THE IMPACT OF CLIMATE CHANGE ON FOOD AND NUTRITION SECURITY IN THE BONGO DISTRICT OF THE UPPER EAST REGION OF GHANA

BY

PATIENCE ATITSOGBEY

ID: 10508212

THIS THESIS IS SUBMITTED TO UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF MPHIL NUTRITION DEGREE

JULY, 2016

DECLARATION

I, Patience Atitsogbey, author of this thesis —The impact of climate change on food and nutrition security in the Bongo District of the Upper East region of Ghana; do hereby declare that this thesis is the result of my own work carried out at the Department of Nutrition and Food Science, College of Basic and Applied Sciences, University of Ghana, under the supervision of Prof. Christina Nti and Prof. Matilda Steiner-Asiedu. All references to other works have been duly acknowledged.

.....

Patience Atitsogbey

(Student)

Date…..

....

Prof. Christina Nti **Prof. Matilda Steiner-Asiedu**

(Main supervisor) (Supervisor)

Date..... Date.....

DEDICATION

I dedicate this work to God Almighty, my parents and all my loved ones who tremendously supported me financially and through prayers. **I love you all**.

ACKWOLEDGEMENT

My gratitude goes to God Almighty for His grace, love, protection and guidance throughout my stay in school and most especially during the research.

My deepest appreciation to the Department of Nutrition and Food Science for accepting me to read my master's programme without which I would not have had the opportunity to do this research.

I am sincerely indebted to my supervisors Prof. Matilda Steiner-Asiedu and Prof. Christina Nti for their tutelage, modelling my knowledge on research and their motherly love shown me throughout the study.

It would have been impossible to complete this course without the immense support of all the lecturers and staff of Nutrition and Food Science Department, to all I say may God bless you.

My appreciation to Africa Climate Change Adaptation Initiative -ACCAI project-University of Ghana and the Open Society Foundation (OSF) funding. It will have been impossible to undertake this research without their funds.

I am sincerely grateful to the following persons for their enormous contribution during the analysis stage of this work and beyond; Prof. F.K Saalia, Isaac Boadu and Humphery Thompson all of Nutrition and Food Science Department, Fred Abban of Computer Engineering, Dr. Nana Ama Browne-Klutse of Ghana Atomic Energy, Prof. Adongo and Philip Tabong of Public Health Department and Mr. George of Nugochi Memorial

Institute for Medical Research; Statistics Department.

My in-depth appreciation to my family and friends for their invaluable support throughout this course especially, Sam, Jerry, Dan, Austin and Bernice.

I will like to appreciate very much the efforts of the Honourable Assembly members, Chiefs, Elders and all the inhabitants of the four communities during the data collection. I am very grateful.

I am sincerely thankful to Cabral Bantiu and Cosmos Minyila; District Nutrition Officers at Bongo and Garu. Guys' thanks for allowing us use your instruments for data collection.

Hajia Mary Isaka and staff, Ghana Health Service Bongo, "Ma" thank you so much and God bless you.

To MOFA Upper East regional office and Bongo district office, my gratitude most especially to Mr. Emmanuel Abobire, Director of Agric Bongo, Nicholas Atubiga crops officer and all the Agric extension officers of the four communities we worked in.

I also want to extend my gratefulness to Mr. Ambrose, the meteorologist at the Upper East regional office and his staff for their assistance.

Thank you so much Crossby Osei-Tutu, Nelson and Selasie for reading through the entire work.

Finally, I am extremely grateful to all my field assistants most especially Edward Azure, Nabs and Francis leaders of the teams. Guys this work would not have been possible without your tremendous efforts. And to my roommates Bridgette and Valerie, thanks for all the support I will forever cherish this great friendship. May God continue to strengthen and bless you all.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS

ACF	Action Contre La Faim (Action against Hunger)
BMI	Body Mass Index
CBAS	College of Basic and Applied Sciences
CHPS	Community-based Health Planning Services
CI	Confidence Interval
FAO	Food and Agriculture Organization
GAWU	General Agriculture Workers Union
GDHS	Ghana Demographic and Health Survey
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft Internationale Zusammennarbeit
GPJ	Ghana Policy Journal
HAZ	Height-for-Age Z-score
HDDS	Household Dietary Diversity Scale
HFIAS	Household Food Insecurity Access Scale
HLPE	High Level Panel of Experts on food and nutrition security
IPCC	Intergovernmental Panel on Climate Change

MICS	Multiple Indicator Cluster Survey
MOFA	Ministry of Food and Agriculture
MUAC	Mid -Upper Arm Circumference
MRFCJ	Mary Robinson Foundation Climate Justice
NCDHR	National Campaign on Dalit Human Rights
OR	Odds Ratios
SD	Standard Deviation
SPSS	Statistical package for Social Sciences
USAID	United States Agency for International Development
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children Fund
UNSCN	United Nations System Standing Committee on Nutrition
WAZ	Weight-for-Age Z-score
WDDS	Women Dietary Diversity Score
WFP	World Food Programme
WHO	World Health Organization
WHZ	Weight -for- Height Z-score

ABSTRACT

Introduction: Among the most substantial impact of climate change is its potential to escalate food insecurity and malnutrition**.** The adverse impact of climate change will be most felt by the poor and the highly vulnerable which includes women, children and the aged in the neglected areas. The objective of this study was to examine the impact of climate change on food and nutrition security of households with emphasis on women and children below five years of age in the Bongo district of the Upper East region of Ghana.

Methodology: A cross-sectional survey was conducted using mixed methods in four purposively selected farming communities (Anaafobiisi, Bogrigo, Gurigo and Gowrie) in the Bongo district of the Upper East region of Ghana. A sample size of 246 mother-child pairs (children below five years of age) were used in the study. Stratified simple random sampling was used in selecting 62 households each in Anaafobiisi and Bogrigo and 61 households in Gurigo and Gowrie. Data was collected on socio-demographic characteristics of the participants, awareness of climate change, dietary information (24-hour recall), coping strategies, food preservation and household food security. Anthropometric data of both mothers and children were also collected as well as haemoglobin level of participants. Four focus group discussions were held, one in each community and thirteen key informants' interviews involving 8 farmers, 4 agriculture extension officers and a meteorologist were also conducted. Data on rainfall and temperature in the district was collected from the Ghana Meteorological service for a 30 years period. Crop yields data over a period of 21 years in the district was also collected from Ministry of Agriculture (MOFA).

Results: The research revealed that rainfall in the Bongo district has been decreasing at - 0.3mm per annum and maximum temperature has been increasing at 0.005°C. About 62.6% of the

participants were aware of climate change in their communities but more than a quarter (31.3%) did not know what the causes of climate change were. The most frequent coping strategy adopted by majority (89.4%) was reduction in quality and quantity of food consumed. There was a significance difference (P = 0.001) between some specific crops (millet, maize, rice, sweet potatoes) which were being consumed less due to effect of climate change and how participants thought these crops were being affected by climate change. Almost all (97.2%) of the households were food insecure Participants who reported decrease in rainfall were more likely to be food insecure (OR= 3.96; CI= 0.56 – 27.81).

The proportion of children under five years who were stunted, underweight, and wasted were 42.3%, 24.4%, and 17.5% respectively. About 24% of the women were overweight, 9% were obese and 5% were underweight. Women who reported to have experienced decrease in rainfall were more likely to be underweight (OR = 1.26; CI=1.02-1.56) or overweight (OR =1.31; CI= and 1.13-1.52). The prevalence of anaemia among the women and children was 18.7% and 82.8% respectively.

Conclusion: More than half (62.6%) of the study participants were aware of climate change in the district. The coping strategy employed by the majority was reduction in the quality and quantity of diet during food shortage periods. Almost all the households were food insecure and sun drying was the food preservation method used by 52.3%. There was high level of stunting, wasting and underweight among the children under five years of age and maternal body mass index was emerging to be high. Prevalence of anaemia among the children was also high.

There is the need to intensify climate resistant agriculture technology such as irrigation methods to offset the negative impact of climate change on food security in the district. Also timely and

appropriate nutrition intervention programmes aimed at reducing malnutrition and anaemia among children below five years of age in the Bongo District should be instituted.

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND

The alterations in the climate globally are negatively impacting on living condition of people including drinking water, food and the air we inhale. This has made it difficult to sustain human life and good health. The changing climate has greatly posed "unacceptable risks" to public health worldwide. Already, poor nutrition resulting from insufficient food consumption is accounting for 3 million deaths each year in the most vulnerable regions in the world. Increasing temperatures and rainfall variability are expected to decrease crop yields, and further exacerbate food security (WHO, 2014b).

