributions to GHG emissions, and in the design of national and international food system governance (HLPE, Report-3).

The way one interprets the linkages between climate, agriculture and food security fundamentally shapes the ways in which forecasts are usually framed, disseminated and eventually used (Siva Kumar, 2005).

The adaptive measures that households use when faced with climate change will vary in ways of implementation, equity effects lag between implementation and effects, their cost of implication compatibility with other programs and agents implementing measures (Nanki-Kaur, 2013).

It is necessary to strengthen the resilience of rural people and to help them cope with this additional threat to food security. Particularly in the agriculture sector, climate change adaptation can go hand-in-hand with mitigation. In doing so, farmers should be put at the center and location-specific approaches ensuring the needs of communities devised and taking advantage of their-knowledge (HLPE, 2012).

2.5 Conceptual Framework

As food security is multi-dimensional, there is no specific factor or outcome rather, all factors and outcomes are considered when describing food security. So, these developed in consistence with World Food Program (2014) based on objective of study and theoretical framework.

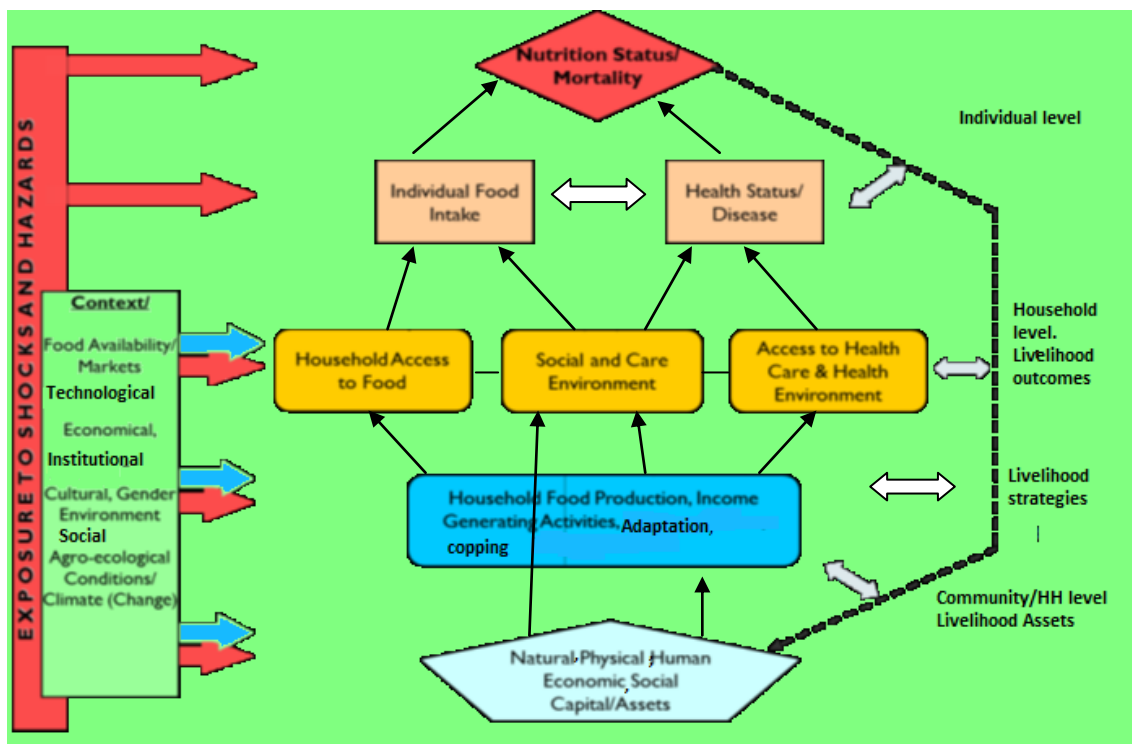


Figure 1 Conceptual framework of food security.

Source: Adopted from WFP (2014)

Food security is an outcome of the livelihood strategies adopted by households. A livelihood strategy is an organized set of lifestyle choices, goals, values and activities influenced by biophysical, political, economic, social, cultural and psychological components. In simple terms, livelihood strategies are the behavioral strategies and choices adopted by people to make a living including how people access food, earn income, allocate labor, land and resources, their patterns

of expenditure, the way they manage and preserve assets, how they respond to shocks and the coping strategies they adopt.

Livelihood strategies are based on assets or capital available to households, which include human, social, natural, physical and financial resources. A livelihood strategy is sustainable when “it can cope with and recover from stresses and shocks, and maintain or enhance its capabilities and assets both now and in the future while not undermining the natural resource base. The conceptual framework recognizes that a household’s food security situation is subject to change and fluctuates. Capacities to withstand shocks such as floods, high food prices and droughts depend on many factors, including a solid asset base, the ease with which households are able to alternate between and rely on the incomes from different livelihoods, the health and physical strength of individual household members and the political environment. The framework considers malnutrition and mortality to be the final outcome or the manifestation of insufficient food intake and/or disease at the individual level. These two immediate determinants of malnutrition and mortality are in turn determined by the household’s ability to access food, the care practices used, and the wider health and hygiene environment in which the household lives.

CHAPTER THREE

3. Study Area, Design and Methodology

3.1 Study Area

The study was conducted in *Misrak Badawacho Woreda*, which is located in *Hadiya zone, South Nations Nationalities and Peoples Regional States (SNNPRS)*. The capital town of the *Woreda* is *Shone* that located at a distance of 345km away from Addis Ababa city on the way towards *Wolaita Sodo*, about 120km far from SNNP Regional city- *Hawassa* and about 97km far from Zonal town-*Hossana*. Geographically, the absolute location of the *woreda* is between $7^{\circ} 9' 00''$ to $8^{\circ} 15' 00''$ North latitude and $37^{\circ} 5' 00''$ to $40^{\circ} 00' 00''$ East longitude. The relative location of *Woreda* is, it bounded by *Mirab Badawacho Woreda* to the west, *Wolaita zone* to the south, *Kembata Tambero zone* to the north, *Alaba special Woreda* to the north east and by east *Arsi Oromiya zone* to the east (Addise, 2014; Woreda road transport office, 2015).

3.2 Topography

The altitude of *Misrak Badawacho Woreda* ranges from 1580meter above sea level, which is *dry woina dega* to 1980 meter above sea level that is *moist woina dega* climate type. Totally there is 39 kebeles within *Misrak Badawacho Woreda*. Of which, the most part is situated along *dry woina dega* that contains 23 kebeles that is 59% and the rest 16 kebeles about 41% are situated within *moist woina dega* agro-ecological zone (MBWAO, 2015).

3.3 Population

Based on Central Statistical Agency/CSA, 2007, the total population of the *woreda* is 185,305, excluding the 5 kebeles of newly added population from Oromiya region through referendum. According to (MBWFEDO, 2015) report, including newly added 5 kebeles population, the total population of *woreda* is 230,728, of which 115,226 (49.9%) were males and 115,502 (50.06%) were females. When we see sex ratio, it is nearly balanced.

And, the majority of inhabitants are *Hadiya* ethnic groups with its distinct language and culture. The other ethnic groups living in the *Woreda* include *Wolayta, Guraghe, Kembatta, Amhara and Oromiya*.

The main language spoken in the woreda is *Hadiyyissa*. In terms of religion, the majority of the inhabitants were Protestants, accounts 67.47% of the population, 20.07% were Muslim, 8.02% were Catholic, and 3.58% practiced Ethiopian Orthodox Christianity(https://en.m.wikipedia.org/wiki/Misraq_Badawacho).The study sample population was drawn from two rural kebeles of *Misrak Badawacho Woreda*.

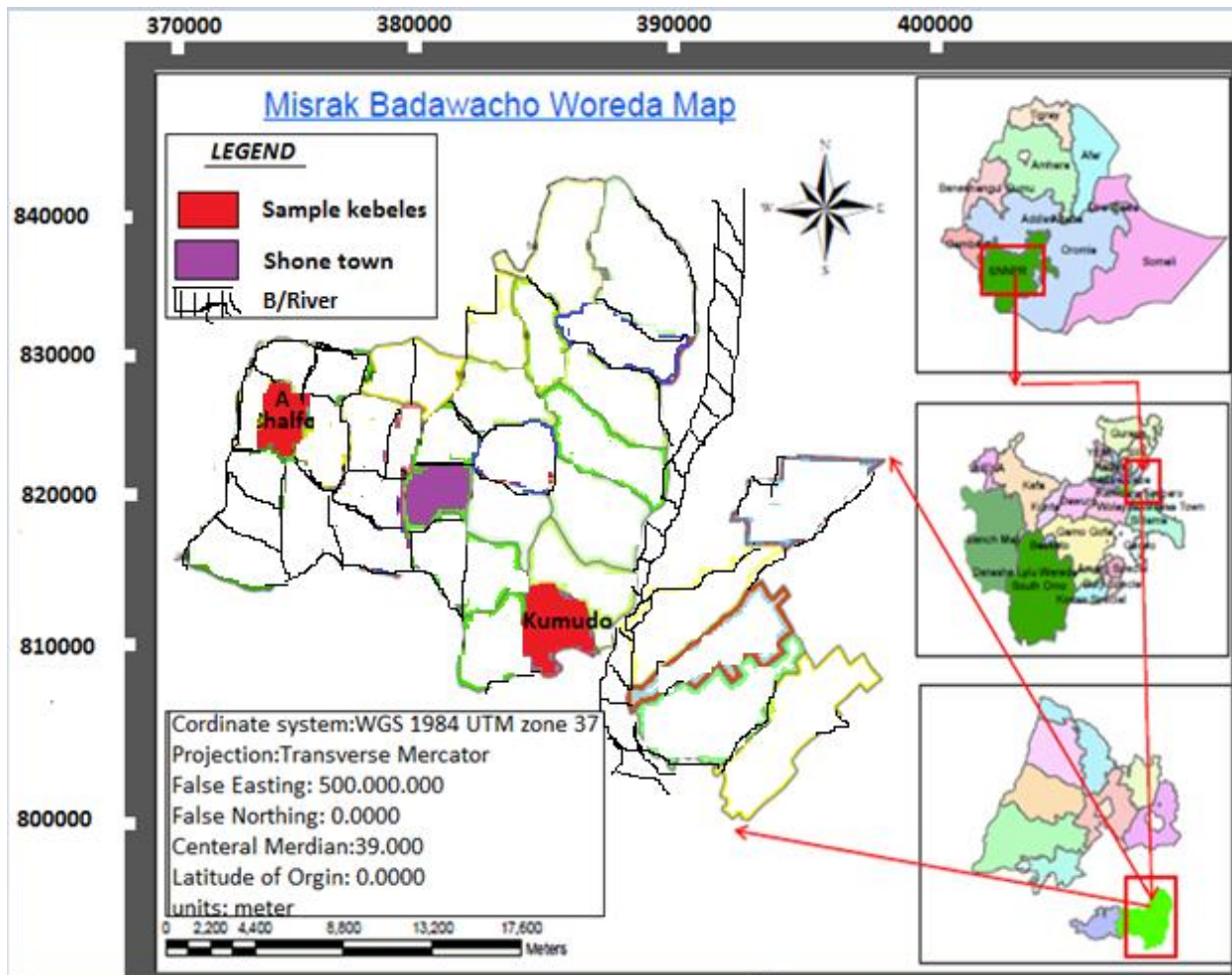


Figure 2. Map of the study area

Source: Ethio-Gis 2007

3.4 Special Features in the Study Area

There are various special features on the study area, for instance, there is no boundary share with other *Hadiya zone Woredas* except *Mirab Badawacho Woreda* since it separated by presence of *Kembata Tembaro zone* between *Misrak Badawacho Woreda* and other *Hadiya zone Woredas*.

The other special feature is-*Bilate River crosses the Misrak Badawacho Woreda* in to two separating 5 kebeles to the East or towards *Oromiya* regional states.

And, in the separated kebeles there are different special tourist attractive features/ sites like a Deep *Budameda Lake* which is 28km far from woreda's capital-Shone town and it is found in *Sherkogefarso* kebele and its amount is constant during summer and winter seasons and that is without any tributaries, *Tilo Lake in Kubi-dimtu* kebele is about 34km from Shone town, *Mechafera* Islands with varied depth, plants and animals species and areal coverage, Three Finchawa waterfalls in a line with Bilate River that is deep up to 90meters, *Adebe hot Spring in Dongorobonkoya kebele*, and *Shelo Bolo* natural Cave are few of special features (MBWCTCO,2015).

3.5 Climate Condition of the Study Area

The average annual rainfall in *Misrak Badawacho Woreda* ranges from 531.1mm to 1261.4mm while the mean annual temperature varies between 7.2⁰c and 33.7⁰c.*Dry woina dega* agro-ecology relatively reveals high temperature condition than moist woina dega agro-ecology. The rainfall is characterized by fluctuation in amount and periodicity from year to year in both agro-ecology. The highest rain season occurs from March to September and dry season occurs from October to February. Extreme fluctuation in rain fall, both in its annual totals and the distribution throughout the year, are the primary constraints for agriculture resulting in food insecurity particularly under rain fed conditions. That means within the woreda, in each of the cropping seasons the rain usually either begins lately or quits very early before the crops get mature. On the contrary, unusual and intense heavy rain causes series damage leaving no chance for farmers to salvage the losses. In some years, it comes early and in others late, in which this situation has a significant implication in agricultural productivity and food security. A brief study by Messay (2011) indicates that the annual total, onset and termination periods, rainfall has a great impact on the amount Agricultural output and, in turn, on the food security situation of the people.

3.6 Research Approach/Research Design

Mixed research approach was used because the method is believed to be more appropriate to investigate the topic under discussion. Here up on the principle of mixed research approach; survey research design was used because it is presumed to provide a breadth of information

about the topic under discussion. In this regard, Brian and Hilda (2002) dictated that survey research design would provide information about the prevalence of patterns found in case study sites and helps to understand what makes this site exemplary.

The quantitative approach was carried out on households' social characteristics like livelihood system, income, meteorological data and qualitative method was applied on people's perception about past and present conditions of the area and about coping mechanisms they have been using. Descriptive statistical analysis was applied in the documentation of the basic characteristics of the sample households.

3.7 Research Methodology

3.7.1 Data Collection Instruments

To generate the required data, the researcher has used different data collection instruments such as questionnaire, interview, focus group discussion and observation.

3.7.2 Questionnaire/HHs survey

Questionnaire used as a data collection instrument and these were administered by researcher and trained enumerators. Because it involves large number of respondents', it is relatively easier for administration and analysis. The researcher prepared both open ended and closed ended questionnaires on the basis of the objectives of the study. The questionnaires were translated into *Amharic*. Since, farmers speak *Haddiyyissa and partially Amharic* language; the enumerators were selected on the base of fluency in speaking *Haddiyyissa* and *Amharic* as well. Before the implementation of survey, enumerators were trained and tested for their clarity and understanding the questions. The survey questionnaire covered a wide range of information which includes household characteristics, household livelihood, perception of farmers on severity of climate variability impact, food insecurity, asset endowment, coping mechanisms, institutional and stakeholder's adaptation strategies issues.

3.7.3 Key Informant Interview and Field Observation

Interview method is particularly suitable for intensive investigation issues. The researcher prepared both structured and semi-structured interview guides and conducted interview with fifteen key informants from different authorities/experts/professionals like agent of administrative office (1), forest and environment protection office (1), *woreda* disaster

prevention and preparedness office (1), water resource office (1), health office (2), agriculture and natural resource development office (1), developmental agents (3), kebele Chairman (3), health extensionists (2) etc. Generally, from dry *woina dega* four KII interviewed such as; developmental agents (2), health extensions (1) and chairman (1) and from moist *woina dega* also four KII interviewed such as; developmental agents (1), health extensions (1) and chairman (2); totally (8) KII interviewed from both kebeles. The rest seven (7) experts are interviewed from the different offices that has clue on the issue. Here also certain questions rose like; perception of farmers on climate variability, impacts of climate variability on productivity, its effect on crop yield and livestock rising, perception on food insecurity and about their indigenous and learned coping and adaptation strategies. Researcher also prepared observation check list which is helpful in identifying the problem like; to observe production access and price in the market, to see damaged productions by climate variability and floods as well as cross checking each survey questionnaire administered to households.