Variation in the weather occurs as a result of manmade activities or natural variability that changes the arrangement of the atmosphere globally for an extended period of time, transcending three decades (IPCC 2007; Antwi, 2013). The influence that humans brought to bear on the changes in the composition of the atmosphere cannot be over emphasized, some man-made activities leads to major pollutions of the environment including the emissions of greenhouse gases. These have become highly unprecedented in recent years having negative impact on society as whole. The interaction between human environment and weather extremities such as high temperatures, floods and drought, can lead to disasters (Field, 2012). The extreme weather events also has the ability to cause destruction to farm produce especially crops and important community infrastructure, depreciating livelihoods and worsening poverty (WFP, 2012a).

The negative effect of the changing climate on food crop production and livelihoods exist and are very real. The effect of extreme weather events has more than doubled compared to earlier decades carrying in its wake major disasters that affect the main drivers of food security (ACF, 2014). The steady rise in temperature and variations in the seasonal rainfall patterns due to climatic disturbances, greatly increase hunger and all the determinants of undernutrition. This has exacerbated undernutrition among over 180 million children while an overwhelming 842 million people are still suffering from hunger (ACF, 2014). Many forecast of the climate change impact shows that these conditions could get worse (ACF, 2014). This is because major staple crop production is already affected and future climatic predictions indicate that this pattern could worsen. In that, increase in temperature is shown to reduce crop yields whiles variations in precipitation could have an impact on both crop quality and quantity (WFP, 2012a).

The effect of changing climate is felt hardest by the most vulnerable people more especially women and children. This has major effect on the food and nutrition security of millions of individuals making it extremely difficult to solve the current undernutrition problems. Already farmers, pastoralists, and fishermen are having major difficulties in producing and procuring food due to alterations in the weather patterns such as erratic rains (FAO, 2015). These alterations in the weather conditions is seen as an important "hunger-risk multiplier". By 2050, 24 million children are predicted to be malnourished due to the effects of changing climate and nearly half of these children will be in sub-Saharan Africa (FAO, 2015).

Nutrition security occurs when the food consumed by a person is safe and sufficient nutritionally and used biologically to maintain good health and physical work throughout all life stages (Pangaribow *et. al.,* 2013). But a person's nutrition security can be influenced by climate change through various causal pathways that impact food security and health such as adequate environmental health, water availability, health care system for women and children and many socioeconomic factors (UNSCN, 2010). The changing climate will worsen the intensity of inadequate nutrition and poor health and will further reduce people's resilience to overcome the sudden difficulties that climate change bring and weaken their capacity to adapt (FAO, 2015).

Although several economic sectors are affected by the changing climate, the most significant sector is rural livelihood (NCDHR, 2013). Rural folks whose livelihood is dependent on agriculture but lack arable lands resulting in low yield, will have a major challenge of increased crop failure and loss of livestock under the climate change regime. The most vulnerable will be those residing along the dry lands, flood prone areas, the mountainous regions, along the coast and the arctic (Edame *et. al.,* 2011).

Meanwhile the most important sector that can help in minimizing global hunger is agriculture. To achieve good nutrition outcomes globally, agriculture must be combined with good health care practices. The risk associated with the changing climate require swift action in finding a more efficient and resilient ways in sustaining the food systems (UNSCN, 2010). This has become more important as majority of Africa's workforce is into agriculture but are not able to contribute much to their national GDP as a result of low yield (GAWU, 2012). The menace of climate change is

no longer an issue of a single continent but that of all countries in the world. This demand a collaborative effort to prevent the destruction of crops and harvest of farmers by extreme weather conditions such as drought and floods in developing nations which leave them in a poor conditions (De Pinto *et. al.*, 2012).

Ghana needs pragmatic coping and adaptive strategies to avert the challenges of the climate because already climatological predictions indicates rise in temperatures and in rainfall variability. Moreover many studies have shown that production of major crops were reducing. Reduction in groundnut, maize and rice yields is likely in Ghana (De Pinto *et. al.*, 2012). Developing climate resilient strategies will boost Ghana's agriculture sector and help solve the food security problems domestically and put Ghana forward in Africa (De Pinto *et. al.*, 2012).

1.2 RATIONALE

The impact of the climate change is felt by almost all people but women living in the typical rural areas in Africa are the most affected. The changing climate is restraining food security and undermining the health of the people and their economic growth. Together these result in a wide spread starvation and insufficient food intake that leads to child mortality. The negative impact of climate change has pushed several millions of rural dwellers out in search of food outside their communities, adversely affecting their health (Antwi, 2013). The most vulnerable to this change are women and children because of the role they play in both production and preparation of food, fetching of water and fuel (Antwi, 2013; MRFCJ, 2013).

According to statistics, 1.2 million Ghanaians have decreased access to adequate and nutritive diet during the year, and extra 2 million of the population are in danger of becoming food insecure most especially in the minor season or during times of disaster. These figure represents 5 to 10% of the Ghanaian population who are at risk of becoming food insecure, but majority of these people are found in Upper East, Upper West and Northern region (Ahwoi, 2011). While 92.5% of the people in the Upper East region are farmers (Saaka *et. al.,* 2015), achieving food security in the north is becoming a herculean task due the direct impact of the changing climate on agriculture on which majority of the people depend as their source of livelihood, resulting in chronic hunger which exacerbate food and nutrition security (Akudugu *et. al.,* 2012). Research undertaken by World Food Programme showed that 20% of households in Bongo district were food insecure (WFP, 2012b).

Research conducted in the Upper East region mostly focused on the impact of the changing climate on food production, creating an information gap on the impact of climate change on food and nutrition security among households, most especially on women and children. This study therefore sought to assess the impact of climate change on food and nutrition security of households, dietary habits as well as food preservation methods used by households in the Bongo district with emphasis on women and children below five years of age to provide information which will help in developing implementable policies that will guarantee food and nutrition security.

1.3 OBJECTIVES

1.3.1 Main Objective

The main objective of the study was to examine the impact of climate change on food and nutrition security with emphasis on women and children below five years in the Bongo District.

1.3.2. Specific Objectives

The specific objectives were to:

1. Investigate the awareness of climate change in the study area.
2. Identify coping strategies used to offset the negative impacts of climate change and household food preservation methods.
3. Assess the association between climate change and household food consumption patterns and dietary changes.
4. Determine the impacts of climate change on household food security.
5. Determine the impact of climate change on the nutritional status of women and children in the study area.

1.4 HYPOTHESIS

Climate change has a negative impact on the nutrition and food security status of women and children below five (5) years.

1.5 SIGNIFICANCE OF THE STUDY

Although policies for food production and food security are available and certainly rural populations have been adjusting to climatic variability, food insecurity and malnutrition rate among households in the Upper East region of Ghana is still high. This means that climate

change adaptation will require a greater paradigm shift which goes beyond just national policies to implementable policies. In effect this study will co-produce knowledge on the impact of climate change on food and nutrition security to add up to the body of existing knowledge while filling in the gap on the information available on the research topic in the region and for formulation of implementable policies in Ghana.

Significantly the study will collect and document information on the following;

- Awareness of climate change in the study area.
- Coping strategies of rural farmers including food preservation methods in relation to climate change.
- Climate change and household food security.
- Climate change, food consumption patterns and dietary changes.
- Household food and nutrition security status and quality of diet.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 OVER VIEW OF CLIMATE CHANGE

The United Nations Framework Convention on climate change (FCCC,U., 1992) stated that the changes observed in the atmospheric component of the climate globally is either human induced or as a result of natural variability. The natural variability of the climate includes wildfires, cyclones, floods, heat waves, temperature changes and droughts (IPCC, 2014). The human induced activities result in accumulation of nitrous oxide, methane and carbon dioxide in the atmosphere causing greenhouse gas (GHG) emissions and its intensity now is the highest in the last 800,000 years. These human induced activities are mainly industrial and economic activities which have resulted in the warming of the atmosphere globally since the mid-20th century up to date (IPCC, 2014). The rate at which the atmosphere is warming, according to Ghana Policy Journal, is 0.5°C and 1.3°C between 1951 and 2010 (GPJ, 2013).

The continent of Africa is among the worst hit globally in the face of the changing climate and its potentially harmful effects. This is due to several factors including it being the hottest continent naturally and so any further warming will be disastrous to the inhabitants. Also the challenge of Africa is worst because most of its economic activity is agriculture based which rely heavily on natural resources such as rivers and the rain which are affected by the changes in the weather (GPJ, 2013). According to Ghana Agriculture Workers Union (GAWU), Ghana is already experiencing the impact of the weather extremes as there are extended drier and hotter days during the dry seasons and more floods during the raining seasons (GAWU, 2012). Northern Ghana is the most

susceptible to the erratic weather pattern caused by climatic alterations than the other regions in the country owing to its drier and poorer nature and by reason that majority of its people are involved in subsistence agriculture (Darko and Atozona, 2013).

2.2 THE IMPACT OF EXTREME WEATHER CONDITIONS

According to World Food Programme, changes in the weather patterns have negative effect on the consistency, the volume and the duration of extreme climatic elements which would adversely affect food security in most susceptible areas (WFP, 2012a). These include temperature, drought, rainfall and flood.

2. 2.1.Temperature

Increase in temperature has been identified to be 0.7°C in the 20th century but the 21st century has seen a higher increment of 1.0°C in temperature making it the warmest century ever resulting in many havoc and abnormalities in the climate system globally (Rasul *et. al.*, 2011). The rise in temperature has no end. Global mean temperature has been suggested to increase to nearly 1.8°C by the end of the 21st century which is about 66% higher than what was observed at the end of the 20th century (GPJ, 2013). Appraisal of national impacts of weather variables generally agreed that most susceptible countries to climate change are in Africa, most especially in south Sahara Africa. It must be appreciated that because Africa continent is already warm, any little upward change in temperature will make the continent very susceptible to negative impacts associated with high temperatures (GAWU, 2012).

The rise in regional temperatures could have detrimental effect on agriculture and will be more critical if it occurred during important developmental stages in crop production. Yields of several

crops could severely decrease when the temperature is beyond 32°C especially at the flowering stage. Some studies have established that yields of rice decrease by 90% when temperature rapidly rise to 32°C and beyond 35°C (WFP, 2012a). Other verifiable studies also asserted that recent hikes in temperature had already had adverse effect on the yields of some major crops globally. Any further increase in future temperature would decrease crop production in some regions (WFP, 2012a). According to Lobell *et. al.,* (2011), increase in temperature has resulted in the reduction of world maize production by 3.8%. Yields of wheat in India and Australia have been greatly affected by extreme temperatures during certain stage of growth. Highest and the lowest temperatures in September (about 34/20°C), negatively affected seedling development hence yield of wheat. Rice also loses pollination during heat exposure resulting in low yield (Rasul *et. al.,* 2011).

Ghana is already experiencing rise in temperature of about 1°C (GPJ, 2013). But the northern regions of Ghana have the greatest increase in temperatures during the dry season with an increment from 27°C to above 30°C while the southern ones have between 25°C to 27°C around the same period of January- March (GPJ, 2013). Ghana's average yearly temperature is predicted to rise by 1-3.0°C by the end of 2060s, and 1.55-2°C by 2090s, with warming drastically increasing more in the northern regions than the coastal regions (GPJ, 2013).

2.2.2 Drought

Forecast from global meteorological models predict that change in the weather conditions will bring about prolong drought (IPCC 2007c; GPJ, 2013). Extreme aridity have detrimental effect on food security. Globally drought have affected vast areas where main staples such as barley,

sorghum, rice, wheat , soya bean and maize are grown impacting negatively on the yields. The rise in the long spell of dryness was detected in the 1960's to range from 5-10% but now it is between 12-25% approximately (Li *et. al.,* 2009; WFP, 2012a). In Russia for example, research findings asserted that decrease in food production as a result of consistent drought may double in most of the food growing areas by 2020 and triple by 2070 which will have major implications for some crops especially wheat production which could decrease by 40% (Alcamo et al, 2007). According to GAWU, variability in the climatic conditions which led to erratic rainfall in Africa for two straight years resulted in extreme drought and widespread hunger in 2011 (GAWU, 2012). The World Food Programme stated that the quality and quantity of yields of major crops are severely affected by drought resulting in a considerable economic losses most especially in Africa (WFP, 2012a).

The adversity of weather extremes most especially drought have negative impact on nutrition. Verifiable evidence suggest that children who are born during long periods of dry spells are more likely to suffer from malnutrition (WFP, 2012a). Children born in drought-prone areas in Kenya are 50.4% likely to be stunted and 71.1% likely to be severely stunted (WFP, 2012a). Drought have a detrimental impact on water security, causing the evaporating of soil moisture resulting in failure of crops. Aridity has also been identified as the cause of forest fires as well as large scale deforestation which has impact on agriculture (Field, 2012).

Inadequate moisture at sowing period will result in poor seed germination and sprouting of crops. As such the formation of grains, nuts, tubers and fruits at various stages of growth will be adversely affected leading to decrease in crop yields (GPJ, 2013). The northern regions of Ghana where

major crops such as rice, millet, sorghum, groundnuts, bambara beans, soya beans and yams are grown, experiences the most extended period of drought from October to April or May under which crops can only survive by irrigation because the soil becomes drier and poorer (GPJ, 2013).

2.2.3 Rainfall and floods

Rainfall is a climatic variable, therefore any alterations in the atmospheric conditions will impact on the volume of rainfall and the quantity available for absorption by crops as the content of soil moisture is affected. These could either result in the reduction or increase in the yields of crops (GPJ, 2013). Globally, the intensity of heavy rainfall is on the rise and models indicated that there will be extreme heavy rains as global warming increases (Held and Soden, 2006). According to Field, Bangladesh, China and India are facing major challenges of human and material losses due to extreme flood and empirical evidence suggested that more of this drastic events will occur (Field, 2012). Meteorological research conducted on the impact of current weather variability in the United Kingdom, suggested that excessive precipitation in August was the cause of inferior cereal quality due to fungal infections (Kettlewell *et al*, 1999).

Adverse rainfall patterns have been observed on the continent of Africa since 1960s and this has significantly affected agriculture production. Erratic rainfall patterns have negative impact on food crop production due to destruction of crops as rainfall may stop while crops are still developing and may need water to complete the growth cycle. This variability in the rainfall pattern decreases the availability of moisture content in the soil for crops and hence have implication for yields and food security (GPJ, 2013). Inadequate moisture in the soil also results in the disruption of the development of crops and this is irreversible at certain stages affecting the outputs of yields (GPJ,

2013). On the other hand, extreme rainfall events also have negative impact on food security. This is because extreme rains causes flooding and floods destroys farmlands including crops. Floods also have adverse effect on food stores and agriculture inputs resulting in food insecurity (WFP, 2012a). These alterations in rainfall patterns in general have had an effect on water sources and its availability for agricultural activities resulting in an extensive rise of susceptibility to water and food security, with consequences for health (mostly nutrition and water-borne diseases) and poverty. Decreased rainfall has created an emergency situation for areas that have been susceptible to water scarcity and are dependent on rain-fed crop production (USAID, 2008).

The prediction of periods of rainfall has become impossible in Uganda and in some localities seasons of sowing have combined from two separate periods into single indeterminate season. This implies that farmers can no more forecast the best period to sow (MRFCJ, 2013). From a study conducted in Uganda, a farmer affirmed that majority of the areas no longer have enough food due to erratic rainfalls resulting in families eating once a day (MRFCJ, 2013). The yearly trend of rainfall pattern in Ghana mostly varies. Ghana experienced high rainfall during 1960s after which it drastically reduced later in 1970s and early 1980s. Accumulation of this has resulted in the low level of rainfall observed in the country between 1960 and 2006 with a mean decline of 2.3mm (GPJ, 2013).

2.3 LEVEL OF AWARENESS OF CLIMATE CHANGE AMONG HOUSEHOLDS

Awareness of changes in the atmospheric variables greatly impact on how farmers handle climatic threats and opportunities. The accuracy of their knowledge on these matters and their responses to the climatic threat is important in shaping their adaptation alternatives, the methods to be employed

and the adaption outcomes (Pauw, 2013; Debela *et. al.*, 2015). Misapprehension of climate change and its detrimental effects may lead to no adaptation or inappropriate adaptation methods which may worsen the climate change impact (Debela *et. al.*, 2015). But discussions on the evolutions occurring in the weather patterns and its adverse effect has not yet reach the most vulnerable people although they have begun experiencing the negative impact of climate change (The Asia Foundation, 2012).

Several factors account for awareness level on climate change issues among the rural folks and its impacts on the livelihood of local farmers. Research conducted among small scale farmers in Africa shows that formal educational level of farmers has an impact on the way they observe the effects of the changing climate (Mustapha *et. al.*, 2012). Information on meteorological variability from the extension services has been shown to improve the awareness level of farmers on climate change and its adverse effect (Debela *et. al.*, 2015). Rural households with inadequate access to weather reports are most likely to misconstrue the alterations in the weather patterns especially extreme atmospheric conditions to be due to non-observance of sacraments and cultural practices (Nyanga *et. al.*, 2011).

Research conducted by Mutimba *et. al.* (2010) indicated that awareness of climate change especially among rural Kenyans is low. About 44% of Kenyans whose livelihood are dependent on the weather patterns have no knowledge on the climate variability and any alternatives to mitigate its impact. Another study to verify what gives rise to the changing climate by the Asia Foundation in Bangladesh shows that knowledge of respondents was low on the issue. About 46%

of the respondents believe that it is God who is changing the climate while 31% believe that the action of human beings brought about the changes in the climate (The Asia Foundation, 2012).