3.7.4 Focus Group Discussion

It helps to generate data on group dynamics, and allows a small group of respondents guided by the researcher to focus on key issue of the research topic. The focus group discussions were held with a few selected individuals of the communities; from wealthy one elder, one young and one female headed in the same manner from medium and poor households chosen. At the discussion seven up to nine members involved. And, at each *Kebele*, one focus group discussion was held with the community. In addition to these primary data sources; published materials such as reports, plans, official records, census record, and meteorological data were used as secondary source of data. Here also similar issues were rose with key informants.



Figure 3. Focus group discussion in both kebeles

Long term climate data (25 years) and crop production data (10 years) were used for analytical purpose.

This helps the researcher to observe the historical climate constraints to agricultural productivity by seriously observing the impact of rainfall and temperature variability and major crop outputs.

3.7.5 Sampling Techniques and Sample Size Determination

In this research, multi stage sampling techniques was used. First, woreda was purposefully selected because of the researcher previous and current knowledge, access to get data's and understanding food insecurity status of the study subjects. Secondly, the kebeles, (two sample kebeles, *Ajaba chalfo* and *Kumudo*) were selected by stratified random sampling technique based on agro-climatic condition. Thirdly, sample households were selected based on systematic random sampling techniques because of homogeneity in agricultural practices and settlement arrangement, identical in topography, dressing and eating styles.

Hence, *Kumudo* and *Ajeba chalfo* were chosen from dry woina dega and moist woina dega respectively. These two rural kebeles has a total population of 1589. Of which 1153 were males and 436 were females. From these populations *Kumudo* had 441 males and 198 females with a total of 639 populations. While *Ajeba chalfo* had 712 males and 238 females with a total population of 950 and six percent of the population was taken as sample households from each total of their population. Therefore, number of sample households was 39 in *Kumudo* kebele, of which 26 were males and 13 were females and in *Ajeba chalfo* there is 58 samples households of which 41 were males and 17 were females. Totally, 97 sample households were selected from both kebeles through systematic random sampling techniques, of which 67 were males and 30 were females due to budget, time and resource constraints. In the study, more food insecurity, victims to drought and famine, presence of sufficient rain fall, level of development, socio-economic and environmental factors were assumed.

Table 1. Distribution of sample households

No	Kebele	Total HHs	Sex		Total sampled HHs	Sex	
			M	F		M	F
1	<i>Chelfo</i>	950	712	238	58	41	17
2	<i>Kumudo</i>	639	441	198	39	26	13
	Total	1589	1153	436	97	67	30

Source: Own survey, 2016

3.7.6 Data Sources

In order to get reliable and valid data, the researcher used both primary and secondary data. The primary data were collected through questionnaire, field observation and key informant interview. Secondary data have been gathered from published articles, journals as well as unpublished documents and reports available on the study area.

Before actual work begins permission was requested from the local administration, by providing permission letter that has took from Addis Ababa University.

Then, formal and informal discussions with district institutions, villagers and local households, (focus group/elders-male headed, female headed, better off, medium, poor, young and old) and with key informant interview/ experts, knowledgeable individuals, kebele chairman's, DAs, health extensions etc. were carried out from both moist *woina dega* and dry *woina dega*. Household participants identified from community chairman list name by using the checklist prepared for the purpose. Obtained information from these discussions, structured and open ended questions, and checklists were prepared for further data collection and analysis. In addition to this, direct observations to farmer's locality /area visit were conducted to see food security, the coping mechanisms and the severity of climate variability impact.

Hence the secondary data that obtained from two major sources; NMA and CSA, were used to look in to the dynamic relationship between historic and current climate variability and agricultural production as well as livelihood systems and coping strategies across *woreda* that help as forum for exchange of ideas and prioritization of adaptation options that are relevant for the context of the area.

3.7.7 Methods of Data Analysis

Data which collected from both primary and secondary sources were ordered, presented, analyzed via quantitative and qualitative method of data analysis. The questionnaire results were presented in the use of ratios, means, tables, averages, graphs, percentage, standard deviation, coefficient of variance, precipitation concentration index, and pluviometric coefficient.

Some structured household survey data would be analyzed using percentages, frequency and cross tabulation, and descriptive statistics using the Statistical Package for Social Sciences (SPSS) software of version 20. Discussion held with key informants on household characteristics, household livelihood, perception of farmers on severity of climate variability and coping mechanisms, food insecurity, asset endowment, institutional and stakeholder's adaptation strategies issues were also analyzed descriptively. Long term climate data (25 years) and crop production data (10 years) were used for analytical purpose.

3.8 Socio-Economic Profiles

3.8.1 Agriculture

The economic source of the households is both crop production and livestock rearing practices.

3.8.2Crop Cultivation

The agriculture activity is characterized by subsistent, less productive and traditional farming practices. The land holding system is highly fragmented. However due to lower productivity, hostile climate condition and shortage of feed and grazing land, productivity is at very minimal stage. Off-farm activities such as petty trade, local handicrafts and others are very insignificant, therefore, the community have no other income source except the agricultural activity. Traditional oxen-plough and hoe culture subsistence agricultural practices are common in the study area. The drier *woina dega* is characterized by large land holding size when compared to the *moist woina dega* agro-ecology.

The study area is dependent on cereal crops such as maize, *teff*, *haricot bean* and *sorghum* that are most common agricultural products. The *moist woina dega* agro ecology practices relatively diverse crops such as cereals, root crops like *sweet potato*, *chills*, in some extent *sugarcane*, *potato* and *taro*, tubers like *enset*, *banana*, from fruit trees like *avocado* and *coffee* is the main source of cash mostly for moist agro ecology.

Dry woina dega practices relatively few crop types mainly *maize*, *teff*, *haricot bean* etc. The productivity of the major cereal and root crops vary from year to year due to climatic variability impacts. As the *woreda* report of 2008, sweet potato was totally destroyed by the pests, frost and drought. This crop is very crucial by filling crop gap during food insecure and hunger months as it mainly harvested between April and June in the *woreda* but now they were distributing through buying from neighbor *woredas* and zones. Insignificant amount, and distribution of rainfall results in low agricultural performances and productivity.

Irrigation schemes and other water development projects across the *woreda* are in at low level, arising from rainfall scarcity and variability except *Lenda* Irrigation scheme which is poorly constructed so that couldn't provide proper service.



Figure 4. Affected teff and maize crops by drought and flood in the study area.

Source: Field observation, 2016.

3.8.3 Livestock Production

Livestock production is the other economic activity in the study area. Oxen, cows, horses, donkeys, sheep, goats, hens and bee hives are the important in *Misrak Badawacho Woreda*.

It is important in both agro ecological zones as one type of mixing farming. Livestock provide foods such as meat, milk and milk products, non-food products such as hide and skin. It is also a main source of income for periods of distress time when crop failure happened due to erratic nature or when seasonal climate variation and drought occurred in rural areas. According to *woreda* agricultural and natural resource office report of 2015, milk yield of local cow reaches 3 liters per day during the first two to three months of lactation.

In *woreda*, there are 203,999 cattle's (cow and ox), 12,741 sheep, and 13,630 goats and 57,360 poultry. But now a day its production decreased and its number is very insignificant because of the adverse impact of climate variability on their fodder and water, resulting in disease and high deaths. The only chance to households is selling the cattle those left from death to cope the risk in a very low price due to its low quality. The cattle death amount is severe in dry woina dega than moist woina dega because in moist woina dega agro-ecology households relatively use banana tree and different root crop residue to animals feed by digging and collecting underground water. This situation creates livestock production provides negligible output for the *woreda*'s economy (MBWFEDO; MBWANRDO, 2015).

3.8.4 Safety Net Program

The Safety Net Program has been designed as asset protection mechanism for the household to create productive community asset. The unpredictability of rainfall and temperature in *Misrak Badawacho Woreda* led to low productivity of agricultural practices and this exacerbated food insecurity. To overcome such challenges government set Safety Net Program launched in cooperation with donors. As *woreda* disaster prevention and preparedness office expert, the service has been given by categorizing the victim households in to two- chronically food insecure like aged, diseased, orphans etc. by giving priority and transitory food insecure those under risk due to incapability to the prevailing problems having participate in land and soil conservation works.

It provided in a form of direct support and public work. The world vision Ethiopia gives products like wheat, vegetable oil and pulse (*woreda* disaster prevention and preparedness office, WDPPO).



Figure 5. Safety Net Program users, DPPO coordinator (KII) and crops damaged by flood around kenchara.

Source: Own survey, observation 2016.

3.8.5 Land Use Pattern

Table 1. Distribution of land use

Types of land cover	Area hectare	Percent
Bare land	3619	8.22
Cultivated land	36,857	83.82
Pasture land	834	1.9
Forest cover	1014	2.3
Constructed land	1208	2.7
Water bodies	464	1.06
Total	43,996	100

Source: *Woreda* agriculture and natural resource development office, 2016.

Based on the above table 2, from the total land area of 43,996 ha cultivated land occupied 83.82%, while 8.22% is a bare land and, 1.9% is pasture land, 2.3% is covered by forest and 2.7% and 1.06 is respectively held by constructed land and water bodies. In third case 2.7% is under the human settlement and construction. Generally, majority of land area was occupied by cultivated land. This is by itself has influence on livestock raising by affecting pasture land.



Figure 6. Affected land by flood and traditional farming system in the study area

Source: Own observation, Ajeba chelfo, 2016.

3.9 Social Infrastructures

3.9.1 Road Transport

Road is the only modern means of transportation in *Misrak Badawacho Woreda*. There is one asphalt road that crosses *woreda* in to two through *Halaba* town towards *Wolaitta Sodo* passing through *Shone* town. It serves market connection more for households who settled in line with the asphalt road. There is also a URRAP road from *Shone to Korga and Hannicha* town that is 28km. Even if there are improvements on allowance of vehicles, it is poorly constructed that needs giving more attention to make proper network of market access to the community farmers. Also there is another URRAP road from *Shone to Lendagenet* about 13.5km in the same status to *Korga and Hannicha* road. Both are located in dry *woina dega* agro-ecology towards the east direction from the capital of the *woreda*. In moist agro-ecological zone there is a road from *Shone town to Denema* about 7km in *Mirab Badawacho* that is well constructed rather than others. There is also fourth URRAP road from *Shone to Weragere to Ajaba and Mazoria* about 12km. And from *Amburse through Abuka to Dendo* town there is a road as long as 12.42km.

Generally in the study area road is not a serious challenge to households and there is a good start of road to link farmers' market access even though it requires well organized constructions to make effective market linkage and particularly *Kumudo* kebele has a more access of road than *Ajeba chelfo* kebele that allows entering vehicles (*woreda* road transport office, 2016).

3.9.2 Energy sources

These are mainly associated with source of energy for cooking, heating and lighting by poor households. As FGD mentioned in the study area these sources comes from traditional woody biomass, mainly fuel wood, dung, crop residues and charcoal. Moreover, they use planted trees within each farmer's field having cut it. Also in a harvesting season they collect and store the maize crop residues and utilize it later on.

3.9.3 Health

There is a strong and growing, global, scientific consensus that warming of the climate system is a fact and is affecting human health. It is a well-established fact that climate change has great impact on the health of the nation in three different ways, which include: **-Direct impacts**, which relate primarily to changes in the frequency of extreme weather including heat, drought, and heavy rain, **Effects mediated through natural systems**, for example, etiologic agents, animal reservoirs of disease vectors, water-borne diseases, and air pollution and, **Effects heavily mediated by human systems**, for example, occupational impacts, under nutrition, and mental stress. Lack of access to safe drinking water, sanitation, and health services negatively affects people's health. There are strong links between environment and health concerns in Ethiopia, particularly related to malnutrition, indoor air pollution and water-related diseases. Potential climate change health effects include: heat-related morbidity and mortality; weather-related morbidity and mortality; asthma, respiratory allergies, and airway diseases; food borne, waterborne, vector-borne and zoonotic diseases; cardiovascular disease and stroke; nutrition diseases and human developmental effects; mental health and stress-related disorders; neurological diseases and disorders; and cancer (EPCC 2015).

According to *woreda* health office expert, the effect of climate change has been challenging children and women resulting in malnutrition/food shortage in *Misrak Badawacho Woreda*. When temperature increases, malaria cause increases quickly, particularly in dry *woina dega* agro ecology. Sometimes measles are affecting the farmers, for instance in last year, 2015 about

90 people died to this case. As the expert, there are 41 health pole, 7 health center and 1 primary hospital. For the impact; - WFP, Goal Ethiopia and Catholic Church etc. were supporting by proving different food aids.

And, the health expert added as the challenge is series for females and children so that UNCEF was giving food items to under 5 years Childs and child bearing mothers. And, World Vision Ethiopia was providing palm oils and wheat to all victim families to food insecurity.

3.9.4 Education

Education influences farmers' decision to adopt technologies by enhancing farmers' ability to understand and utilize the practice improving overall managerial ability of farmers. The high level of undernourishment has large consequences for health, productivity and education.

For example, malnutrition has a negative impact on children's educational achievement. It is difficult to focus on studies when hungry and fatigued. Climate variability e.g. droughts and floods is a threat to food security and children's education (EPCC 2015).

When we see school distribution of the study area, there are 9 schools of 1-4 grade, 1 school of 5-8 grades, 56 schools of 1-8 grades, 8 schools 9-10 grades, and 2 schools of 9-12 grades. As the expert, due to adverse effect of climate variability students' dropout rate increased because of food shortage and high intensity of temperature. Many students were migrating to towns and different areas searching labor work to get food. As a mechanism state government arranged to seriously affected 11 schools, school feeding center which made somewhat stable condition on such schools but students who learn out of school feeding center were making challenge to shift from non-school feeding center to school feeding center to search food.

3.9.5 Information and Communication

In the study area the means of communication and information is more through political agents (using *woreda* Cabine and lower administrative structures). They disseminate whatever the update information to farmers. Other means is through developmental agents that they live in kebeles most of the time supporting farmers by providing agricultural inputs, disseminating new technologies about crop and animals production as well as weather forecast, pesticides, providing different trainings etc. with households.

In addition to that, there are a few mobile and radio accesses to link market and new technology information among farmers and there is also an information share in community meetings and worship sites as a notice.

Therefore, aforementioned means of information and communication is a common sharing way in *Misrak Badawacho woreda*.

3.9.6 Market

Rising food costs can have considerable impact on vulnerable households, pushing those least able to cope further into poverty and hunger(Gustafson, 2013). In the study area, relatively there is enough market access to sell their production and to involve in off farm activities. The Shone town is a *woredas* capital that helps to exchange their yields. There are also small urban centers like;-*Lendagenet and korga found within dry woina dega zone and bademera is found in moist woina dega* ecology. However, all urban centers require improvement in all aspects.

CHAPTER FOUR

4. Result and Discussion

This chapter deals with the analysis and interpretation of the collected data. An attempt has been made to discuss perception of farmers, concerning individuals and experts about the trend and pattern of climate variability, status of food insecurity, causes of food insecurity and impact of climate variability on agricultural production and food security and investigate responses of farmers to the impact in *Misrak Badawacho Woreda*. The result and discussions consists five sections which is; general demographic characteristics of sample households, climate attributes that reveal *woredas* gradual rainfall and temperature trends, the impact of climatic variability on food security dimension in relation to different indicators and causes, the adaptive capacity of the local people and their methods to cope with the impact of climate change and finally the most food insecure segment of the populations' are identified and discussed based on the results of the collected data.

4.1 General Demographic Characteristics of Sample Households

The following table indicates the age groups of sample respondents in the study area.