2.4 IMPACT OF CLIMATE CHANGE ON FOOD CROP PRODUCTION (AGRICULTURE)

Globally, the ability for food production is predicted to rise with a mean temperature range between 1-3°C above which food production will reduce. In arid and tropical nations, a warming of 1-2°C is projected to decrease yield and a rise in temperature above 3°C will lead to potential hike in food price by 40% (Patel *et. al.*, 2010). Global mean temperature is already projected to be between 2-4°C higher by 2050 with consequences for agriculture worldwide (Edame *et. al.*, 2011; WFP, 2012a). Climate change in the Caribean and Latin America has been predicted to adversely result in the decrease of crop yield by 4.6% and would affect majority of essential crops grown making food intake to be decreased by 300 calories per person (WFP, 2010).

Agriculture is the most important fundamental tool that can be used to decrease famine globally (UNSCN, 2010). But it is the sector that is most susceptible to climate variability (Edame *et. al.*, 2011). Change in the weather pattern have already impacted negatively on food crop production and future climate variability have threaten to worsen it. Increased temperature will affect the outcome of yields while alterations in rainfall patterns could impact on the quality and quantity of food crops (WFP, 2012a). The formation of impenetrable caps leads to the exposure of top soils to run-offs caused by floods and resulting in the decrease of crop production more especially in small scale farming at low latitudes (Abubakari and Abubakari, 2015).

Changes in the atmospheric conditions could result in land degradation and desertification which decrease productive lands available for agriculture. These could have dire consequences for food demands in the future as global population will increase up to 9.2 billion by 2050, a projection by United Nations (WFP, 2009). This notwithstanding, agricultural production in developing nations has been estimated to decrease by 10-20% (Patel *et. al.*, 2012). Africa's agriculture system is mostly rain-fed making it very susceptible to climate change. It has been projected that yields of certain crops will reduce; for instance rice (14%), wheat (22%) and maize (5%) in sub- Saharan Africa by 2050. This will negatively impact the most vulnerable who solely depend on rain-fed agriculture for sustenance pushing them deeper into poverty (WFP, 2010).

Climate change events have shown significant losses in food crop production due to drought and rainfall abnormalities. About 26% loss of arable land is projected in sub –Saharan Africa by 2060 due to climate variability. The effect on agriculture production would be enormous having implication for food security which could leave 600 million people malnourished by 2080 (GAWU, 2012). Another threat to food production caused by climate change is invasion of weeds which compete with crops, disease pathogens and insects on farmlands (Gepts *et. al.*, 2010; GPJ, 2013).

Ghana is not insulated from the climate change impact on food crop production as major staple crops have been projected to decline. Using 2000 as the base year, maize production has been estimated to reduce by 15% while overall rain- fed maize and rice were projected to reduce by 25% by the year 2020. Sorghum, millet and groundnut will also decline by 20% between 2046 and 2065. Cassava is projected to decline in yield up to 53% between 2020 and 2080 (GJP, 2013).

2.4.1 Impact of climate change on food consumption patterns

The impact of the changing climate is not limited to only food production but consumption pattern of individuals and nations as well. Findings from many studies have shown that weather variability could have effect on calorie consumption through its impact on food security most especially from drought. The cumulative effect is change in dietary diversity and decrease in food consumption with persisting adverse impact on stunting (WFP, 2012b). The impacts of the weather extremes are predicted to decrease the amount of harvested foods which may result in the rise of food prices leading to reduction in food consumption. This could increase the number of people suffering from malnutrition most especially the vulnerable (Springmann *et. al.*, 2016).

Global reports on the highest disease burden and deaths in majority of nations including that of developing countries, is associated with exposure to dietary factors. These factors are mostly related to consuming imbalanced diets which are low in fruits and vegetables and highly processed foods (Springmann *et. al.*, 2016). The biological utilization of food is affected through the impact of the changing climate on consumption patterns as a result of decrease nutrient content of food and poor food hygiene. This could also lead to prioritization and allocation of calorie-rich but low nutrient foods as a method of reacting to the changing climate shocks (Porter *et. al.*, 2014).

Also decrease in food consumption could result in persisting health problems. Poor health has been reported to be the cause of decrease food crop production in sub-Saharan Africa (Beddington *et. al.*, 2012). The resultant impact is reduction in dietary quality and quantity, worsened by existing susceptibility leading to loss of health and income (Porter *et. al.*, 2014).

In rural communities in developing nations, wild foods are very important source of food and income to poor households who are food insecure. Any variation in the accessibility of these wild

foods due to alterations in the rainfall or temperature resulting in the reduction of the wild foods, could have implication for food security and consumption in the rural areas (FAO, 2008; Yaro, 2013).

In the northern part of Ghana, poor households are most likely to consume poor or low nutrient diets. Apart from consuming poor diets, they have irregular eating pattern. Their food is less diverse, they eat less meat and fish, sugar and milk product than their rich fellows. Also the poor households often buy food to support what they have (WFP, 2012b). To them food consumption is not eating for good health but eating to survive. Their main food is made from maize and millet which is accompanied occasionally with oil and vegetables. This poor diet can significantly influence the nutritional status of the individuals (WFP, 2012b).

2.5 IMPACT OF CLIMATE CHANGE ON LIVELIHOODS

Globally more individuals are officially living below one dollar (US$ 1) per day and evidence has it that greater number of the underprivileged are directly reliant on farming as their livelihood in the world. Climatological conditions has led to significant losses in food crop productions through changes in rainfall and drought patterns, occurring mostly in sub-Saharan Africa where 26% of productive agriculture land is already lost to degradation due to the extreme weather (GAWU, 2012).

The business activities of numerous developing nations is greatly attached to agriculture including smallholder farmers, meanwhile most farmers consume what they grow now due to decrease in production. Only a small proportion sells part of their yield. Maize is highly produced in Africa

but it's only a small portion that is sold (Field, 2012). For instance in Kenya majority of the households produce maize but only 36% sell their produce (Field, 2012). The adverse effect of climate change will hit the small scale farmers hardest because of their dependent on rain-fed agriculture. Countries such as Zimbabwe and Madagascar in which majority of the rural livelihoods are tied to rain fed agriculture will be impacted greatly by extreme drought, floods and cyclones and abnormal rainfall patterns (USAID, 2008; Dube and Phiri, 2013). The disruption of livelihoods most especially that of agriculture, could limit access to food as unavailability of food will lead to price hikes in staple crops. This could result in food insecurity in rural settlements where the most vulnerable are and who cannot afford to purchase food because their major livelihood which is food crop production is drastically impacted by the changing climate (HLPE, 2012).

2.6 IMPACT OF CLIMATE CHANGE ON FOOD AND NUTRITION SECURITY

2.6.1 Food security

One of the major difficulties that faces the Africa continent is food insecurity. According to FAO, food security occurs when every individuals have physical as well as financial accessibility to sufficient, nontoxic and nourishing food that meet their dietary requirements and variety of food meant for energetic and healthy living (FAO, 2000). By this description, the four pillars of food security which are availability, accessibility, utilization and stability have been established but the challenge is that climate change affects all of these pillars (FAO, 2000; Yaro, 2013).

Climate change through its hazardous meteorological conditions such as drought, increase temperature and floods may prolong growing seasons and erratic rainfalls can adversely impact on

availability of food through variation in crop yields as well as loss of productive land for agriculture purposes (WFP, 2012a). Reduction in food crop production could increase price of available food stuff pressurizing the most vulnerable households who do not have the financial capacity to purchase food the more. The resultant effect is decrease dietary diversity and poor health (WFP, 2012a).

Food accessibility depend on complex mechanism that makes foodstuff available and affordable. For the majority of susceptible people, reduced agriculture production implies lower income (WFP, 2012a). With climate change impacts, the potentials of households to acquire food could be extremely decreased as earnings of farmers in most developing nations is tied to their ability to sell surplus yields. Under this regime, poor people have to make additional sacrifice to meet their dietary requirement (Akudugu *et. al.*, 2012).

Food utilization is achieved by consuming sufficient and safe food in addition to clean water, adequate health care and good sanitation in order for a person's physiological needs to be met (Wheeler and Braun, 2013). This can be achieved by ensuring the wholesomeness and sufficiency of diet at all periods. This means climate resilient strategies must be put in place (Wheeler and Braun, 2013).

According to World Food Programme, majority of the individuals that do not have adequate food reside in the deprived and low regions of Asia, Latin America and Africa, where anthropogenic conditions and the changing climate will most likely worsen the current danger to food security (WFP, 2012a).

Empirical evidence have shown that the changing climate alone could lead to the rise in number of most food insecure in Africa up to 170 million people by 2080 (Rosegrant *et. al.*, 2008).