Table 3. Age and sex of the sample households

Age	Frequency	Percent	Sex	Frequency	Percent
<14	11	11.3	M	67	69.1
15-64	58	59.9	F	30	30.9
>65	28	28.8			
Total	97	100	Total	97	100

Source: Own Survey, 2016

The age of the household heads is categorized in three stages; young, adult and old age populations. Out of the total household age group <14 is 11.3% that is young, 15-64 is about 59.9% age group accepted as adult age group, and from >65 age group comprises 28.8% that is

old age group population. This reveals that the majority of populations belong to adult age groups and that accounted for 59.9% that is working/productive age group. Even though there was majority of working force age group, from 11.3% young and 28.8% old age population about half segments of populations are less productive and food insecure. Table 3 also revealed that, out of the total 97 households /respondents 69.1% were males while 30.9% were females. The household heads of the study area had a total population of 1589 out of which (72.6%) were males and (27.4%) were females. Relatively female headed households are vulnerable to climate variability risks than male headed households because they have a lot of burden to solely carry out livelihood engaging issues and to involve off-farm activity than male headed households.

Table 4. Marital status and family size of the sample households

Marital status	Frequency	Percent	Family size	Frequency	Percent
Single	4	4.1	<4	13	13.4
Married	61	62.9	5-10	58	59.8
Separated	10	10.3	>10	26	26.8
Divorced	14	14.4			
Widowed	8	8.2			
Total	97	100	Total	97	100

Source: Own Survey, 2016

Table 4 depicts that, among all the respondents 4.1% were single, 62.9 were married, 10.3% were separated, 14.4% were divorced and 8.2% were widowed. Therefore, it is evident that, the majority of the respondents in the study area were married. This implies the differentiation of social status and family size affects their livelihood bases and adaptation to climate variability. Table 4 also depicts that, among all the respondents 13.4% had small family size of less than 4, 59.8% had medium size or 5-10 and 26.8% had large family size. The family size of the study area was large. The practices of family planning are not well developed in the study area.

So, farm households have a large number of children range varying from 1 to 12 and with an average of about 7 children per household. This social characteristics poses shock on food security, even if it is insignificant compared with climate shocks.

Generally, age has fewer factors when compared with other serious factors in production and food security in the study area that only 28.8% of households were old segment of populations. Concerning to sex, 30.9% of households were female headed so that in the study area relatively female headed households are more vulnerable to climate risks than male headed. In case of marital status, majority 62.9 of households in the study area were married so that the social status affects the livelihood base. It is common in the study area but at minimal effect on the issue. Concerning to family size, households in the study area has large family size. According to Balcha, (2001) population growth is a prime cause of food shortage in the globe.

The researcher didn't agree this assumption because; one, in the researchers study the prime factor for food shortage is effect of climate variability.

Secondly, population growth will create condition for expanding labor force and for agricultural production and food security. And, researcher agree that population growth will have average factor than prime factor. Therefore, as the objective of the study is to identify causes of food security; age, female headed and education has an impact in food production and on food security.

Table 5 Educational status and source of income of the sample households

Educational status	Frequency	Percent	Source of income	Frequency	Percent
Illiterate	40	41.2	Crop production	12	12.4
Elementary	26	26.8	Animal raising	6	6.2
Junior	18	18.6	Mixed farming	79	81.4
Secondary	10	10.3			
Higher education	3	3.1			
Total	97	100	Total	97	100

Source: Own Survey, 2016

As shown on Table 5 out of the total number of the respondents, 41.2% were illiterate, 26.8% attended elementary (1-4) school level, 18.6% attended junior (1-8) school level, 10.3% followed secondary level education and 3.1% joined college education. But the majority of households were illiterate that is 41.2% solely and thus, when concluded there is high illiteracy rate among local people of the woreda especially the adult and aged people. Illiteracy has its own influence on the introduction of modern technology to the modernization of local knowledge and innovation under western influence educational systems.

Table5 also reveals that of the total respondents' single crop producers comprises 12.4%, only animal raising populations are 6% but mixed farming populations' account for the 81.4% of total households. Therefore, the livelihood of the study area farmers is highly dependent on both crop production and animal raising which is sensitive to climate variability (shortage fodder and scarcity of water).

Table 6. Households land holding size

land holding size	Frequency	Percent
< 0.5 ha	38	39.2
0.5 ha	29	29.9
1 ha	14	14.4
1.5 ha	8	8.2
2 ha	3	3.1
>2 ha	5	5.2
Total	97	100

Source: Own Survey, 2016

Land was one of the most important factors of agricultural production. As in most of the high lands of the country the landholding of farmers in the study area is very small.

In the survey they responded as 89.9% have their own land that most of them 45.4% inherited from parents and 26.8% got from kebele by government allocation but only 10.1% haven't their own plot of farm. Even though the majority of the study populations responded as have their own land, as they added the majority 59.1% of the households has 0.5ha of land and less than 0.5ha. There is small variation in landholding in dry *woina dega* (rests on 0.5ha) and moist *woina dega* (dominated by less than 0.375ha of land). In both agro-ecology the majority 39.2% of the households located in moderate distance to their farm field. It is a great challenge to sustain the large family size of the study area with such fragmented farm land. Not only fragmentation of landholding size but also as the study population about 71.1% pointed as farm land is losing its fertility content due to erosion by wind and running water, over cultivation, unreliable rain fall and moisture stress resulting in decreasing agricultural productivity and yield. Therefore, the objective of the study is to identify the causes of food insecurity, the small farm land and its fertility decrement were devastating causes to yield failure and food insecurity that already risky to climatic variability in Misrak Badawacho Woreda.

4.2 Climate Variability and Its Impact in Misrak Badawacho Woreda

Different studies stated that, the earth's climate is changing. Thus, the climate variability and change in Misrak Badawacho Woreda is assessed by the perception of the local people combined with Meteorological evidences.

“The FGD and KII confirmed that there is variability and change in the elements of weather and climate (rainfall and temperature) in the study area. As they said the onset and termination of rainfall occurring in belg and mehar is the manifestation of this variability and change. However, before two decades the belg and mehar rainfall had occurred in early March and continued till May with normal discontinuity, and followed by kiremt rainfall which continued till mid of September. Sometimes it appeared even until mid of October with fewer amounts. Thus, the variability of rainfall in these two determinant seasons showed variability and change on climate. And one FGD member said, “before one and two decades, when once rained that stays in the farm land 3-4 days; nowadays it rains in lower atmosphere and added if it rains that is so scant that cannot penetrate inside the soil so that it immediately dry up”. Other informant added, “before two decades when it rain, it is warm and this year's yield stays up to next year's

new yield but now a days rain is very cold resulting in different diseases and pests like; locally 'waga' for maize and 'kincho' for teff yields. At harvesting season suddenly heavy rain damages yield that was causing food insecurity which is similar idea with earlier informant” .As other members said surface water dried up and ground water table dropped from 4m to 14m.”

This all data indicates there is climate change and climate variability that resulting damages on yields and causing food insecurity in the study area.

The Table below also supports the perception of the local people that is slight decreasing amount of annual rainfall since 1999. Therefore, it is supported to be an indication of the existence of climate variability and change in the study area.

Table 7. Households’ perception of rainfall pattern.

Perception Variable	Frequency	Percent
Rain fall amount increased	1	1.0
Rain fall amount decreased	35	36.1
Time of onset became late	30	30.9
Time of cessation became earlier or late	31	32.0
Total	97	100

Source: Own Survey, 2016

On Table 7 the majority 36.1% of the respondents mentioned that, the amount of rain fall has been decreasing since the last twenty years, 30.9% also mentioned that the time of onset become late and 32% of respondents decided as the rainfall time of cessation become earlier/late. This also shows that the distribution and amount of rainfall is decreased and so scant which was posing risks and making households vulnerable to its adverse impacts in *Misrak Badawacho Woreda*.

4.3 Rainfall: Amount, Trend and Seasonal Concentration

The long term (1991 to 2015) totally 25 years total annual rainfall in *Misrak Badawacho Woreda* was taken to reassure from *Hawassa* meteorological directorate. The computed annual total rainfall is 1261.4mm. The annual total rainfall is decreasing over the years; mostly 1999 and 2015 was the anomalous year with a total amount rainfall only 763.4mm and 531.1mm respectively. The maximum annual amount of rain fall received in1993 and1998 accounting for 1261.4mm and 1231.8 respectively. *Misrak Badawacho Woreda* receives insufficient total amount of rainfall. The other problem of rainfall distribution was more related to the temporal variability or concentration within a few seasons.

In other words, the inconsistency in onset and termination of rainfall should be given a due attention. The annual total rainfall of *Misrak Badawacho Woreda* ranges between the year 1991 and 2015 for 25 years is between 531.1mm in 2015 to 1261.4mm in 1993.

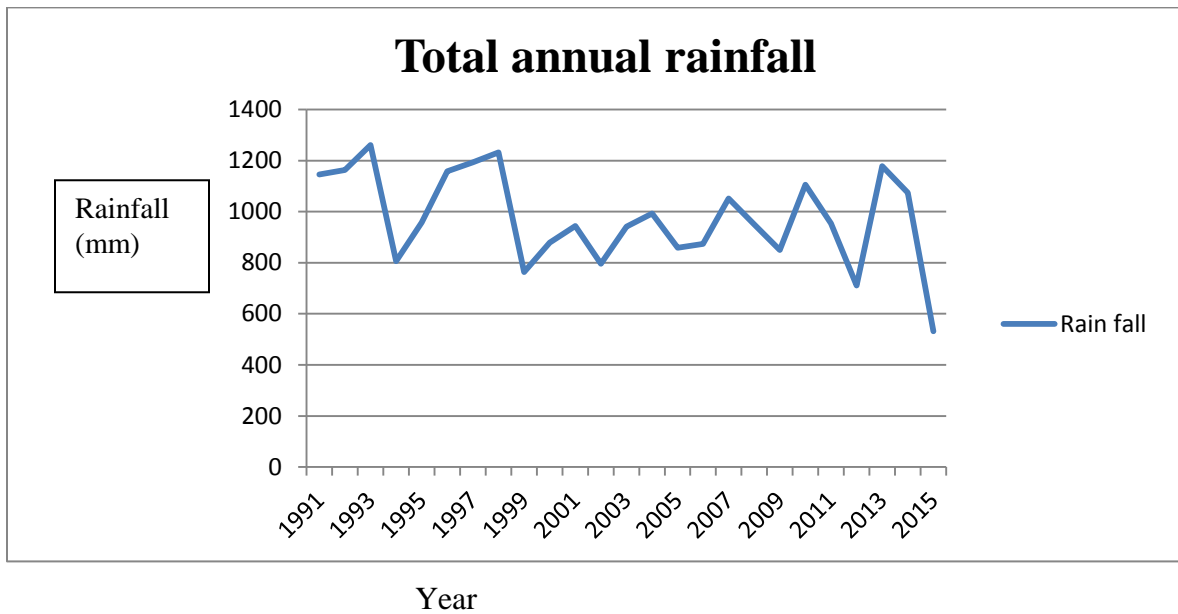


Figure 7.Total Annual Rainfall (1991-2015)

Source: NMA, Hawassa directorate, Shone station 2016.

As indicated in the figure 7 the assessed rainfall trend value (curve) shows slightly increasing between 1993, 1997 and 2013.

It drops in years between 1999 and 2000 as well as 2014 and 2015. Hence, the objective of the study is to assess the trend of temperature and rainfall, overall annual rain fall trend reveals decreasing on average except 1993 and 1998. In general rainfall is one of the vital resources to carry out the overall agricultural output and other developmental activities. Thus, one can infer that, an increasing trend of rainfall tend to have the potential to devastate the soil in a form of soil erosion, which eventually will result in deterioration of agricultural productivity. Effects of rainfall such as drought and flood were damaging both crop production and livestock raring resulting in food insecurity.

Thus, it has a vital risk and impacts on the livelihoods of the rural population. On figure 7 one can infer that, rainfall condition is slightly affected by the annual rainfall variability.

“Thus, As the KII and FGD asserted that, 1999-2000 and 2014/15 was one of the devastative years for the agricultural society. This harmed their livelihoods in general and exposed them to be sustained by the charity organization and by the government. Particularly, the untimely rain (onset and termination) of the belg and mehar rainfall continue fluctuate. Its consequence was harming the rural population.”

It goes in line with long-term annual rainfall data of the study area. Thus, the yields of inter-annual crops in dry *woina dega* agro-ecological zone like teff, groundnut and maize as well as barley and wheat the moist agro-ecological zone was affecting due to moisture stress. This leads to the deterioration of agricultural production, eventually shortage of food at household level. As figure 6 clearly indicates the amount of rainfall has shown slightly decreasing but rarely if increases, the distribution is concentrated in few days (offsetting and terminating). This study concise with the study of (WFP, 2014), as that the erratic rainfall is a main determinant of food production and vulnerability. As the researchers study vital cause for low production and food insecurity is erratic and untimely rainfall.

Table 8. Computation of PCI and pluviometric coefficient for *Misrak Badawacho Woreda*

Months	Long-term mean monthly rainfall in mm (Pi)	Pi ²	Rainfall coefficient (pluviometric coefficient)
January	8.44	71.2336	0.0844
February	6.65	44.2225	0.665
March	5.91	34.9281	0.0591
April	21.81	475.6761	0.2181
May	51.23	2624.5129	0.5123
June	65.27	4260.1729	0.6527
July	115.1	13248.01	1.151
August	301.81	91089.2761	3.0181
September	271.29	73598.2641	2.7129
October	165.1	27258.01	1.561
November	101.89	10381.5721	1.0189
December	22.5	506.25	0.225
	$\Sigma i = 1137$	$(\Sigma Pi^2) = 223592.1284$	
$(\Sigma Pi^2) = 1292769$ $(\Sigma Pi)^2 = 223592.1284,$ $PCI = 100 * [(\Sigma Pi)^2 / (\Sigma Pi^2)]$			

$$\begin{aligned} &= \frac{223592.1284}{1292769} \\ &= 0.17296 \text{ or} \\ &= \underline{17.296} \end{aligned}$$

Source: Computed based on the raw data obtained from NMA, Hawassa branch, 2016.

As shown on the table 8, the precipitation concentration index (PCI) value of *Misrak Badawacho Woreda* is about 17.296. According to Oliver (1980), as cited in Woldamlak (2009), value of PCI less than 10 indicate uniform monthly distribution while values between 11 and 20 signify high rainfall concentration and value greater than 20 represents very high concentration of seasonal rainfall distribution.

More precisely, Monkhouse and Wilkinson (1971), using pluviometric coefficient signifies values between 0.6 and 1 show low concentration, values 1 to 2 indicate medium concentration while values 2 to 3 show high concentration and the value greater than 3 represents very high concentration of attribute. Pluviometric coefficient calculates any month at a given weather station the ratio of the monthly normal precipitation to one-twelfth of the annual normal precipitation. Thus, the months of December, January, February, March, April and May have very small concentration of rainfall (dry) while June has small amount of rainfall. On the other hand, July, October and November have medium concentration of rainfall; September has high concentration of rainfall and very high concentration of rainfall was recorded in the month of August.