In Ghana, majority of individuals who do not have adequate food, reside in the Northern regions (Ahwoi, 2011).

2.6 .2 Nutrition security

Nutrition security has been defined as access to adequate food and absorption of nutrients in the food by all individuals in a household at all periods after consumption, supported by adequate hygienic environs, health and care practices to ensure energetic and healthy life (Wüstefeld, 2013). Nutrition insecurity leads to undernutrition which is a consequence of inadequate consumption and biological utilization of food. In most developing nations however, a major threat to health is undernutrion but it is the least addressed issue. The population at risk of famine stood at 925 million in 2010 and maternal and child malnutrition remains persistent (UNSCN, 2010). Micronutrient deficiencies is also brought about by insufficient consumption of food and illnesses due to inadequate maternal and child health practices and poor access to wholesome food, good sanitation and potable water (UNSCN, 2010).

Moreover, undernutrition also impairs the resistance of susceptible people and distort their coping strategies. It also weakens their ability to repel and adjust to the challenges of the changing climate (UNSCN, 2010). Meanwhile, research has shown that one billion of the world's population are suffering from hunger and the most susceptible people were not able to access adequate macronutrients such as carbohydrates, fats and protein. One billion more are unable to access minerals and vitamins with the resultant risks of mental and physical developmental challenges (Beddington, 2011; WFP, 2012a).

Malnutrition is the underpinning reason for deaths occurring among children up to 35% which is greater than 2.5 million deaths every year. There are also 52 million extremely undernourished children globally, and 29 million of these are suffering from severe acutely malnutrition (Black *et. al.*, 2008 as cited in WFP, 2012a). According to research findings, more than quarter of children below five years old in Yemen are persistently malnourished (47%) while another 13% experienced acute malnutrition. With this high malnutrition rates, Yemen children are at extreme risk rates under development and by the WHO standards Yemen's undernourishment case has reached a severe phase at 13% (WFP, 2012c).

Additionally, research indicated that in all developing nations, almost 165 million children below 5 years are stunted (WFP, 2012a). Particularly, the changing climate will worsen the undernutrition challenges through three major pathways; it will disenable households from accessing adequate, safe and sufficient food. It will also adversely affect care and feeding practices, and lastly it will negatively affect accessing health care services (FAO, 2015).

For instance in Niger, the probability of becoming malnourished will more than double for children who are between one to two years and were born during long spell of dryness. There is also 55.5% risk of these children experiencing undernutrition regardless of the areas where they are born. The inclusion factor will be to be born during climate change crisis (Fuentes &Secks, 2007). In Ethiopia, 35.5% of children born in climatological disaster locations are most likely to become malnourished and another 41% will most likely become stunted (Fuentes &Secks, 2007).

In Ghana however, there are major differences in undernutrition among the regions. A study conducted by MICS (2011) found out that, 13% of children below five years were moderately underweight while 3% were severely underweight, 23% were moderately stunted while 7% were severely stunted. Another 6% of the under five years were moderately wasted while 1% was severely wasted. Majority of the underweight and stunted children were located in rural areas than in the urban settings (MICS, 2011). Another survey carried out by USAID in 2014 in Ghana suggest that undernutrition still persist in Ghana. It indicated that the highest number of stunted under five years children are found in the Upper East, Northern, Eastern, and Central regions of Ghana. With 37% being the stunting rate in the Northern areas, this must be deemed as public health challenge. Upper West region have the worse wasting rate with 9.2% which is close to the WHO cut-off point for serious wasting. Crucial intervention programmes are requested to revert the current situation (USAID, 2014). Meanwhile, Ghana Demographic and Health Survey (GDHS, 2014) findings showed that out of 118 children in the Upper East region, 14.4% were stunted, 9% were also wasted while 10.8% of them were underweight. A survey conducted in 2008 revealed that out of 215 women in Upper East region, 14.8% were underweight thus having a body mass index (BMI) less than 18.5kg/m² (GDHS, 2008).

The World Health Organization has established cut-off points or thresholds for both children and adults with which standard nutritional measurements are compared in order to establish nutritional imbalances such as stunting, underweight, wasting and overweight among children and its health implications. These are vital indicators of health and nutritional status among populaces globally (WHO, 2010). The WHO definitions for the indicators and prevalence cut-offs are shown in Table 2.1. The indicators are: Stunting; height for age < –2 SD, Wasting: weight for height < –2 SD and Underweight: weight for age < –2 SD, Overweight: weight for height > +2 SD (WHO, 2010).

Table 2.1: Indicators and prevalence cut –off values for public health significance

Indicator	**Prevalence cut-off values for public health significance**
Wasting	< 5%: Acceptable 5-9%: Poor 10-14%: Serious ≥ 15%: Critical
Stunting	< 20%: Low prevalence 20-29%: Medium prevalence 30-39%: High prevalence ≥ 40%: Very high prevalence
Underweight	< 10%: Low prevalence 10-19%: Medium prevalence 20-29%: High prevalence ≥ 30%: Very high prevalence

Source WHO 1995: cited in WHO 2010.

The fourth indicator used to determine nutritional status among under five years children is mid upper arm circumference (MUAC) which is a measure of the diameter of the upper arm used in emergency situations as a faster means of assessing the degree of wasting among under five years children. WHO and UNICEF has established cut-off points for MUAC under three categories for the determination of nutritional deficiency amid children below five years of age. The categories

are; severe wasting; < 10cm-11.5cm, moderately wasted; 12.5cm -13.5cm and normal; >13.5 (WHO; UNICEF, 2009).

The WHO established cut–off points for Body Mass Index (BMI), mostly used to classify adults into underweight, overweight, and obesity (Table 2.2). BMI is calculated by dividing weight in kilograms over height square in metres. The unit of BMI is kg/m² (WHO, 2010). The cut- off values are as follows; BMI < 17.0 indicates moderate and severe thinness, BMI < 18.5 indicates underweight, BMI 18.5–24.9 indicates normal weight, BMI ≥ 25.0 indicates overweight and BMI ≥ 30.0 indicates obesity (WHO, 2010).

Table 2.2: Cut-off values for public health significance

Indicator	**Prevalence cut-off values for public health significance**
Adult BMI < 18.5 (underweight)	≥ 40%: Very high prevalence (critical situation) 20-39%: High prevalence (serious situation) 10-19%: Medium prevalence (poor situation) 5-9%: Low prevalence (warning sign, monitoring required)

Source WHO 1995: cited in WHO 2010

The association between climate extremes, variability and change and its impact on food and nutrition security is shown in Figure 2.1.