4.4 Seasonal Rainfall Pattern in Misrak Badawacho Woreda

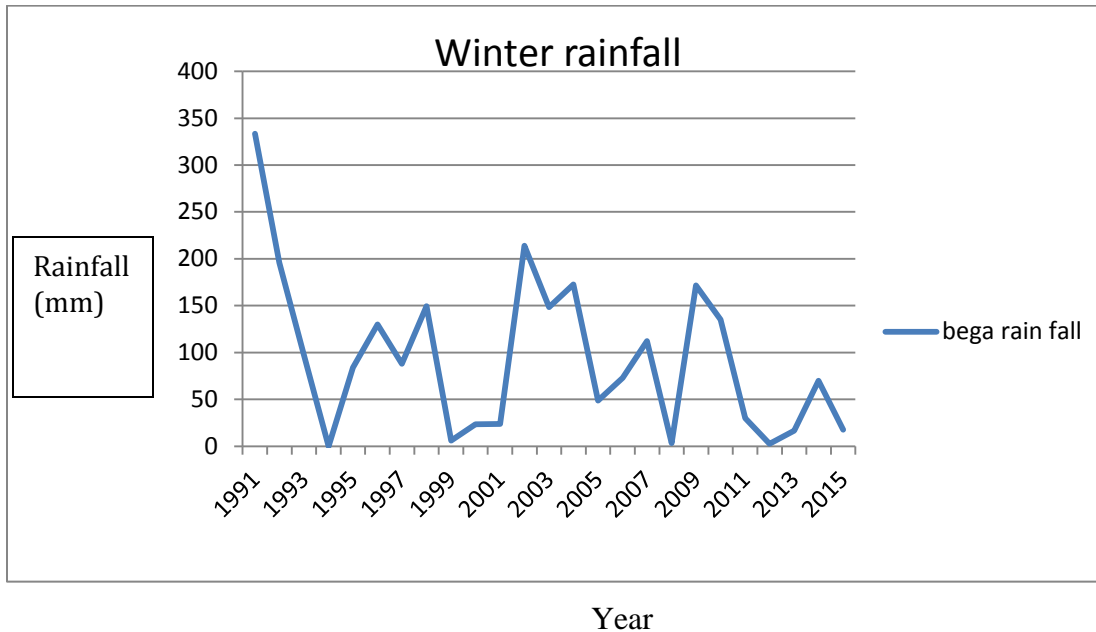


Figure 8. Winter/bega average rainfall pattern

Source: Computed based on raw data obtained from NMA, Hawassa branch, shone station, 2016.

Bega (locally known as 'Bile') is the driest season which receives a total of 2223.1mm rainfall during period 1991-2015. It ranges from 0 mm to 333.1mm which indicates variability is very high. For example, in the year 1994, 1999, 2008, 2012, 2013 and 2015 rainfall was very little.

The scarcity of rain water was cause for the shortage of animals' forage and water, resulting animal disease. Thus, the quality and the quantity of animal product also deteriorated, even in the year 2015 more than 200 cattle died, particularly larger animals were highly affected.

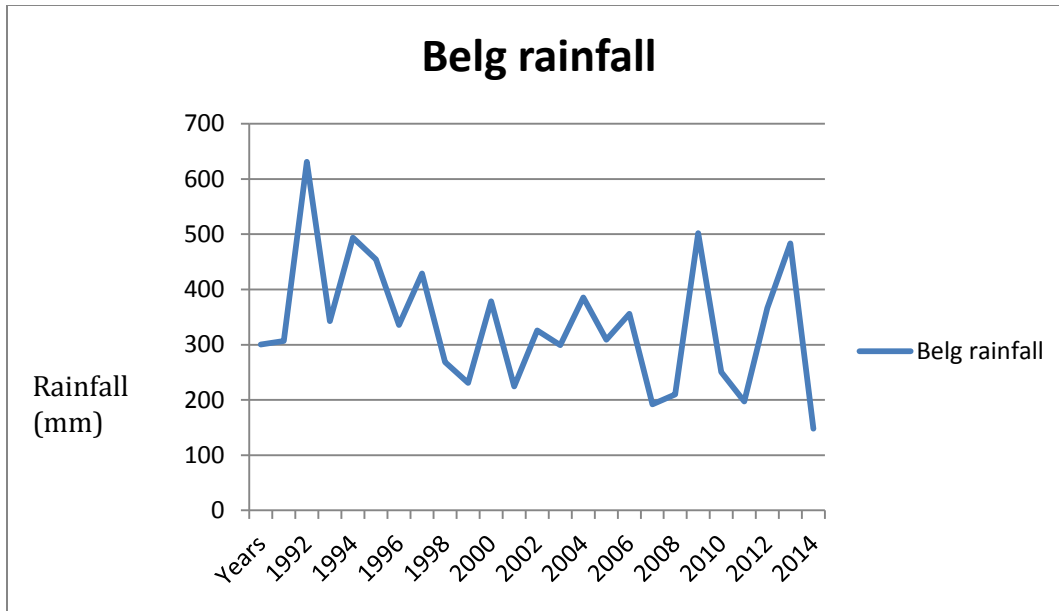


Figure 9. Average belg/spring rainfall pattern

Source: Computed based on the raw data obtained from NMA, Hawassa branch, 2016.

Belg (locally known as 'Qaraaxxo') rainfall is the crucial but the most variable and which receives a total of 8422.2mm rainfall during the period of 1991-2015. As it shown in figure 9 the mean total *belg* rainfall ranges from 148 to 631.2 mm which implies variability was increased. For example, in 2015, 2012, 2008, 2009, 2000 and 1999 rainfall amount was small.

The highest amount of rainfall was registered in the years 1993 and 2010. Sometimes the *belg* rainfall brings flooding which may hide the seeds with mud and create obstacle to farmers to prepare and sow their seeds to the next planting season. On the contrary; it may be dry or minimal to prepare the farm and plant crops. Thus, farmers lost their seeds owing to the unreliable nature of *belg* rainfall.

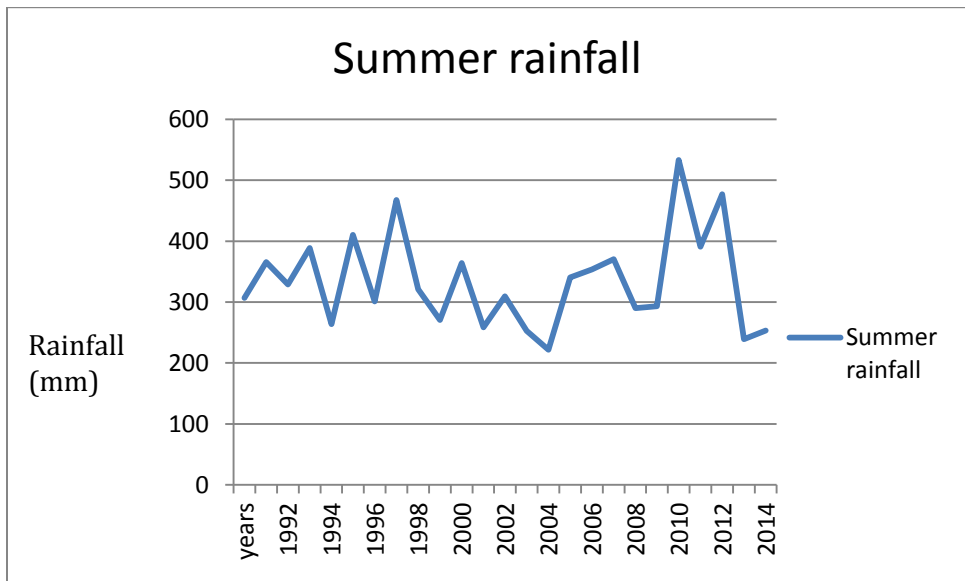


Figure 10 .Average summer/keremt rainfall patterns.

Source: Computed based on the raw data obtained from NMA, Hawassa branch, 2016.

As shown in figure 10 *keremt* (locally known as *Haggayye*) revealed rainfall normal distribution trend generally throughout the season and particularly in 2011 and 2013 and its amount has shown a range of 221.9 mm in 2005 and 533mm in 2011. The total rainfall concentration during this season is about 8370.8 mm. The effect of flooding devastates the planted crops which are already sown during *belg rain* in both agro-ecological zones of *Misrak Badawacho Woreda*.

As a report of DPPO,” April heavy rainfall (flood) caused many damage on households farm produce. The recorded damage was 1268.32ha maize, 158.28ha groundnut and others 52ha totally 1478.6ha affected by flood. As a result households male 1507, female 203 totally 1710 and family members male 5464, and female 5675 totally 11,139 were affected. And, also 1277 households were migrated to other place. Government and NGOs were providing aid to sustain their life.

In these season farmers in both agro-ecology produces teff and moist *woina dega* produces potato and other vegetables. There is relatively a good access to forage- livestock fed. In this season some adaptation practices and planting trees individually and in different associations took place.

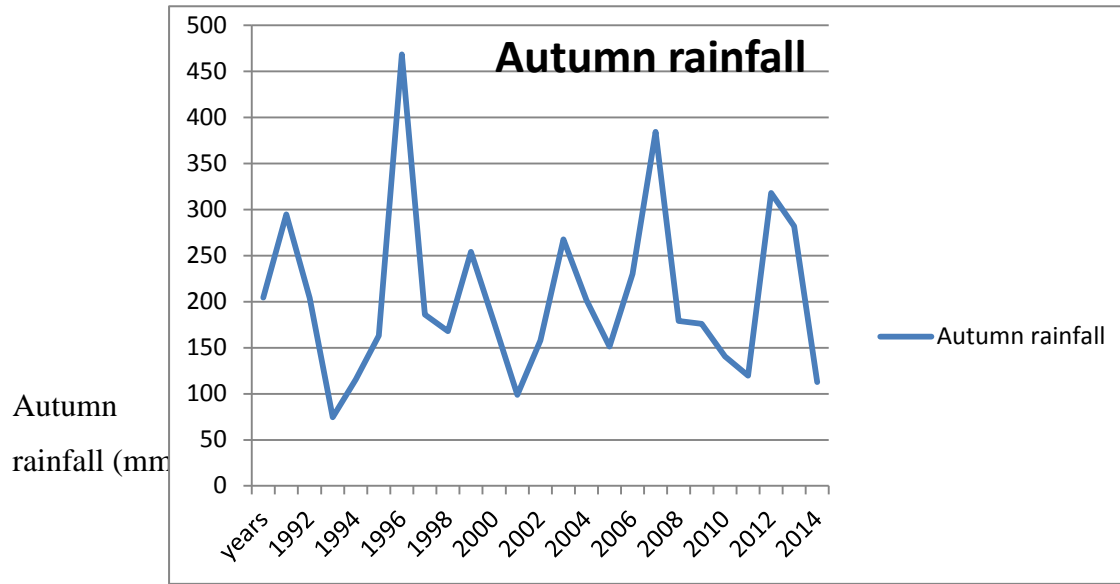


Figure 11. Autumn/tseeday rainfall pattern

Source: Computed based on the raw data obtained from NMA, Hawassa branch, 2016.

The autumn/tseeday (locally known as 'Fitte') rainfall plays significant role in agricultural production. However, as it is indicated on figure 11 the amount of rainfall has shown fluctuating and high variability trend. If the autumn rainfall becomes heavy, it may devastate the crops which are already to be harvested. On the other hand, if the amount of rainfall is scarce in this period particularly in the *dry woina dega* agro-ecological zone the cropland will be invaded by locusts, highly devastate the crops while in moist *woina dega* agro-ecological zone crops affected by frost then they wilt.

4.5 Temperature Trend in the Study Area

Table 9. Households' perception of temperature pattern and trend.

Perception Variable	Frequency	Percent
Increased	73	75.3
Decreased	4	4.1
No idea	20	20.6
Total	97	100

Source: Own Survey, 2016

Table 9 above reveals the responses of households to the temperature variability in the study area. Of the respondents about 75.3% were with the opinion of the temperature has increased. But, only few percentiles, 24% responded as no idea and it has decreased. The researcher also tried to see the trend of temperature with data obtained from national meteorological agency from Hawassa branch and shone station. Accordingly, the seasonal maximum, minimum and average temperature distributions are shown in detail as follows.

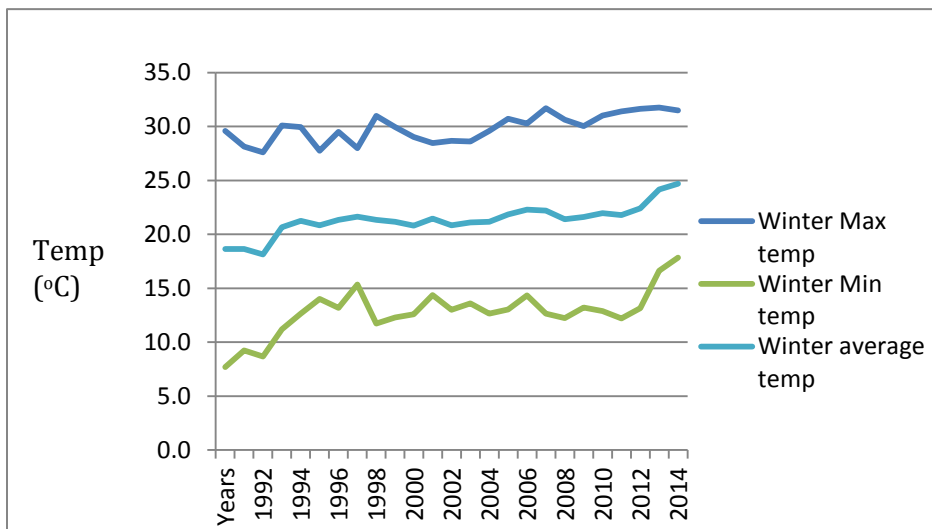


Figure 12. Winter mean annual temperature pattern

Here the maximum temperature, 33.7⁰c occurred in February in 2015 and the minimum temperature 7.2⁰c was occurred in 1993in December month. As depicted above in figure 12, it reveals increment of winter season 6.05⁰c (that means the average temperature in 1991 was 18.65c. in the same season in 2015 was 24.7⁰c, so within 24 years it revealed increment of 6.05⁰c.

“As the one FGD member informed in bega season rain fall is scanty. The quality of animals was decreasing. This is due to the lack of forage and the scarcity of water and the prevalence of animal diseases resulted from high temperature variability. Thus, the quality and the quantity of animal product also deteriorated, even in the year 2015 more than 200 cattle’s died, particularly larger animals are highly affected (KII &FGD,2016).

Annual average temperature distribution of the study area characterized by a general trend of increasing annual variability.

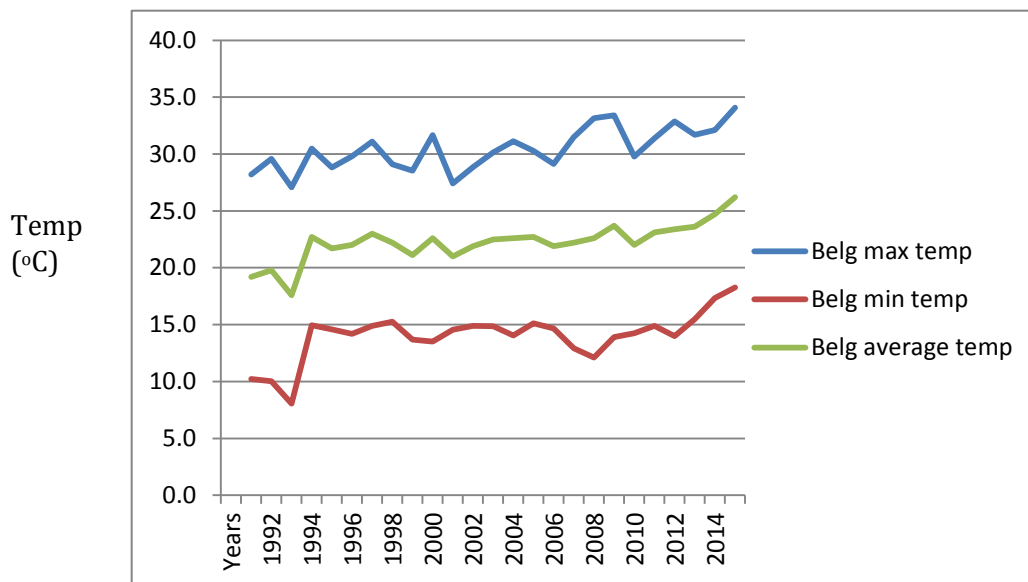


Figure 13. Pattern of *belg* temperature

As shown in figure 13 above in *belg* season, general trend of temperature was increased but relatively with decreasing rate. Specifically, the highest temperature recorded was 34.1⁰c in 2015 in the August month. And the lowest temperature was recorded as 8.0⁰c in March 1993.

As it computed the highest average temperature 26.5⁰c in 2015 recorded and minimum average temperature was 17.6⁰c in 1993 observed within 22 years.

So, belg average temperature difference with in 22 years in the study area reveals 8.6⁰c. This season is the main production months particularly maize and groundnut in *kumudo (dry woina dega)* to the households as well as a time of good access to livestock fodder in *Misrak Badawacho Woreda* but it is drying up with the average increasing of annual and seasonal temperature.

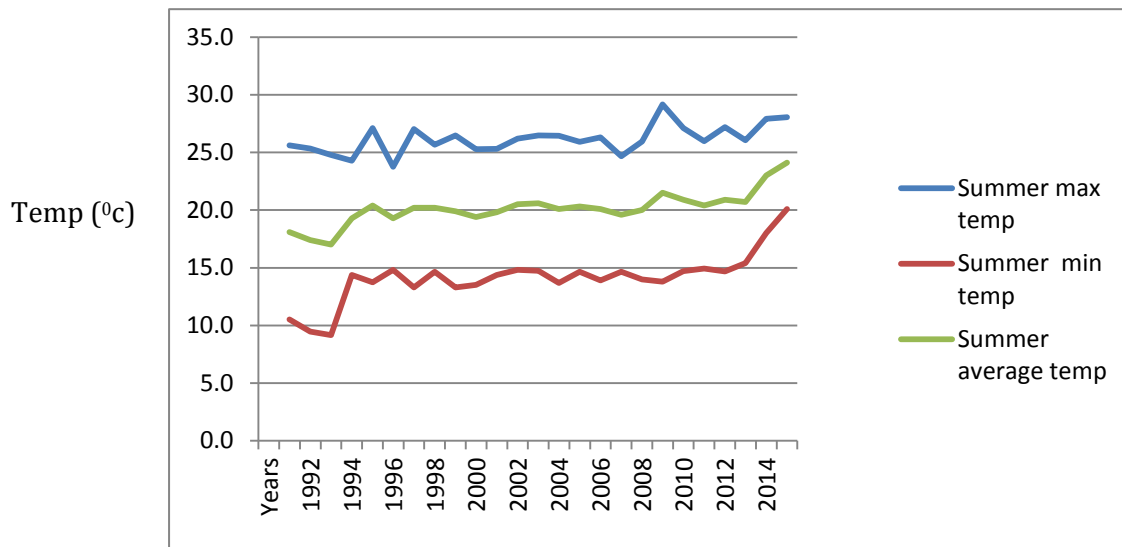


Figure 14. Summer temperature pattern

The maximum temperature of *autumn* season was 32.6⁰c in October, 2015 and its minimum temperature recorded was 5.1⁰c in November, 1993.

As depicted in figure 15 below it reveal increment of temperature on autumn season by 6.05⁰c (that means the average temperature in 1991 was 18.65⁰c and in the same season in 2015 was 24.7⁰c, so within 24 years it reveals 6.05⁰c).

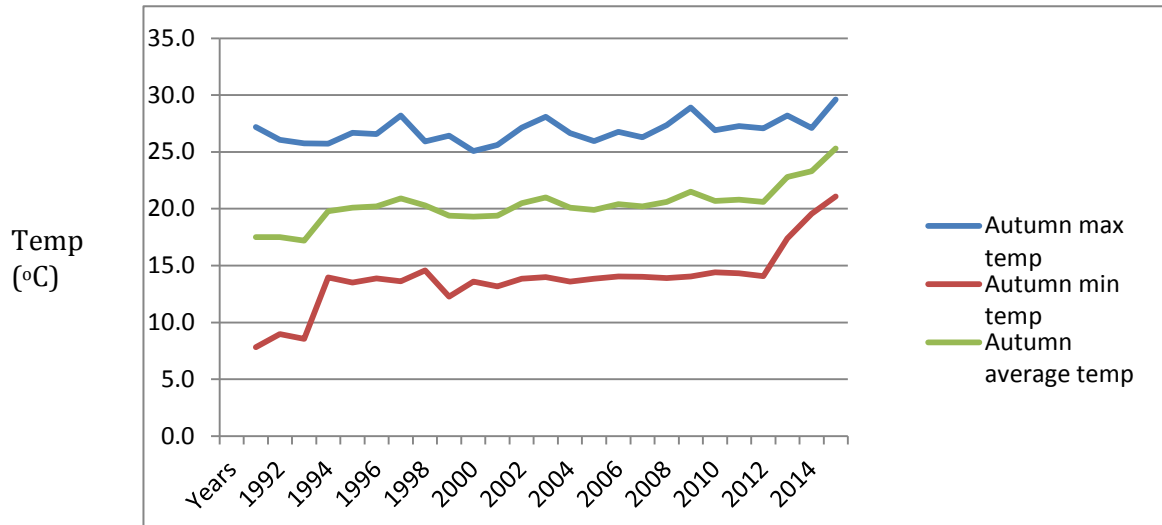


Figure 15. Autumn temperature trend

The maximum temperature of autumn season was 32.6⁰c in October, 2015 and its minimum temperature recorded. Generally, as the study objective is to identify causes of food insecurity and to assess the pattern and trend of climate variability, the temperature fluctuation is a main cause to low yield and food insecurity in the study area. These study also concise with (Balcha, 2001) states as extremely high temperature in the low lands affect agricultural productivity and food security.

4.6 Factors Affecting Crop Production in the study area

Crop production was affected by physical, economic and technological factors. The opinions of respondents are shown as follows;

Table 10. Households perception on factors of crop production

Perception Variable	Frequency	Percent
Poor access to chemical fertilizers	7	7.2
Erratic rainfall and fluctuation of temperature	33	34.0
Erosion	17	17.5
Traditional farming method	11	11.3
Pests	9	9.3
Farm land shortage	20	20.6
Total	97	100

Source: Own Survey, 2016

Table 10 reveals that socio-economic, physical and technological factors were influencing the households in *Misrak Badawacho Woreda* in different magnitudes.

Physical Factors; - such as erratic rainfall and temperature fluctuation is 34% and erosion/ land degradation 17.5% together accounted for 51.5% , was posing major adverse impact than socio-economic and technological factors.

Also from all variables, as respondents, rainfall fluctuation is serious than others. Generally, when rainfall became scanty, onset and late or early affected crop production and animals raising of the farmers in the study community rather than other factors. In addition to survey, woreda disaster and risk management also mentioned that the shortage and erratic rainfall is the prominent physical factor that causes the failure of crop production which ultimately results in the chronic food security. Rainfall starts at the beginning of March (*belg*) rain and continue till the end of September (*tseday*). However, in the last 20 years erratic *belg* rain and the secession of summer (*keremt*) rainfall negatively influenced crop production in the *woreda*.

Particularly the late *belg* rain fall affects production of potato and groundnut in *Ajeba chelfo* and maize crop and teff in *Kumudo*. Increasing temperature makes crop species less able to adapt the changing conditions and plants are more susceptible to attack by pests.

Following the termination of *tseday* rainfall, pest infestation was the second physical factor that affected crop production in *Kumudo* kebele as 9.3% respondents in dry *woina dega*. When rainfall terminates; during *tseday* season pest infestation occurs. Most of the crops in dry *woina dega agro* ecological zone attacked by pests when, the *belg* rain terminates early. Moreover, following the less availability of rainfall in *bega* and *belg* seasons leads to shortage of animal forage and the prevalence of livestock disease is the other challenge of food security mainly in dry *woina dega* kebeles. In general erosion and land degradation is the other natural factor that affected crop production and the challenge of food security. Land degradation indicates that, one or more (soil, water, vegetation, air, climate and relief have changed for the worse).

Economic Factors; - such as farm land shortage as 20.6% and poor access to chemical fertilizers as 7.2% were, considered as second level factor that affected the households of the study area. Under subsistence agriculture the size of agricultural land determines the amount of production on farm households. As mentioned in table 10 about 21% of the respondents in the sample kebeles reported that they have shortage of land. The size of their parcel ranges from 0.25ha up to 2.5 hectares and 10.1% reported as they have no farm land. From both zones, moist *woina dega* is more affected by farm land shortage (0.25ha). Agricultural input, chemical fertilizer improves the fertility of the soil and plays great role to maximize crop production, and however, about 7.2% of the sample households responded that, they have no enough money to buy agricultural inputs.

Thus, the small size of agricultural land and shortage of necessary agricultural inputs have negative consequences on agricultural production and food security .This implies that, the economic status of households were very low to sustain their living condition.

Technological Factor;-here as a variable traditional farming method used and those respondents about 11.3% responded as they were affected by lack of modern technological access and information that they were practicing traditional method of farming.

Education is vital for the implementation and use of appropriate agricultural inputs including farming system either it is modern or rudimentary.

Generally, it is assumed modern technology with improved seed and use of fertilizer may increase yield production. But, many poor farmers including women headed households were vulnerable due to low purchasing power and labor shortage. Relatively moist *woina dega* is better in application of modern fertilizers than dry *woina dega* zone.

4.7 Analysis of Household Food Insecurity

In this part, households' food was analyzed by four pillars or components of food security; which is food availability, access to food, and food stability and food utilization with their indicators because it is a challenge to analyze food insecurity using specific or single indicator. In other words, household food security is multi-dimensional and has complex interaction with various indicators.

4.7.1 Food Availability and Crop Production in Misrak Badawacho Woreda

To assess food shortage, it is vital to gather the amount of production of *woreda* level and of household level. The *Woreda* Agriculture Office reported the ten years agricultural yield from 2005- 2015 respectively as 606 781, 676 282, 641 689, 661 867, 601541, 599 192, 611 216, 576 172, 629 361, 643 645, quintals. Table 11 shows average annual crop productions in *Misrak Badawacho Woreda*, during 3 time segments with SD and CV.

Table 11.Ten years crop production with SD and CV in the study area.

Years	Mean annual production/quintals	Standard deviation	Coefficient of variation
2005-2015	624774.6	29590.826	4.73
2005-2010	637632	29502.411	4.63
2011-2015	611917.2	23456.69	3.83

Source: Field survey, 2016

Table 11 depicted that ten year production of crops in *Misrak Badawacho Woreda* appeared inconsistent as shown with coefficient of variation 4.73 % with an average of 642,774.6 quintals and range between 576,172 quintals to 676,282 quintals.

The first five year (2005-2010) production of crops fluctuated listed by the coefficient of variation 4.63 % with an average of 637,632 quintals and range between 601, 541 quintals to 676,282 quintals. The second five year (2011-2015) production of crops shows 3.83 % with an average of 611,917.2 quintals and range between 576,172 quintals to 643,645 quintals.

Thus, the objective of the study is to examine the impacts of climate variability on agricultural production and food security; one can conclude that the amount of production has decreased in the last five years. The possible reasons might be due to climate change, land degradation, poor fertilizer access, land fragmentation etc. Here all the combined effects are responsible to yield decreasing but the most decisive cause in the study area was climate related hazards and land degradation. According to Balcha (2001), food production capacity can be weakened because of drought/ land degradation. Hence, the researchers study result is consistent with this study.

4.7.2 Household Production Over the last ten Years (2006-2015/6)

Selected crop production cultivated by sample households before 10 years and this time. Respondents asked to report their production in type and amount in quintal. As indicated on Table 15 below the amount of average crop production was decreased. The significant crops in *Ajeba chelfo* were wheat, potatoes and teff. The average production was decreased significantly, hence, the untimely of the mehar rainfall and the occurrence of frost which devastates potatoes crop. Besides to this, the absence of selected seed also triggers the problem.

Moreover, the variability of *belg* and *mehar* rainfall and the presence of crop disease that caused the average low production of wheat production. The shortage of *belg* rainfall during its growing period and, the more excess summer rainfall during its harvesting period caused for the low production of potatoes crop in *Ajeba chelfo*. In case of *kumudo*, (*dry woina dega*), the fluctuation (the late onset of *belg* rainfall and the early secession of *tseday* rainfall) leads to the significance deterioration of crop production. For instance, the late onset of *belg* rainfall is the causes for low production of maize and groundnut crops. Hence, these two crops planted or sow during this season.

On the other hand, the early offset of *belg* rainfall that hampers the production of maize in both agro-ecology.

In general, each variety of crops decreased at least by two quintals in average. Generally, moist *woina dega* (*ajebea chelfo*) produces more varieties of crops than *kumudo* (*dry woina dega*).

Table 12 Agro-ecological comparisons of household average yield production

Agro-ecological zone	No of sample HHs	Type of production	Before 10yrs Quintal/hh/year	2015/16 Quintal/hh/year
Moist woina dega	58	Teff	7	5.5
		Wheat	5	3
		Potato	12	8
Dry woina dega	39	Teff	4	3.5
		Maize	20	11
		Groundnut	6	5

Source: Own Survey, 2016

4.8. Access to Food

4.8.1 Household Income

Land holding and livestock use and other household resources were considered to assess the economic status of the respondents. The average monthly income of the households calculated from the annual household income classified into five based on the response of the households. These are very poor with less than 50 birr per month, poor (51-100 birr) per month, average (101-200 birr) per month and relatively better (201- 300 birr) per month and wealthy ones (>301)

Table 13 Average Monthly income of the sample households (birr)

Monthly income	Frequency	Percent
<50	23	23.7
51-100	17	17.5
101-200	28	28.9
201-300	11	11.3
>301	18	18.6
Total	97	100

Source: Own Survey, 2016

As indicated on Table 13 the majority of the households were grouped as very poor (locally said ‘*Angahoffixxa*’) and poor (locally known as ‘*Buxxichcho*’) together comprises 41.2%. Averages/medium also known as ‘*Lambee’anchcho*’ is 28.9%, better off (*Goddanchcho*) is 11.3% and finally wealthy (*Xibbancho*) is 18.6% based on wealth/asset index. Particularly households that dwell in the *dry woina dega* agro-climatic zone, is much poorer than the moist *woina dega* agro-ecological zone. Hence, the researcher’s objective is to determine the status of food security in household level, the income of the households has been deteriorating since the previous twenty years. Household access to food is determined by households’ own production, sale or income from livestock and off farm incomes. The details are as follows:

4.8.2 Land use Practice and Holding size

At present, about 83.82 % and 1.9 % of the total area of the *woreda* was used for crop production and livestock rearing respectively. The average size of their farm land in dry *woina dega* was 0.5 ha and in moist *woina dega* is 0.25 ha so that the average farm land size in the study area was 0.375 hectare. The small scale of this farm size has been a major bottle neck to enhancement of productivity in the *woreda*’s agriculture .Thus, to overcome the constraint agricultural inputs should be employed. Under subsistence agriculture, holding size is expected to play a significant role on farm household food security. The sample households plough fragmented plots with different sizes and fertility levels.

Table 14. Households' perception of farm land fertility

Perception Variables	Frequency	Percent
Constant	22	22.7
Declining	69	71.1
Do not know	6	6.2
Total	97	100

Source: Own Survey, 2016

To know the perception of farmers, researcher asked about the fertility of their farm land, but the majority of households 71.1% responded as it going infertile. A decline in soil fertility negatively affects food security.

Food production can be increased extensively through the expansion of area under cultivation and through application of modern technologies to keep fertility status of farm land.

4.8.3 Description of Livestock

More importantly, HHs asked to report their livestock both in type and in number that they had before 20 years and this time.

Table 15. Livestock trend in the study area

Type	Oxen	Cows	Sheep	Goats	Donkeys	Poultry	Hives
20 years ago	3	4	6	5	2	8	4
Nowadays	0.5	0.3	1	1	0.1	3	0.5

Source: Own survey, 2016

In the above Table 15 the researcher asked as, how many of the following livestock did you have before 20 years and nowadays to know its trend. The distribution of livestock is not uniform throughout the household. As respondents, oxen average number before 20 years ago was 3 but nowadays its average has decreased to 0.5.

Similarly the average numbers of Cow reduced from 4 to 0.3, sheep from 6 to 1, goat from 5 to 1, donkey from 2 to 0.1, poultry from 8 to 3, and hives from 4 to 0.5.

Oxen are the most important one than other livestock for households, who engaged on crop production. Cow is the second biggest animal next to oxen, because it provides milk and milk products that support in a season of hardship. When both environments compared, *moist woina dega (Ajeba chelfo)* has relatively better concentration of livestock than *kumudo (dry woina dega)* due to presence of forage (banana tree, ground water etc.) and the absence of animal diseases. Before two decades, bee hives is considered as one of the best source of income. Donkeys help to petty trade and for the transportation of yields to the market center. It is common more in dry woina dega agro-ecology of the study area. Generally, the number of livestock has decreased within the previous two decades as 88.7% of respondents even if 11% responded as no change at all.