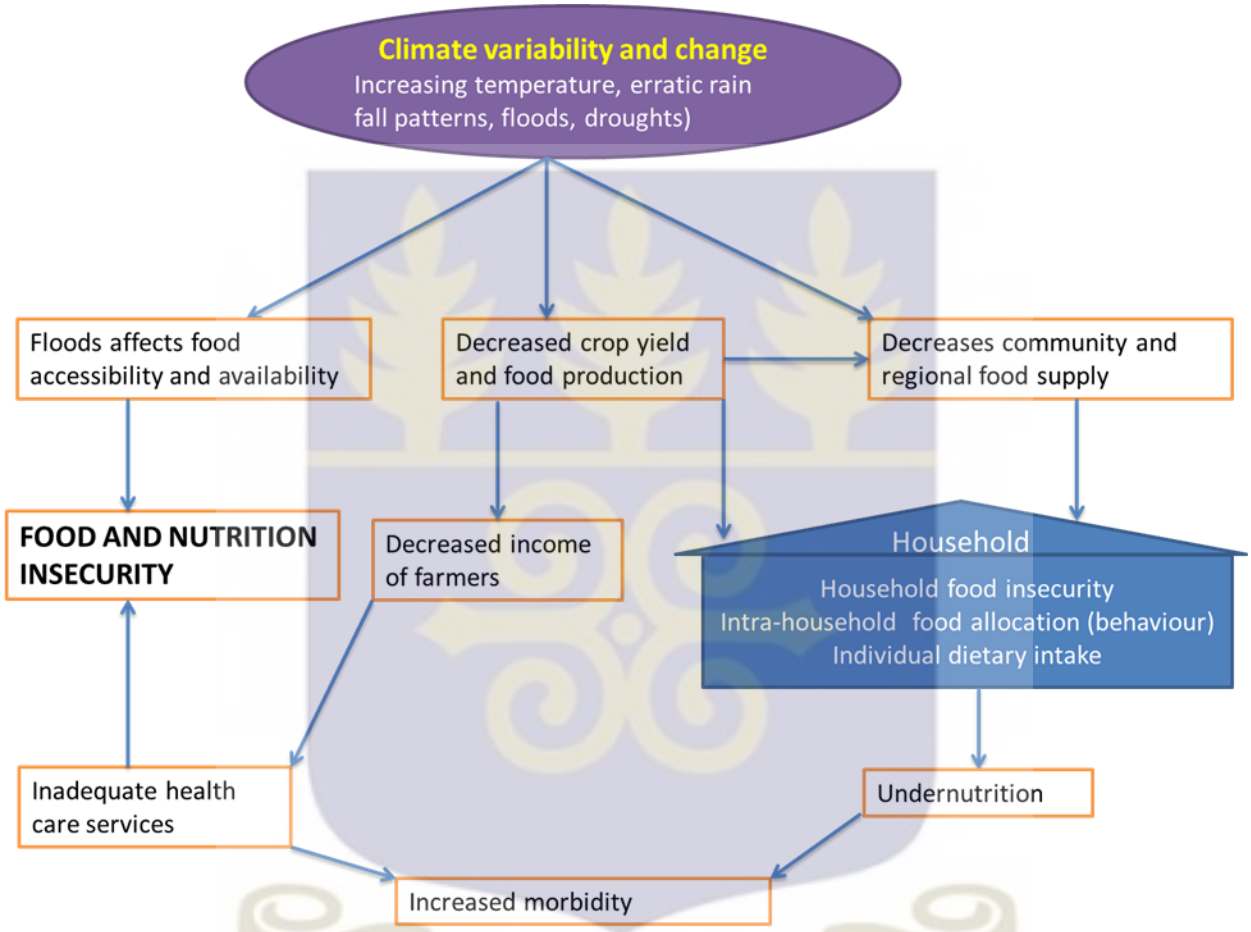


Figure 2.1: Conceptual framework illustrating the impact of Climate Change on Food and Nutrition Security

2.7 IMPACT OF CLIMATE CHANGE ON WOMEN AND CHILDREN

According to United Nation's Standing Committee on Nutrition, the adverse impact owing to weather extremes, mostly will be felt by the poor and the highly susceptible which includes women and children in the neglected areas. This stem from their greater exposure to climate change disasters and their direct reliance on natural resources that are sensitive to the changing climate coupled with low ability to adapt and cope with the stress of the changes in the weather patterns (UNSCN, 2010).

In Eritrea for example where there is consistent erratic rainfall patterns and small scale farmers have less access to water, women have to walk long distances to wells for water supply (WFP, 2012a). Women are also significantly involved in agriculture most especially staple crop production. They made up 43% of the agricultural workforce in developing nations, nearly 50% in sub-Saharan Africa, Eastern and South-eastern Asia and about 20% in Latin America (FAO, 2012; cited in GIZ, 2013).

The multitask roles played by women make it quite difficult in terms of apportioning time. Moreover, farming activities doubles the workload of women with the changing climate degrading many lands and drastically impacting food security, women spent more time tilling lands hence having reduced time left for caring for their children. The resultant effect is increased rate of children discontinuing education to provide care for their younger ones (GIZ, 2013). A research conducted by Akudugu *et. al.*, also affirmed that the capacity of women as food producers and care providers is greatly threatened under climate change regimes as women in the northern part of Ghana have to trek far distances in search of potable water, land and wood for home chores and for agricultural purposes. Many women who could not engaged in the search for these vital

resources end up having serious issues with their husbands resulting in divorce (Akudugu *et. al.*, 2012).

2.8 COPING STRATEGIES EMPLOYED TO MITIGATE THE NEGATIVE IMPACT OF CLIMATE CHANGE

Climate change threats on livelihoods and agriculture production have made indigenous people in all places to develop knowledge and skills to help them sustain life in the changing environment. These coping strategies enable them to modify the detrimental effect of the changing climate on livelihoods and life (Field, 2012). Droughts and weather associated threats consistently push households to adapt to some deleterious coping mechanisms such as decreasing the quality and quantity of meals, decreasing health and education expenditures in order to acquire food and the sale of vital personal assets. These adverse copping strategies could lead to rise in malnutrition among women and children most especially (UNSCN, 2010).

Under climate change difficulties, many copping strategies are being used to overcome the stress among the most vulnerable. This includes families purchasing food on credit. In Yemen for instance, one-quarter of the population borrow money to purchase food hence increasing the debt toll on households (WFP, 2012c). Also in Uganda, reduced crop yields resulting from erratic rainfall have limited peoples access to sufficient food hence some families eat once a day while others depend on wild foods to supplement their meals as coping adaptations. The unpredictable nature of agriculture periods have also coerced families to sell their farmlands and migrate to towns for greener pastures (MRFCJ, 2013). In food scarcity situations it was found out that women reduce their own food so as to feed their children and men (MRFCJ, 2013).

Empirical evidence has shown that farmers in various nations are coping under climate change by varying cultivation periods, and trying new varieties of crops to sustain food security and their livelihoods (Porter *et. al.*, 2014). Nonetheless these coping mechanisms compulsorily will not decrease all the adverse impacts of the changing climate, and the potency of these coping strategies could reduce at higher temperature projections (Porter *et. al.*, 2014). In Ghana, research conducted by Quaye revealed several coping strategies adopted by households in the three northern regions during food shortage periods (long dry periods). These strategies are presented in Table 2.3.

Table 2.3: Coping strategies adopted during hunger periods in the Northern regions of Ghana

Copping Mechanism	Upper West	Upper East	Northern
Sell livestock (pigs, sheep and goats)	81.6%	96.0%	70.8%
Send certain members of household to live elsewhere	9.2%	9.1%	10.7%
Members work for pay in food	7.5%	23.1%	12.4%
Eat less preferred foods	76.2%	72.4%	40.3%
Reduce the portion/ sizes of meals	89.8%	89.9%	69.0%
Sell personal valuables	17.0%	19.6%	22.8%
Eat wild vegetables and fruits	80.1%	71.3%	33.7%
Sell durable household possessions (small items	16.5%	21.5%	21.5%
Reduce number of meals served each day	87.2%	97.0%	71.6%
Sell fowls and chicken	78.1%	97.0%	67.9%
Seek food from relatives/friends	24.4%	11.2%	17.1%

Source: Quaye, 2008

2.9 IMPACT OF CLIMATE CHANGE ON HUMAN HEALTH

Scientific evidence concerning the changing climate shows that it is the biggest threat to health in the 21st century, adding to the public health disease load (WFP, 2012a). The well-being of humans can be influenced by the changing climate in different ways either owing to variations in heat

waves, temperature, rainfall, , torrents, fires or droughts or as a result of environmental and social interruptions leading to displacement of individuals, inconsistent patterns of disease causing organisms and decrease crop yileds (Springmann *et. al.*, 2016). A number of vector –borne disease has been associated with the changes in the climate such as, cholera, dengue, Bluetongue, malaria, Ross River Virus and Hantavirus. Vector-borne diseases have been predicted to rise significantly with increase temperatures whiles cholera episodes will vary according to the changing climate (Field, 2012).

The extreme weather conditions will be most felt by the vulnerable. Heat waves can result in heatstroke and cardiovascular illnesses, while variations in air pollution concentrations that is caused by ozone mostly rises with higher temperatures (Field, 2012). High temperature has been implicated in many studies to be the cause of diarrhoea incidents. Meningitis, diarrhoea, acute respiratory infection and measles are significant food security and nutrition related illnesses. These diseases increase the nutritional requirements of sick people and decrease nutrient absorption hence impeding its utilization by the body (WFP, 2012a). High rate of poor health within populations contribute to reduced productivity and increased dependency ratio (WFP, 2012a). However, positive relationship has been established between agriculture production and health. In that, national and local food availability influences dietary intake and its nonavailability have dire repercussion for health. Research findings indicated that the least decrease in the consumption of food due to unavailability for individuals could result in a detrimental health implications (Springman *et. al.*, 2016).

Anaemia is another repercussion due to the weather extremes and its negative impact on nutrition most especially in the vulnerable areas. Anaemia has been defined by World Health Organization

as a condition occurring as a result of a decrease in the red blood cell capacity and a reduction in the concentration of haemoglobin in the blood. Haemoglobin is essential for conveying oxygen to tissues and organs in the body (WHO, 2014a). Anaemia hinders the state of wellness of women and escalates the hazards of maternal and neonatal negative outcomes. Half a billion women of reproductive age are affected by anaemia globally. In 2011, 29% (496 million) of non-expectant females and 38% (32.4 million) of expectant females aged 15-49 years were anaemic (WHO, 2014a). The incidence of anaemia was greatest in south Asia, central and West Africa (WHO, 2014a).

Iron-deficiency anaemia decreases the potentials of individuals and whole populations, with dire repercussion for national economy and development. Also iron-deficiency anaemia has detrimental effect on the cognitive ability and physical growth of children. It also impairs the productivity of adults (WHO, 2010). Children below two years of age having severe anemia as a result of iron deficiency, are at higher risk of death and those under two years having mild form of anaemia even if corrected, could have their cognitive permanently damaged which leads to reduced mental ability. Children who have anaemia on average have IQs that are two points lower per every 10 g/L reduction in haemoglobin (www.k4health.org).

The principal risk factor for iron-deficiency anaemia is insufficient consumption of iron rich foods or poor absorption of iron from diets rich in phytate or phenolic compounds. The most vulnerable to iron –deficiency anaemia are pregnant women, young children and less educated people (WHO, 2010). As shown in Table 2.4, it is expected that 2.5% of normal population will be below the

anaemia threshold. But iron-deficiency anaemia will be considered a public health issue if the haemoglobin level among populations is greater than 5% (WHO, 2001).

Table 2.4: Public health significance cut-off values for anaemia

Indicator	**Public health significance prevalence cut-off values**
Anaemia	≥ 40.0: Severe public health problem 20.0–39.9: Moderate public health problem 5.0–19.9: Mild public health problem ≤ 4.9: No public health problem

Source: WHO, 2008 cited in WHO, 2010

The following cut-off value for normal, mild, moderate and severe anaemia ranges among children below five years and women of reproductive age as established by World Health Organization (WHO, 2011) are shown in Table 2.5. A study conducted by UNICEF in Northern Ghana revealed that two children out of every five is stunted and more than 80% of children have anaemia (UNICEF, 2011).

Table 2.5: Anaemia cut-off values for three physiological states

Physiological state	Anaemia categories/Cut-off values
Pregnant women	Normal –(11.0g/dLor higher Moderate- (7.0g/dL-9.9g/dL) Mild- (10.0g/dL-10.9g/dL
Non-pregnant women	Normal- (12.0g/dL or higher) Mild- (11.0g/dL-11.9g/dL) Moderate- (10.9g/dL- 8.0g/dL) Severe- (< 8.0g/dL)
Children 6-59 months	Normal- (11.0g/dL or higher) Moderate- (9.9g/dL-7g/dL) Mild- (10.0g/dL-10.9g/dL) Severe- (< 7. 0 g/dL)

Source: WHO (2011)

CHAPTER THREE

3.0 METHODOLOGY

3.1 Study Area and Design

3.1.1 Study Area

The research was conducted within four farming communities namely Anaafobiisi, Bogrigo, Gurigo and Gowrie in the Bongo district of the Upper East region of Ghana. The Bongo district was established in 1988, with Bongo as its capital. The district is 15km away from Bolgatanga, the regional capital. Bongo district shares borders with Bolgatanga Municipal to the South, Kassena-Nankana West and East districts to the West and Burkina Faso to the North and East. The district has a land area of 459.5 kilometre square and lies between longitudes 0.45° W and latitude 10.50° N to 11.09°and fall within the Onchocerciasis Free Zone. There are thirty-six (36) communities in the district with total population of 84,545, comprising 40,084 males and 44,461 females forming the majority (53.3%) (Ghana Statistical Service, 2010). The four (4) distinct major economic activities within the district are; agriculture, trade, industry and service. Majority of the populace (90%) are into agriculture which include rearing of animals and food crop production. Although the district is made up of multi-ethnic groups, the two dominating ethnic groups are the Frafras and the Bossis. The major languages spoken are Bonni by the Bossis and Guruni by the Frafras. There are three major religious groups in the district; traditionalists (44.0%), Muslims (7.2%) and Christians (45.1%).

The climate is characterized by one rainy season from May/June to September/October (an average of 70 rain days a year). The annual rainfall is between 600mm to 1400mm. The rainfall is erratic

in nature after which, an extended dry season follows from November to May characterized by cold dry and dusty harmattan winds. Temperature ranges between 12°C at night during the dry season to over 40°C during the day time. The flora is that of Guinea Savannah. Streams and rivers desiccated up throughout the dry season and the trees and grasses wither. During this period, agricultural activities are stopped and animals starve resulting in the reduction in the weight of livestock which in turn affects household income. The study setting was selected based on 20% of its households being food insecure (WFP, 2012b). The district and the regional chart of the research location are shown in Figure 3.1.

Figure 3.1: Map of the study area

3.1.2 Study Design

The study was a cross-sectional survey using mixed methods. A cross-sectional survey is a study directed at measuring the occurrence of a specific trait such as a precise exposure, illness or any health-related occurrence, in a given populace within a specific period (Kanchanaraksa, 2008). It

allows for a research to be carried out in a whole population or a subgroup. It enables the establishment of association between an exposure and the outcome at a particular time among the populace. A cross-sectional survey can be used to measure prevalence, generate hypotheses and can form the basis for future research studies (Olsen and St George, 2004).

Mixed methods research involved the blend of qualitative and quantitative research techniques and approaches in answering research questions and data collection. This approach provides better understanding of data that is generated in a single or multiple studies and is used to predict future occurrences (Creswell and Plano Clarks, 2007). While quantitative studies involve the use of surveys to collect data and statistical tool for analysis, qualitative studies on the other hand are explorative and focus on discovering and understanding the perceptions and the experiences of the research respondents (Neuman, 2002).

3.2 Study population, Sampling Size and Sampling Technique

3.2.1 Study Population

3.2.1.1 Population of household survey

The study population for the quantitative survey included all households with children below five years and their mothers within the Bongo District who were residing within the selected communities at the time of the research.

3.2.1.2 Category of focus group/ key informant participants

The study considered thirteen (13) key informants and 40 focus group discussion participants. Ten (10) from each community. Table 3.1 indicates the various categories of the participants of the focus group discussion and key informants in the study.

Table 3.1: Category of Key Informants

Category	Number
Key Informants	
Elderly Farmers	2 From each community (8)
Agric Extension Officers	3
District Director of Agric	1
District Meteorological Officer	1
Focus Group Participants	10 from each community (40)

3.2.2 Sample Size Determination for Household Survey

Sample size determination was based on formula quoted by Daniel (1999)

$$n = \frac{Z\,P\,(1-P)}{d2}$$

Where n = sample size; Z = Z statistic for a level of confidence; P = expected prevalence or proportion; d = precision.

Where Z=1.96 (for 95% confidence interval), P=20% = 0.2 (prevalence of food insecurity in Bongo District; WFP, 2012) and d=5% = 0.05, the formula gives a sample size of 245.86 which was rounded up to 246.

3.2.3 Sampling Technique for Household Survey

The four (4) communities were purposively selected based on the primary occupation and the population of women in these communities. A total of 62 eligible households were selected in Anafobiisi and Bogrigo and 61 eligible households each in Gurigo and Gowrie. Each community was divided into three strata due to the dispersed nature of the dwelling houses. Stratified simple random sampling was employed in selecting households with mothers having under five years' old children. Using information collected from Ghana Health Service's community –based and health planning services (CHPS), the mothers with children below the age of five were located together with a community volunteer and interviews conducted upon the mothers agreeing to take part in the study. The qualitative survey participants were also purposively selected.

3.2.4 Inclusion and Exclusion Criteria

3.2.4.1 Inclusion Criteria for Household Survey Participants

Households were included in the study if they:

- Were involved in food crop farming
- Have a mother and under five years old child
- Have stayed in the community for at least five (5) years

3.2.4.2 Exclusion Criteria for Household Survey Participants

Households were excluded from the study if they were involved in the production of only cash crops.

3.2.4.3 Inclusion Criteria for Focus Group Participants

Participants were considered eligible for the study if they:

- Were 30 years and above
- Were involved in staple crop production
- Stayed in the community for the past ten years

3.3 Data Collection

Community entry was done to inform the community leaders about the intended research to be carried out in their respective communities after the selection. Dates and time that were suitable for each community for the research to be conducted was scheduled. Meetings were held with the key informants and appropriate time scheduled for the discussion to take place. For quality control, fieldworkers were trained on how to administer the questionnaire and taking of anthropometric measurements. The study was in two parts; a questionnaire survey conducted by means of a semi-structured questionnaire and key informant interviews and focus group discussions done using interview guides.

The semi-structured questionnaires for the household survey were pre-tested in ten (10) households in Abonya, a community which has similar characteristics with the communities selected for the study. This enabled the researcher to determine the clarity of the questions, reliability and precision of the instruments before data collection commenced. The pre-testing was also used to estimate the amount of time that would be allocated to each respondent and the number of interviews the researcher would be able to carry out in a day in order to organize the schedule of activities.

3.3.1 Questionnaire Survey

The semi-structured questionnaires were used to obtain data from 246 mothers that agreed to partake in the study. The participants were interviewed to obtain their socio-demographic information to enable their background to be compared. These information included age, place of residence, educational level, occupation and income. Additionally information on household's awareness of climate change, coping strategies to offset the negative impact of climate change, food consumption and dietary patterns in relation to climate change, food preservation methods adapted by households and household food security were collected. The data collection was done in January 2016. The semi-structured questionnaire is shown in the Appendix1.