Hence, the study result concise with the study of WFP (2014) which states as households that rely on rain-fed agriculture as the main source of livelihood, unfavorable climate conditions such as drought can be experienced as a major shock and may well lead to food insecurity.

Table 16. Households perception about constraints of livestock raising

Perception Variables	Frequency	Percent
Lack of pasture	28	28.9
Stock disease	11	11.3
Poor stock management	8	8.2
Water scarcity due to drought	50	51.5
Total	97	100

Source: Own survey, 2016

As shown on the Table 16 above, the majority of them 51.5% responded as drought and associated water scarcity as a major challenges and constraints to livestock rearing in the study area. In second level lack of pasture is also a serious constraint to livestock production.

Currently, the number of livestock in each agro-ecological zone has decreased than before a decade.

Livestock are highly exposed and attacked by diseases when the late onset *belg* rainfall starts. Generally, the shortage of rainfall which causes scarce availability of fodder and water, and the presence of livestock diseases were the significant problem.

Table 17. Households' perception on why animal feed declining

Perception Variables	Frequency	Percent
Expansion of farm land	31	32.0
Degradation of grazing land	5	5.2
Drought	46	47.4
High popn growth	15	15.5
Total	97	100

Source: Own survey, 2016

From the table 17 above, as respondents, the reason to animal feed declining as 32% responded in their opinion as expansion of farm land/ fragmentation of farm land size, as 5.2% of respondents land degradation is a cause, and as 47.4% households opinion the cause is drought still now it is a leading factor, population pressure 15.5% and degradation of grazing land 15.5% also for some segment of population opinion is a cause. Generally, even if climate variability poses a major challenge to animal rising and its forages, the above variables have its own factor. Therefore, their forages limited to crop residue and individual grazing field as the respondents.

4.8.4 Sale of Livestock

Access to sale or income from livestock is the other parameters of household either to be food in secure or not. In both kebeles have very low income from their livestock sale .Therefore, if their agricultural production fluctuates because of the effects of climatic variability and change or the effect of natural disasters, income from livestock could not support their food access. However, comparatively the households in *Ajeba Chelfo* earned better income from livestock than *kumudo in dry woina dega*. Thus, such amount of income is not enough to support their life. However, income from livestock is insufficient because of certain constraints. Such as lack of pasture (forage), poor stock management, traditional attitude towards large numbers of livestock is the major ones in both kebeles.

The absence of rainfall during *bega* season and the unreliable rainfall in *belg* season makes limited quantity of animals' pasture and drinking water.

Moreover, during these seasons animal' diseases also highly affect livestock production. Livestock disease highly devastates in dry agro-climatic zone.

For example, animal disease like *Abagorba (Muuraato)*, *Abasenga (Ellinchcho)*, *Aftaegir (Xinnxichcho)*, *Lobbaxxa and Anjichcho* are locally known cattle disease in both climatic zone. Thus, this constraint leads the sample households to be food insecurity.

Assets;-The available assets can indicate the wealth of the respondents. One of the major assets that indicate the wealth of households in many countries is how much as house is worth (Oxfam, 2008). Therefore, the respondents estimate the cost of their house in birr as shown below.

Table 18. Estimated costs of house per household (birr)

Costs (birr)	No	%
< 2000	44	45
2001-4000	31	32
4001-6000	16	17
>6001	6	6
Total	97	100

Source: Survey, 2016.

Housing is the predominant component of wealth for the typical household in many countries. Thus, table 18 briefly indicated that the cost of houses that we estimate the status of the wealth of the respondents, about 45 % of the respondents consist the highest percentage that estimated their house was worth less than 2000 birr. The majority of the houses were categorized between birr 2000 and next to it under 4000 birr. Very insignificant houses cost about 6000 birr and more than it. Building materials and house types were the major parameter for relative financial status and tend to correlate the households economic strength. The size of the houses and the types of materials which houses made indicate the economic status of the households. Comparatively, houses in moist *woina dega (Ajeba chelfo)* are better constructed than dry *woina dega (kumudo)*, because they built their houses relatively with expensive materials and roof than *kumudo*.

Generally, researcher concluded that since the objective of the study is to determine the status of food security in the study area, their asset (livestock as well as houses) value and monthly income was very low for majority of households to fit any challenges that imposed on their livelihood. So that 45% of households have no access to food and but only 6% of households have enough access to food and 49% have medium access to food in the study area.

4.9 Aspect of Food Utilization

Food Utilization is a household uses of food and is determined by such factors as households' access to drinking water, adequate sanitation, food storage and processing techniques and knowledge. Access to safe drinking water and sanitation are vital indicators on key health and nutrition. Hence the scarcity of food and the frequent presence of epidemic disease like malaria are the direct and indirect consequences of climate change in the study area.

Table 19. Household perception of causes of disease

Perception Variables	Frequency	Percent
Poor access to health care	19	19.6
Nutritional	10	10.3
Sanitation problem	13	13.4
Malnutrition	7	7.2
Environmental problem	22	22.7
Food shortage	26	26.8
Total	97	100

Source: Own survey, 2016

The prominent causes of repeated disease in the study area as shown on Table 19, include; food shortage 26%, Environmental problem including climate change 22%, poor access to health care 19%, poor sanitation 13% and nutritional problem 10% of the respondents with order of decreasing severity. Therefore, in the study area prevalence of disease that associated with food shortage, environmental problems, and disproportional health center distribution has significant impact in study community. But, still now the severe challenge is environmental that associated with climate variability.

Relatively, more vulnerable societies were of dry *woina dega* zones. As seen below in Table 20 majority of households 34% walk to the health center about 30' to 1hr, secondly 23.7% of the households walk to 2hrs mostly this is in the dry *woina dega* environment and more than 2hr like 11.3% of respondents. So that in the study area the aspect of food utilization is very poor that requires improvements all most in all aspects.

Table 20. Households perception of distance to health center

Perception Variables	Frequency	Percent
<30'	9	9.3
30'-60'	33	34.0
1:30hr	21	21.6
2hr	23	23.7
>2hr	11	11.3
Total	97	100

Source: Own survey, 2016

Table 21 Households perception of distance to water source

Perception Variables	Frequency	Percent
<500m	14	14.4
500m-1000m	20	20.6
1000m-1500m	27	27.8
1500m-2000m	21	21.6
>2000m	15	15.5
Total	97	100

Source: Own survey, 2016

In above Table 21 for the question to assess water access, some respondents 14.4% walk less than 500m to get water. Next to 20.6% walk about 500km to 1km, 27.8% get within 1km to 1.5km, and 21.6% get having walk between 1.5km to 2km and about 15.5% with in long distance. Generally, in both kebeles the respondents do not have better access of safe drinking

water. The majority of the households' fetches drinking water from unprotected sources. But the rest fetch from unprotected springs and open wells are not too safe for drinking and about 31.1 households travel up to 2km and beyond.

But relatively moist *woina dega* is better concerning to distance to water sources. In access to livestock water dry *woina dega* is better than moist *woina dega* due to the presence of *Bilate River and Cherake River* even if it is dry up in winter season.

5.10 Vulnerability to Food Insecurity

The researcher tried to assess the major causes of food insecurity in the study area. Accordingly, the households responded as follows in the table;-

Table 22. Households perception of causes of food insecurity

Perception Variables	Frequency	Percent
Rainfall shortage	36	37.1
Animal disease prevalence	5	5.2
Poor access to modern farm input	5	5.2
Low non-farm income	9	9.3
Poor soil fertility	11	11.3
Land fragmentation	31	32
Total	97	100

Source: Own survey, 2016

The Table 22 above indicates that, about 37.1% respondents the rain fall fluctuation attribute food insecurity to, 10.4 responded as animal disease prevalence and poor access to modern farm input attribute to, low non-farm income as 9.3%, and as 11.3% households poor soil fertility attributes to and finally as the households reported the other serious cause is land fragmentation

about 32%. Generally, all factors reported in the Table above could have contributed to food insecurity. But as indicated in long term national meteorological data of Hawassa branch in Shone station, and as this survey result the dominant factor is rain fall and temperature fluctuation and then high population growth and land fragmentation could have prominent effect on food security.

Hence, the objective of the researcher’s study is to determine the status of food security, about 85.6% of the respondents believed and added the existence of food insecurity in both kebeles.

In case of non-farm income practices moist *woina dega (Ajeba chelfo)* is relatively better than dry *woina dega* community. Because, they were involving in day to day income generating activities and were earning their livelihood in time of climate related risks. Most of the time females and Childs’ involve in small business. Relatively in *kumudo* community those victims to food insecurity simply wait for the support from government, NGOs and Safety Net program.

Table 23. Households’ meals interval per day.

meals interval	Frequency	Percent
2 meals	53	54.6
3 meals	24	24.7
4 meals	1	1.0
1 meal	19	19.6
Total	97	100

Source: Own survey, 2016

As indicated in table 23 as researcher asked the question to assess food insecurity status by observing food intake interval per day, majority of the households 54.6% responded as they are eating two meals per day. Next to that about 24.7%, of respondents told they have had choice per day. And, of the total respondents, 19.6% were eating meals only once per day and finally only 1% of the respondents were eating the 4 meal per day.

“Focus group discussants, one 55years old women added as they were eating two meals that is with very low quality, quantity and inadequate foods like; locally in Amharic’ kita ina kolo ke kital buna gar’ or ‘qorroshsho’oo inqaalaa qawwawinne’ as major food

for prolonged months and even we may not get it continuously in a severe food insecure months.”

Severely food insecure segment of populations buy these food items by selling coffee leaf and serving as daily laborer to the better off particularly in moist *woina dega* agro ecology.

Table 24. Households perception of food insecure months per year

Perception Variables	Frequency	Percent
For <3 months	5	5.2
For 4 months	11	11.3
For 5 months	22	22.7
For 6 months	44	45.4
For 7 months	9	9.3
>7 months	6	6.2
Total	97	100

Source: Own survey, 2016

From the combined above two Tables' (23 and 24) data, the household's food sufficiency within a year is categorized in to four groups. Accordingly, 15.5% of the households were severely food insecure that they face the problem of food insecurity for seven and more months like; December, January, February, March, April, May and June months. The second category, moderately food insecure 34% faced the problem of food insecurity for 4-5 months like; March, April, May and June months. Third category, those 45.3% food secured households faced the challenge in a very small scale for the less than three months particularly in a May and June months with in risk years and finally highly food secure segment of population comprises 5.2% they were not faced food insecurity problem throughout the year.. Comparatively, households of the moist *woina dega (Ajeba chelfo)* is still better than dry *woina dega kebeles (Kumudo)* because they take part in different income generating tasks and planting early maturing crops like potato groundnut and even they plant enset, sugarcane, avocado, chills and banana trees used for livestock forage but Kumudo sells the livestock the left over from death in very low price.

When it concluded the above two tables reveal that in *Misrak Badawacho Woreda* households use meal twice per day with very low quality, quantity and adequacy for more than six months. Therefore, this is one of indications to food insecurity in the study area. The most food insecure segment of populations are elders/aged households who have no support, female headed households, households with large family size, patient household heads, landless households, households who didn't have oxen, households with less access to diversified source of income and households who dwell in degraded areas.

4.11 Summarized Causes and Indicators of Food Insecurity in the Study area.

Table 25 Summarized causes and indicators of FI

Causes of food insecurity.	Percentage of respondents (%)	Indicators of food insecurity	Percentage of respondents (%)
Erratic rainfall and fluctuation of temp.	52.6	Low quality and quantity food intake	21.6
Fragmentation of farm land size.	11.3	Low quality and quantity livestock	17.5
Presence of livestock and crop diseases.	6.2	Low crop and livestock product outputs	24.7
Land degradation and soil erosion.	9.3	Relying on less preferable and less expensive food items	13.4
Population growth	13.4	Selling more livestock than usual.	11.3
Low non-farm income	4.1	Reducing number of meals per day. And, production only for	7.2

		consumption.	
Relying on traditional farming methods.	6.2	Relying on help from relatives, friends, NGOs and Gov't as well as migrating somewhere.	4.1

4.11 Adaptation and Copping Strategies

As climate variability has been common, farmers in the study area were practicing different adaptation and coping strategies. According to Negatu, (2016), in developed and developing countries all over the world, farmers and indigenous and local communities have traditional knowledge, expertise, skills, and practices related to food security, agricultural production, diversity and adaptation. Adaptation strategies are methods that local people used to adjust themselves with the existing change to minimize and adapt the impact of climate change.

Table 26. Households' perception on coping to shortage of livestock forage.

Perception Variables	Frequency	Percent
Increasing grazing land area	14	14.4
Introduction of controlled grazing	17	17.5
Reduction in livestock number	2	2.1
Modernize feeding and management system	64	66.0
Total	97	100

Source: Own survey, 2016

As the researchers' study objective is differentiating local coping and adaptation strategies in the study area, as observed in Table 26 above, for the shortage of animal feed as an adaptation strategy the majority households 66% responded that modernization of feeding and livestock management system. One of the livestock feeding modernizing way is grass strip that is bund of grass laid out on cultivated land along the contour.

Usually grass strips are about 1m wide and spaced at 1m vertical interval. In addition to be fodder for livestock, they are mainly used to replace physical structure on soil with good infiltration on gentle slopes. Of the respondents, 17.5% and 14.4% of households respectively responded as controlling and increasing of grazing land as better choice.



Figure 16. Households adaptation strategies (planting elephant grass/grass strip) in the study area (Fig. a and b).

Source: Field observation and, February, 2016 in *Ajeba chelfo*.

In addition to survey result focus group discussants and key informants pointed out the implementation of all soil and water conservation technologies. The most widely used improved soil and water conservation technologies were physical soil and water conservation measures such as soil bund, *fanyajuu*, cutoff drain, water ways, stone bunds and check dams.

Soil bund; - that is an embankment constructed from soil along the contour with water collection channel or basin at its upper side. It is used to control runoff and erosion from cultivation fields by reducing the field slope length which ultimately reduces velocity of runoff as a result soil going to be fertile and land degradation improved.



Figure 17. Soil bund in the study area of adaptation (Fig. a and b).

Source: Field observation, 2016

FanyaJuu; - This is an embankment constructed by throwing the soil dug from basin to uphill. This conservation structure is also constructed during dry season. The aim is to reduce and stop erosion and increase water holding capacity of the soil so as to enhance crop yield. Moreover, it has a potential to increase or sustain soil productivity and environmental protection.

Cutoff drains;-This structure is a graded channel constructed mainly in moist area to intercept and divert the surface runoff from higher slopes and protect downstream cultivated land or village. On the contrary, cutoff drains in dry area are used to divert runoff and additional water into cultivated fields to increase soil moisture.

Waterways; - Waterways can be natural or man-made drainage channel to receive diverted runoff from cutoff drains in upper slope. The waterways safely carry excess runoff to rivers, reservoirs, or gullies without causing more erosion damage.

Stone bunds; - stone bunds are embankments or ridges made of stones built across a slope, along contours. These structures prevent water from flowing down the slope, and so also prevent soil erosion.

Check dams

These are structures built across the bottom of gullies to reduce the velocity of runoff and prevent deepening and widening of the gully.



Figure 18. Stone bund and check dam for adaptation strategy (Fig. a and b).

Source: Field observation, 2016.

Closure areas it is closure of areas and denying access to all human and livestock activities and allowing it to recover by natural process.

These areas have been closed to improve land affected by severe erosion, limited vegetation and low fertility through natural regeneration to rehabilitate degraded lands.



Figure 19. Closure area and water harvesting ponds in the study area public work participant farmers in *bade mera* village.

Source: Own survey, Field observation, January, 2016.

Generally, the households of the study area were implementing and practicing soil and water conservation technologies to adapt and mitigate the risks of climate variability, that is important conditions to improve soil fertility, to conserve land degradation and erosion, to harvest water to animals drink , to increase agricultural production and resulting food security and, also it contributes more about conservation of environment as a consequence it regulates the balance of climate variability. What is needed is carrying out such activities more organized manner considering the problem of land degradation and infertile soil to agricultural production and food security.

Moreover, as both indigenous and learned strategies; crop rotation, sowing variety of crops particularly in moist *woina dega*, planting early maturing plants in both agro-ecology, growing drought resistant crops, shifting harvesting season from season to season, weed control, insect and pest control are frequently practicing adaptation and coping strategies in the study area. The local people and the institutional leaders of *woreda* designed strategies in different sectors. Some of these strategies were changing crop and animal type, planting trees and engaged in additional works to diversify their source of income. Changing crop and animal type;-local people perceived that the erratic rainfall and changing temperature in last twenty years. Thus ,they change from late to early maturing crop type like groundnut and potatoes, Vegetables, cabbages, roots and fruits are some of the short grown crop type. Rearing small animals like goat in *dry woina dega* and sheep in moist *woina dega* and hens rather than cattle. This is because the changing climate makes the quality and the quantity of forage deteriorating, it is a challenge to feed cattle.

However, to increase their earning potential households were practicing weaving, pottery making, wood work, fuel selling, garment and petty trading which add values to farmers in the study area. *Ajeba chelfo* used underground water in order to harvest twice in a year which enabled them somewhat to alleviate their food shortage or to sustain their food insecurity. However, lack of capital and water scarcity became its main constraint in the study area.

4.12 Household Strategies to Coping food Insecurity

Coping strategies refers to adjustments in behavior and activities made by household during periods of food insecurity. During food insecurity periods these households use a wide range of mechanisms and social networks to cope with the situation.

As shown earlier, farm households produced only for their consumption. These farmers were not able to produce enough to cover their consumption throughout the year. The respondents find immediate solution. Support from relatives and friends, seasonal migration and sale of livestock and request aid from organizations.

As usual, the researcher asked the households as how did they cope through food consumption. In the pie-chart below the majority of households 49.5% answered they were eating food that is less preferred, the next largest respondents 26.8% copped with the food insecurity problem by

reducing the consumption amount during each meal. Also, 16.5% of the respondents were using completely changing the type of food in a food insecure seasons. And, certain segment of farmers sometimes does not eat for whole day that comprises 7.2% of the respondents. Generally, in *Misrak Badawacho Woreda* farmers have indigenous coping strategies like this and others. But from both kebeles *Ajeba chelfo* has a good habit of coping mechanisms than *Kumudo*.

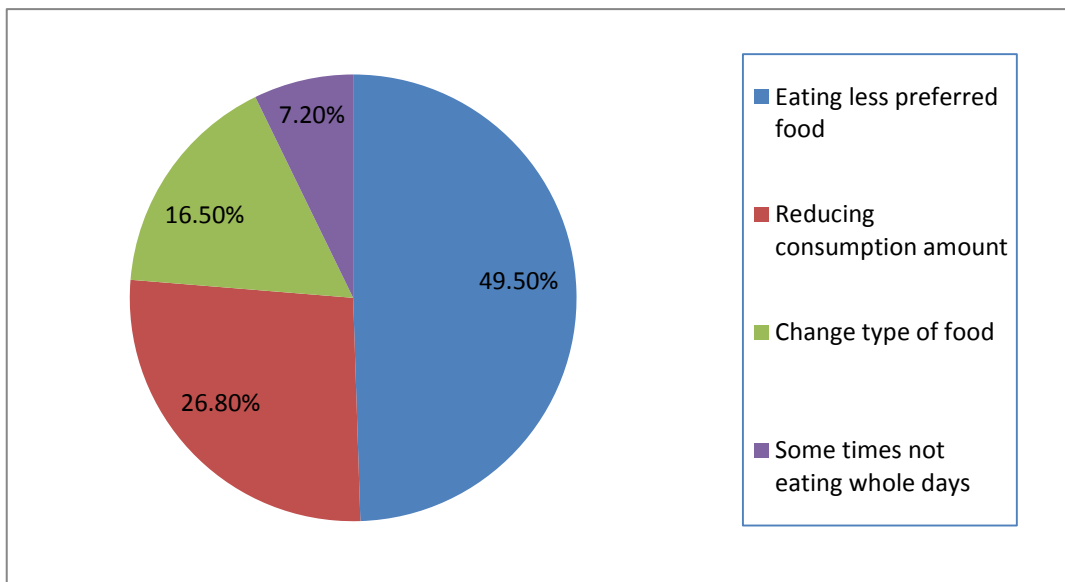


Figure 20. Households' coping strategies through food consumption

In the study area in months of food insecurity to coping the existing challenge community cooperatives, friends, relatives, even NGOs and government support the victim farmers.

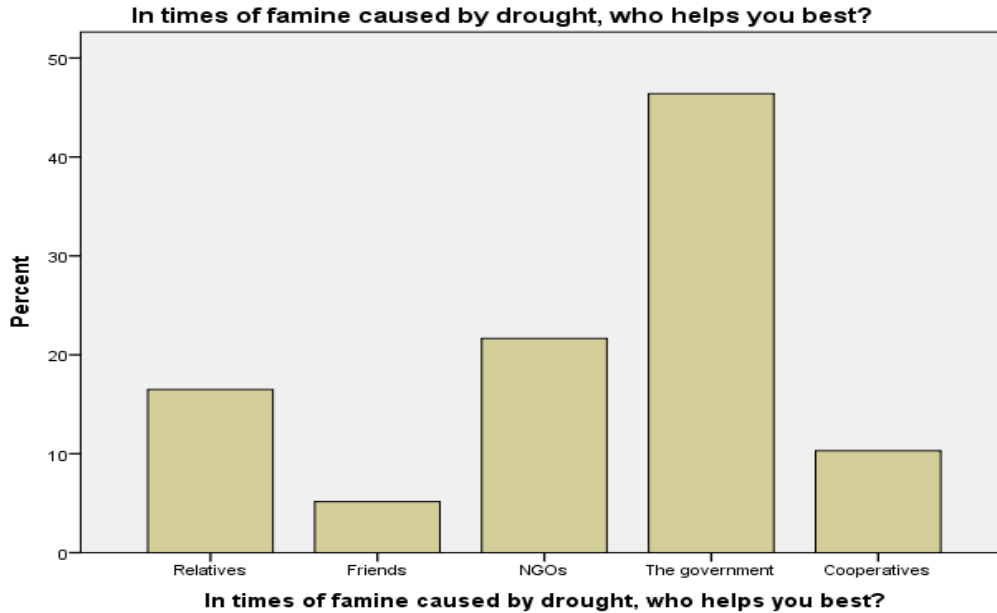


Figure 21. Helps to households in hazard season.

For the above question, 16.5% of the respondents reported that relatives were supporting in time of drought and flood risks.

Of which 5.2% answered as friends supporting them, 10.3% agreed that community associations and cooperatives help in a time of hardship, 21.6% responded as they got aid from NGOs and finally the majority 46.4% answered as the government was supporting them when they become vulnerable to the impacts of climate variability. For the impact, WFP, Goal Ethiopia and Catholic Church etc. were supporting the households by proving different food aids. And, as added the health expert, the challenge is serious for females and children so that UNCEF was providing food items to less than 5 years child and child bearing mothers. And, World Vision Ethiopia was providing palm oils and wheat to all victim families to food insecurity.

Table 27. Households' perception to what government agents used to do.

Perception Variables	Frequency	Percent
Supplying agricultural input	36	37.1
Giving money	5	5.2
Food aid	8	8.2
Facilitating additional job opportunity	26	26.8
Showing different mechanisms	22	22.7
Total	97	100.0

Source: Own survey, 2016

Table 27 indicates that government was supporting them through different angles. As respondents answered 37.1% the government used to supply agricultural inputs, 5% and 8% giving money and food aid respectively and 26% and 22% of respondents responded the government was supporting by a means of facilitating additional job opportunity and showing different mechanisms to the farmers respectively.

In summary, the discussions made so far reveal there is a food insecurity problem so that as a coping strategy farmers were practicing mechanisms at a house hold level like selling small animals, sending children to better relatives in order to keep livestock to get money, females serve better off, males migrate to towns and other rural areas, borrowing money from relatives and friends, reducing food consumption by restricting the size, diversity and number of meals, buying less preferred food items from market, etc. and beside of government and NGOs the vulnerable farmers were getting support to cope with shocks even if it is not sufficient.

CHAPTER FIVE

5. Conclusions and Recommendations

5.1 Conclusions;-

Food insecurity and undernourishment is the most acute challenge in the study area. As the study objective is to identify the causes of food insecurity and to examine climate variability impacts on agricultural productivity and food security. Food insecurity challenges have been compounded by effects of erratic rain fall and temperature fluctuation that resulted either in heavy flooding or drought that destroyed farm produce and caused crop failure respectively. As a discussion, the impact of climate change on crop production would be mainly through change in temperature and rainfall, which collectively influenced the length of growing period, time of critical growth rate, increased evapo-transpiration and hence seriously reduced and in some cases caused complete crop failure.

According to the study findings households were affected by physical, economic and technological factors in varied magnitude.

As above mentioned the dominant climate elements were rainfall and temperature fluctuation that was posed major impact than economic and technological effects in the study area. As the findings show economic factors such as farm land shortage and poor access to chemical fertilizers considered as second level factor that affected households of the study area. Technological factor as revealed traditional farming method used and lack of modern technological access and information method were main affecting conditions. Socio-cultural factors could have its own factor on food security in family level. As a study result household livelihood in the area mainly dependent on crop and livestock production that is dependent on rain-fed agriculture. The study objective is to determine the status of food insecurity in the study area; households were relied on rain-fed agriculture that is more sensitive to physical, socio-cultural and technological. As a result, households categorized as severely food insecure 15.5%, moderately food insecure 34%, food secure 45.3% and highly food secure 5.2%.

And, also the objective of the study is to assess the rainfall and temperature trend in the study area, as long- term meteorological data shows there is high concentration of rainfall that is erratic in nature and there is high fluctuation of temperature with increasing trend.

And, the researcher's study objective is to differentiate local adaptation and coping strategies at household level, as finding indicated farmers in both micro agro-ecological zones were aware that climate is changing mainly through observation of rainfall and temperature trends over a long period of time and its adverse effects on natural and human systems. Community households have recognized such challenges so that they were using different adaptation strategies and coping methods so that were implemented improved soil and water conservation technologies although no in well-organized manner. Researcher also find the coping methods like selling small animals, sending children to more able relatives in order to keep livestock to get money, females serve better off, males migrate to town and other rural areas, borrowing money from relatives and friends, reducing food consumption by restricting the size, diversity and number of meals, buying less preferred food items from market, etc.

5.2 Recommendations

Based on the findings and conclusions of the study, the researcher forwarded following points as a recommendation to policy makers and planers:

- To address food security issue in Misrak Badawacho Woreda, the household head and members should involve in different income generating activities for means of living and coping mechanism and the government of Ethiopia and local governors should incorporate different research outputs to design income diversifying programs that could relieve the study area from its chronic and transitory food insecurity.
- Rainfall seasonal variability and temperature fluctuation was influencing agricultural productivity and food insecurity. Therefore, government with the experts from disaster prevention and preparedness, crop and animal production offices and farmers have to integrate in the update information of weather and climate conditions and there should be established well organized weather forecasting and meteorological stations.
- The issue of climate change and its adverse impacts on agricultural production, on human health, on food security, and generally its effects on natural and human systems should be noticed to public servants, non-governmental organizations, farmers, students and to societies at large grass root level through mass media (using newspaper, radio, television, songs, poems etc.) and in different meetings through arranging panel discussions by inviting guest specialized the issue to fill the knowledge and skill gap that revealed in the study area and to initiate and to empower the communities and all stakeholders in *Misrak Badawacho Woreda*.
- Even if there is a good start of adaptation and coping strategies in the study area, still soil erosion and land degradation resulted from climate related hazards like flooding is a serious challenge to crop production and food security. So, researcher desires well organized implementing improved soil and water conservation technologies with integration of concerning bodies from water and irrigation development office, forest and environment protection office, agricultural and natural resource development office, health office and with leading role playing by

woreda administrative office (even by allocating sufficient finance) through incorporating NGOs and community at large. And, the government and any concerning bodies have to appreciate and support local adaptation and coping strategies that is very important to the issue under studied and the farmers should develop awareness creation on family planning (to limit population growth), adoption of technologies, pre and post-harvest management and education of household heads are also crucial activities.

- There is a limitation in harvesting water resources in the study area. It is a precondition to use irrigation, to animals and humans healthy life, to increase product and productivity and to assure food self-sufficiency. Therefore, the community with government technical support shall dig water harvesting deep ponds and open wells using man power and as much as possible with tractor giving priority to flooding sites like in kenchera-Aliye Gadore village, because digging water harvesting ponds will serve as a minor dam for flood damaging area and in a seasons of water scarcity serve as animals drink, small scale irrigation and indirectly helps to food security.
- To strengthen the coping strategies of farmers, local administrative organs have to arrange and organize work experience sharing program among very poor and poor with wealthy at community level as well as zonal and regional level to encourage and initiate vulnerable segment of population to involve in all income generating activities with in hazard seasons due to climate variability to able to support their life
- Of households majority (41.2%) is an illiterate farmers. Lack of education has its influence to the dissemination of modern technology among farmers. Therefore, government has to foster that already started integrated adult education by giving due attention and with adequate follow up. In general farmers and all concerning bodies in *Misrak Badawacho Woreda* will succeed in achieving sustainable agricultural production, food security, and economic income if they apply the recommended choice effectively in all aspects.

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Appendix I: Questionnaire

Questionnaires filled by farmers

Dear respondents,

This questionnaire is designed to obtain or gather data to develop a thesis for academic purpose and so, that are intended to investigate the farmers perception and adoption of impact of climate variability on food security of the rural households in case of Misrak Badawacho Woreda. The success of this academic research depends on your honest answer and, thus you are kindly requested to respond clearly and genuinely. You do not need write your name and you may not respond if you are not comfortable with the questionnaires.

Thank you in advance!

Socio economic and demographic profile of HH heads

A. Demographic profile

1. Age of the household head _____
2. Sex of the household head
 1. Male _____
 2. Female _____
3. Marital status
 1. Married
 2. Single
 3. Widowed
 4. Divorced
 5. Separated
4. Family size _____
5. Educational status of the household head
 1. Illiterate
 2. Elementary
 3. Junior
 4. Secondary School
 5. Higher education
6. Monthly income _____

15. How do you describe the trend of animal feed?

1. Declining 2. The same 3. Increasing 4. I do not know

15.1. If it is declining, why is that?

1. Expansion of farm land 2. Degradation of grazing land 3. Drought
4. Expansion of settlement (Popn. Growth) 5. Others, specify _____

16. Constraints of livestock rising

No	Constraints	1. Yes	2. No
1	Lack of sufficient pasture (feed)		
2	Stock disease		
3	Poor stock management		
4	Traditional attitude towards large number of live stock		
5	Moisture stress (water scarcity due to drought)		

17. What should be taken as a remedy for shortage of animal feed?

1. Distributing communal grazing land for private use
2. Increasing grazing land area
3. Introduction of controlled grazing
4. Reduction in livestock number
5. Modernize feeding and management system
6. Others, specify _____

18. Do you have your own land? If yes, how many hectares do you have?

- 1 < 0.5 ha 2. 0.5 ha 3. 1 ha 4. 1.5 ha 5. 2.0 ha 6. >2 ha

19. How do you perceive the fertility of your farm land?
1. Improving
 1. Constant
 3. Declining
 4. Do not know
- 19.1. If the fertility of your land is declining what is the indicator? _____
20. How did you get the land you have currently? (More than one choice is possible)
1. Through renting
 2. Through share cropping
 3. Inherited from parents
 4. Allocated by *Kebele*
21. How do you perceive the distance of cultivation field from your home?
1. Near
 2. Moderate
 3. Far
 4. Very far
22. How do you perceive the productivity of your land?
1. Increasing
 2. Decreasing
 3. Constant
 4. Do not know
- 22.1. If the yield from your farm land is decreasing, what could be the reason behind?
(More than one answer is allowed)
1. Absence of fallowing
 2. Poor access to chemical fertilizers
 3. Unreliable rainfall
 4. Erosion/runoff
 5. Over cultivation
 6. Pests
 7. Moisture stress
 8. Other reasons _____
23. How was/is the amount of agricultural production before a decade compared with this time?
1. Has no change
 2. Decreased in crop yield
 3. Increased in crop yield
 4. Standard crop growth.
24. What is your house hold health status?
1. Fully healthy
 3. Have prominent sickness
 2. Some times (occasionally become) sick
25. What are the causes of disease in your family mostly? (Put in order of severity)
1. Nutritional problems
 3. Sanitation problem
 5. Malnutrition
 2. Poor access to health care
 4. Environmental problem
 6. Food shortage
26. How far is the nearest modern health center, put it in hour to walk

37.1. If yes, what happened to rainfall and temperature in your opinion? (Mark“*” in the box)

Variables	1.increased	2-decreased	3– No idea
Rainfall			
Temperature			

38. Are you vulnerable to climate change related problems? 1. Yes 2. No

38.1. If yes, which of the following affects your life please put in order of severity?

1. Drought _____
2. Food inadequacy _____
3. Flood _____
4. Price fluctuations for agricultural products _____
5. Shortage of water supply _____
6. Shortage of animal’s feed _____
7. Poor grazing land _____
8. Malnutrition _____
9. Migration _____
10. Poor health _____
- 11 .Others, specify _____

39. What happened to pattern of rainfall on set and cessation in your area in the last 20 years?

1. Rain fall amount decreased
2. Rain fall amount increased
3. Time of onset became late
4. Time of cessation became earlier or late
5. Rarely season become shorter

4. **Adaptive and Coping Strategies**

40. Do you think that is it possible to avert or adapt to the impact of climate change by action in your locality?

1. Yes
2. No

41. What local actions/coping do you think and possible in your capacity?

(It is possible to give opinion more than one actions)

1. Reforestation and afforestation
- 2 Doing additional non-farm activities
6. Migration to other area
7. Diversification of household’s income

3. Soil and water conservation 8. Change in cropping pattern

4. Irrigation

5. Selling small animals and charcoal

9. Others, specify _____

42. Do you use irrigation?

1. Yes

2. No

42.1. If yes, when you start irrigation? _____

42.2. If no, what is the reason?

1. No access to water 3. Financial problem

2. Cultural practices 4. Lack of awareness

5. No irrigable land 6. Others, specify _____

43. Do you have off-farm or non-farm income resources?

1. Yes

2. No

44. Do you change the cropping pattern? Why do you change so?

1. Because of the change in rainfall pattern

2. Because the changed crop price in the market

3. Governmental or other developmental organizations forced to do it

4. Because of increased temperature

5. Others, specify _____

45. Is there food insecurity in your locality? 1. Yes

2. No

46. If yes what factors do you think have caused food insecurity? Indicate their level of influencing causing the problem?

No	Major Causes of Food insecurity	1. Yes	2. No
1	Rainfall shortage		
2	Torrential rainfall		
3	Animal disease prevalence		
4	Poor soil fertility		
5	Deforestation		
6	Farm land shortage		
7	Pest infestation		
8	Low non-farm income		
9	Poor access to modern farm input		
10	Traditional farm practices		
11	Land fragmentation		
12	Over grazing		
13	Lack of access to market information		
14	Poor access to motor able transport		

15	Shortage of labor		
16	Old age		
17	Poor access to Gov,t/NGO services		
18	Poor access to credit		
19	Land lessens		

47. Do you use food consumption related coping mechanisms in times of food crises? How often did you cope using the following mechanism?

No	Strategy	How often			
		1. Every day	2. 2-5times/week	3.1-2times /week	4 .Never
1	Eating food that were less preferred				
2	Reducing consumption amount during each meal				
3	Skipping meal for adults to feed children instead				
4	Change type of food				
5	Not eating for whole day some times				

48. How many times does your HHs normally eat every day?

1. 2 meals 2 .3 meals 3. 4 meals 4. 1 meals

49 .In times of famine caused by drought, who helps you best? Put in order

1. Relatives 3. Friends 3.NGOs 4.The government 5.Traditional association

6. Cooperatives 7. Others, specify_____

50. Do you think the government services are adequate in minimizing your vulnerability and diversifying your livelihood?

1. Yes 2. No (please explain your answer) _____

51. What type of aid do the government and other institutions give you?

1. Supplying agricultural input 2. Giving money 3. Food aid

4. Facilitating additional job opportunity 5. Showing different mechanisms

6. Specify (if others) _____

Appendix II: Checklist for Focus Group Discussion /FGD

Check lists questions for focus group discussion to be held at Misrak Badawacho Woreda February, 2016.

1. How many households are there in kebele? _____
2. What is the main climatic zone of this kebele? _____
A. *Dega* B. *Woina Dega* C. *Kola* D. Extreme cold E. Others
3. What is major livelihood of this area? Is it related with climate variability? How?
4. Which rain are you dependent on? Put in priority importance?
A. *Belg* B. *Mehar* C. *Kiremt* D. *Bega*
5. How was the vegetation cover in the past? How is today?
6. Is there change in temperature and rain fall pattern? What do you think the reason?
7. Which year was memorable with big crises of crop output in the past two decades?
8. Have you faced food insecurity? How you explain it in relation with climate change?
9. Do you participate in the rehabilitation of natural resources? What is your benefit?
10. What are the local coping mechanisms used to reduce the impacts of climate change and food insecurity? Please list community based, governmental and/or NGOs assistance?
11. Is there irrigation schemes? How you practice it?
12. Have you encountered unconditional pest infestations? When?
13. Do you use fertilizers (organic or inorganic)? For what purpose?
14. Which crop and livestock types is more resistance to climate variability?

Appendix III: Checklist for Key Informant Interview /KII

Which include experts from agricultural offices, land and environment protection office, woreda administration, water resource office, mineral and energy office, disaster prevention and preparedness office, Woreda health office, kebele DA, kebele chairman,...etc.

Dear respondents;

My name is Kebede Birhanu. I am a postgraduate student at Addis Ababa University colleague of social sciences, department of geography and environmental studies in a stream of climate change and adaptation. Currently, I am writing my thesis on the impact of climate variability on food security in Misrak Badawacho Woreda, SNNP. You have been selected purposely from different experts in Misrak Badawacho Woreda. The responses you give are valuable and will be held in utmost confidentiality and will be used only for the analysis of this research. You are honestly requested to respond to any following questions.

Thank you in advance for your cooperation!!

1. Name _____
2. Position/profession _____
3. In your view, are there climate change /variability in Woreda? If yes, please tell me the pattern. Which year was the most devastative in the past two decades?
4. Is the amount of rainfall and temperature increased or decreased over 20 years in Misrak Badawacho Woreda?
5. What do you think the reason for this?_____
6. Can you explain the general relationship between climatic variability, agricultural production and food security?
7. Please can you tell me the major agricultural practices (crops &livestock) in Misrak Badawacho Woreda?

8. Based on your experience, what look like its implication and trend on crop output in the Woreda for last 20 years?
9. Is there food insecurity problem in the area? What can be its causes? _____
10. Describe who are likely to be the most vulnerable people to food insecurity in that community and why? What indigenous and learned strategies might be used to support these vulnerable people?
11. Which agro-ecological zones of households are more vulnerable to food insecurity?
Why and in which season?
12. What are the local coping mechanisms used to reduce the impacts of climate change and food insecurity? Please list community based, governmental and/or NGOs assistance?
13. Is there any disease that damage agricultural production rather than climate variability?
Please list them?
14. Is there any irrigation system in Misrak Badawacho Woreda? Which crops produced? How many percent it cover from total land of Woreda?

Appendix v :Monthly Average Min. Temp.(°C)

Awassa

Station Name :- **Shone station** **'Element :- Monthly Average Min. Temp.(°C)**

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1991	7.7	6.2	10.2	8.9	10.0	10.5	9.8	8.4	7.8	6.4	6.5	8.0
1992	9.2	10.5	10.0	9.8	9.5	9.5	8.1	9.3	9.0	8.0	7.6	8.6
1993	8.7	8.0	8.0	9.6	9.2	9.2	8.6	8.8	8.6	7.0	5.1	7.2
1994	11.2	12.3	15.0	14.5	15.0	14.4	14.5	14.3	14.0	10.1	11.8	12.1
1995	12.6	14.6	14.6	15.2	14.2	13.7	14.7	14.2	13.5	11.9	11.0	13.6
1996	14.0	13.5	14.2	14.6	14.9	14.8	14.4	14.1	13.9	10.4	10.0	11.1
1997	13.2	12.8	14.9	14.8	13.6	13.3	14.3	14.5	13.6	14.2	14.0	12.4
1998	15.3	15.8	15.3	15.0	15.3	14.7	15.1	15.1	14.6	14.6	10.3	10.0
1999	11.7	11.9	13.7	12.9	13.0	13.3	13.7	13.0	12.3	13.9	10.3	11.8
2000	12.3	12.8	13.5	15.0	13.9	13.5	13.9	13.9	13.6	14.0	13.0	12.0
2001	12.6	13.2	14.6	14.3	14.2	14.4	14.3	14.6	13.2	13.2	11.8	12.3
2002	14.4	13.3	14.9	14.4	15.1	14.8	14.5	14.5	13.8	12.0	12.8	14.9
2003	13.0	13.6	14.9	15.1	15.5	14.7	14.5	14.6	14.0	11.5	12.4	11.9
2004	13.6	13.1	14.0	14.9	13.4	13.7	13.5	14.2	13.6	11.9	11.4	12.6
2005	12.7	13.6	15.1	14.8	15.1	14.7	14.0	14.6	13.9	12.0	10.5	10.2
2006	13.0	14.0	14.7	14.4	13.9	13.9	14.8	14.5	14.0	14.0	11.8	14.3
2007	14.3	14.8	12.9	13.6	14.4	14.6	14.1	14.5	14.0	11.0	11.5	10.9
2008	12.7	13.2	12.1	13.9	14.5	14.0	14.1	14.2	13.9	12.1	11.3	10.9
2009	12.2	13.0	13.9	14.3	13.8	13.8	14.3	14.3	14.0	12.6	11.2	15.0
2010	13.2	15.6	14.2	15.3	16.1	14.7	15.0	14.8	14.4	12.1	11.2	12.2
2011	12.9	13.4	14.9	14.7	15.2	14.9	14.3	14.6	14.3	12.3	13.4	11.3
2012	12.2	12.3	14.0	15.3	14.7	14.7	14.7	14.4	14.1	11.8	12.0	12.5
2013	13.2	13.8	15.5	15.1	14.6	15.4	16.6	17.6	17.4	16.7	16.3	14.6
2014	16.6	18.2	17.3	17.0	18.3	18.0	19.2	19.3	19.6	16.2	16.4	16.6
2015	17.9	18.3	18.3	18.1	19.5	20.1	20.2	20.9	21.1	20.4	19.8	20.6

Appendix vi:
Monthly Average
Max. Temp.(°C

Station Name :- **Shone station** *'Element: - Monthly Average Max. Temp.(°C)*

<i>Year</i>	<i>Jan</i>	<i>Feb</i>	<i>Mar</i>	<i>Apr</i>	<i>May</i>	<i>Jun</i>	<i>Jul</i>	<i>Aug</i>	<i>Sep</i>	<i>Oct</i>	<i>Nov</i>	<i>Dec</i>
1991	29.6	28.2	28.2	28.6	27.8	25.6	22.1	24.6	27.2	28.2	28.5	27.0
1992	28.1	27.4	29.6	29.1	28.1	25.3	23.5	26.0	26.1	26.7	27.1	27.8
1993	27.6	30.0	27.1	27.0	25.8	24.8	23.2	24.2	25.8	26.5	28.1	28.7
1994	30.1	31.6	30.5	28.9	27.0	24.3	23.0	23.6	25.7	28.1	28.8	28.5
1995	29.9	30.2	28.8	27.1	27.8	27.1	24.4	24.3	26.7	28.0	29.4	29.3
1996	27.7	30.8	29.8	27.9	26.5	23.8	23.3	24.7	26.6	28.2	29.0	29.5
1997	29.5	30.1	31.1	27.2	28.1	27.0	24.6	24.7	28.2	27.4	27.5	29.2
1998	28.0	29.9	29.1	29.9	28.6	25.7	23.6	24.0	25.9	26.3	28.7	30.9
1999	31.0	32.1	28.5	30.3	28.1	26.5	23.5	25.1	26.4	25.0	27.9	29.1
2000	30.0	30.7	31.7	30.2	27.0	25.3	24.4	24.6	25.1	26.1	27.8	28.7
2001	29.0	31.0	27.4	28.6	27.0	25.3	24.1	24.7	25.6	27.3	28.8	29.7
2002	28.5	30.4	28.9	29.2	28.1	26.2	26.3	25.2	27.2	29.2	30.4	28.6
2003	28.7	31.6	30.1	28.3	29.6	26.5	24.4	25.0	28.1	29.2	28.7	28.7
2004	29.6	30.2	31.1	27.8	28.7	26.4	24.7	24.8	26.7	28.0	29.9	30.0
2005	29.6	32.0	30.3	29.5	26.4	25.9	24.3	25.3	25.9	28.6	29.2	29.7
2006	30.7	31.4	29.1	27.3	27.9	26.3	23.7	24.2	26.8	28.7	30.0	29.5
2007	30.3	29.9	31.5	29.2	28.6	24.7	24.9	24.8	26.3	28.4	30.0	29.9
2008	31.7	31.4	33.2	31.1	28.3	25.9	24.1	25.4	27.4	29.1	28.5	30.3
2009	30.6	31.7	33.4	30.5	30.4	29.2	25.7	26.7	28.9	29.1	31.1	29.3
2010	30.0	29.2	29.8	29.3	28.0	27.1	25.1	25.6	26.9	30.6	31.5	30.7
2011	31.0	31.9	31.4	32.0	28.4	26.0	25.6	25.5	27.3	30.3	29.6	29.7
2012	31.4	32.3	32.9	28.4	30.8	27.2	24.7	25.3	27.1	30.3	31.7	31.0
2013	31.6	33.0	31.7	29.9	28.0	26.1	24.6	24.9	28.2	29.0	30.0	30.3
2014	31.7	30.4	32.1	30.8	28.6	27.9	25.7	26.2	27.1	27.1	29.3	28.6
2015	31.5	33.7	34.1	33.4	30.3	28.1	28.2	28.7	29.6	32.6	31.8	31.1

Appendix vii: Rainfall records

Seasons

Year	Winter RF	Spring RF	Summer RF	Autumn RF	Annual total RF
1991	204.5	1145	333.5	300.4	306.6
1992	195.9	306.5	365.6	294.6	1162.6
1993	97.1	631.2	329.1	204	1261.4
1994	0	342.8	388.7	74.6	806.1
1995	83.8	493.9	263.5	115.5	956.7
1996	129.9	454.5	410.5	163.2	1158.1
1997	87.9	335.7	301.1	468.5	1193.2
1998	149.2	429.2	467.3	186.1	1231.8
1999	6.1	268.4	320.8	168.1	763.4
2000	23.5	230.7	270.8	254	879
2001	23.8	378.7	364.2	177.5	944.2
2002	214.1	224.6	258.5	98.8	796
2003	148.4	325.7	309.2	157.8	941.1
2004	172.7	299.3	252.9	267.8	992.7
2005	48.7	385.8	221.9	201.7	858.1
2006	73	308.8	340.6	151.4	873.8
2007	112.3	355.9	353.3	230.1	1051.6
2008	3.3	192.2	370.3	384.5	950.3
2009	171.5	210	289.8	179	850.3
2010	135.1	502	292.9	175.8	1105.8
2011	29.8	250.7	533	140.5	954
2012	2.6	197.1	390.8	119.7	710.2
2013	16.6	366.4	476.9	318	1177.9
2014	70	483.7	239.3	281.8	1074.8
2015	17.5	148	253.2	112.6	531.3