3.3.2 Dietary Intake Assessment

The women who participated in the study were asked to recall all the foods and drinks they had taken in the previous 24 hours prior to the interview using a single 24 hour dietary recall.

3.3.3 Anthropometry and Biochemical Assessment

3.3.3.1 Anthropometric Assessment

Anthropometric data were collected using digital weighing scale, a stadiometer, an infantometer, measuring tape, board maker and mid-upper arm circumference (MUAC) tape.

3.3.3.1.1 Weight Measurement

A. *Children:* The weight of children above two years of age was taken using a digital scale. They were weighed with minimal clothing. With the scale on a solid level floor and the children barefooted, were then asked to stand upright and erect on the middle of the scale. Measurement

was recorded to the nearest 0.1kg and taken in duplicates. The weighing scale was tarred after each weighing for accuracy.

Weight of children who were two years and below was taken by weighing their mothers or caretakers first without shoes or slippers and heavy ornaments on a digital scale. They were asked to stand upright with heads up. The weight of mothers or caretakers were recorded and the digital scale tarred while they were still standing on the scale. The children were then given to their mothers on the scale with minimal clothing and without shoes and slippers. Measurement was recorded to the nearest 0.1kg and taken in duplicates and the average strike for accuracy (WHO, 2004).

B. ***Mothers/Caregivers*****:** Weight of adults were taken using digital scale. They were weighed without heavy clothing and ornaments and without shoes or slippers. With the scale on a solid level floor and tarred, the barefooted adults were asked to stand upright in the middle of the scale with their heads up. Measurement was written down to the nearest 0.1 kg and taken in duplicates. The scale was tarred after each weighing for accuracy.

3.3.3.1.2 Height Measurement

A. ***Children*****:** The height of children who were above two years were measured using a stadiometer. The children were asked to stand erect, with their legs slightly apart against the rule with their ankles, buttocks and heads touching the measuring rule without slippers or shoes. They were then asked to breathe in. Ornaments and pony tails of girls were removed. Measurement was recorded to the nearest 0.5cm and taken in duplicates (WHO, 2004).

B. *Mothers/ Caregivers*: The height of each respondent was measured using a stadiometer. Respondents were measured without shoes or slippers. They were asked to stand erect and upright with their legs slightly apart, heads and ankles against the wall (measuring rule) on a flat and smooth surface and asked to take a deep breath. Women were asked to lose their pony hair and hair ornaments removed. Measurement was recorded to the nearest 0.5cm and taken in duplicates (WHO, 2004).

***C. Recumbent length*:** Children less than 2 years were positioned on the infantometer. The recorder held the child's head in the Frankfort plane and mildly bring the head to touch the static headboard. The examiner held the child's legs by placing one hand mildly but firmly over the knees with the child's toes pointing directly upward. By exerting mild pressure on the legs to check the knees from bending, the examiner then slid the movable footboard to rest firmly against the child's heels. The dimension was written down to the closest 0.1 cm. It was essential to have a third person help with agitated infants to take the dimension as rapidly as possible while maintaining precision (WHO, 2004).

3.3.3.1.3 Mid Upper Arm Circumference (MUAC)

Children: Measurement was done on the left arm of children below five years. The arm was bent at the elbow to make a right angle. The mid-point between the tip of the shoulder and the tip of the elbow (olecranon process and the acromion) was located and marked. The arm was straightened, and the tape placed around the marked area. The reading was taken twice to get an average (WHO; UNICEF, 2009)

3.3.3.2 Biochemical Assessment

The biochemical data were collected using heamoglobin meter (URIT-12), lancets, strips, cotton wool and 70% alcohol. The haemoglobin meter (URIT-12) was used in determining the haemoglobin concentration of both mothers and children. Blood samples were collected from the thump. The thump was cleaned and wiped with 70% alcohol and cotton wool with a disposable hand glove to prevent contamination. The finger was then pricked with a lancet and a drop of blood collected on URIT-12 haemoglobin meter strips. The strips were immediately inserted into the haemoglobin meter for reading and recording of values. The values were recorded in g/dL for women and children involved in the study.

3.3.4 Focus Group Discussions and Key Informant Interviews (Qualitative)

Focus group discussions and key informant interviews were done to explore the level of awareness of participants on the impact of climate change in the study area, impact of climate change on food crops production and changes in food consumption patterns. It was also done to obtain information pertaining to the type of coping strategies employed to mitigate the negative impact of climate change during food shortage periods. Discussions were held using open-ended questions.

3.3.4.1 Focus Group Discussions

Four focused group discussions were held, one in each community. Community leaders were consulted to help in identifying participants who consented to take part in the focus group discussions .It was done separately for men in two of the communities and for women in the other two communities through balloting. The groups were separated because of cultural reasons and to allow for free flow of discussion. Each group was made up of 7-10 participants aged 30-60 years. The focus group discussions were held on non-market days suitable for the participants. The

discussions were held at a neutral and comfortable venue. Each participant was given a unique number instead of his/ her name for anonymity. There was a moderator and an assistant eloquent in the indigenous dialect and English. The assistant took notes and recorded non-verbal communications. The discussions were also audiotaped using digital voice recorder and lasted for an hour and half or two hours maximum. Each participants was given soft drink, biscuits, water and soaps in appreciation of their time and contribution. The focus group discussion guide is shown in Appendix 2.

3.3.4.2 Key Informant Interviews

Thirteen key informant interviews were conducted. Eight (8) farmers, two from each of the four communities were interviewed. Community leaders were consulted to help in identifying key informants who were willing to be part of the study. Other participants included four Agriculture officers who were in charge of the selected communities and a meteorological officer in charge of the district from the Upper East regional office. This was done in the comfort of the homes of the farmers and in the offices of the agriculture officers and the meteorologist. The discussions were conducted in Frafra for the farmers and in English for the officers. The participants were given soft drink, biscuits, and soaps in appreciation of their contribution and time. The discussions were audiotaped using digital voice recorder and lasted for one hour maximum. The key informant interview guides are shown in the Appendix 3.

3.3.5 Climate Change and Crop Yield Data

A 30 years retrospective climate change data was collected from Ghana Meteorological Service Department on temperature and rainfall patterns in the study area. Also a 21 years retrospective

data on crop yields within the research location was collected from the Ministry of Food and Agriculture (MOFA), Upper East region.

3.4 Data Analysis

Data analyses were done independently for quantitative and qualitative data.

3.4.1 Quantitative Data

Quantitative data was entered into SPSS version 20 (Statistical Package for Social Sciences) for analysis. Means and standard deviations were used for continuous variables and frequencies and percentages were generated for categorical variables.

Awareness of climate change: Data on awareness was analysed by creating categories of awareness of climate change in the study area, the questions on awareness were regrouped into two main categories namely; adequate and inadequate awareness and a score of two (2) was assigned to a Yes answer and zero (0) to a No answer, summing up to twelve (12) correct answers (Table 3.2). If a participant choose Yes and also answer the follow up question correctly, she was awarded 2 marks but a Yes and wrong answer to the follow up question attracts zero (0).

Table 3.2 Awareness of climate change questions

Questions	Options	Score
1. Have you heard about climate change? What do you know about climate change?	1) Yes 2) No	2 0
2. Do you think climate change can affect you or your household? How does it affect you or your household?	1) Yes 2) No	2 0
3. Have you observed any variations in the rainfall pattern over the past five years? What type of changes?	1) Yes 2) No	2 0
4. Do the changes in rainfall patterns affect the food crops you grow in any way? If yes how?	1) Yes 2) No	2 0
5. Have you observed any changes in temperature over the past five years? What type of changes?	1) Yes 2) No	2 0
6. Do the changes in temperature affect the food crop you grow? If yes how?	1) Yes 2) No	2 0

Coping strategy: Information collected were analysed by regrouping the list of coping strategies into three categories. Frequencies and percentages were generated for the groups. The three categories were;

i. Quality and Quantity

ii. Aid and Emergency

iii. Saving Cost

These categories reflect similarities in the different coping strategies. Coping strategy (i) included the following:

1. Consume less quality and variety of food
2. Decrease the meal of adults in favor of children
3. Limit the portion of meal for all household members
4. Reduce number of meals per day

Coping strategy (ii) included the following:

1. Depend on aid from family and friends
2. Use part or all of your life savings to purchase food
3. Sell any assets to purchase basic food
4. Reduce health and education expenses in order to meet food needs
5. Take a loan to purchase food
6. Harvest immature crops
7. Skip a loan payment
8. Purchase food on credit

And coping strategy (iii) included:

1. Send children to eat elsewhere (from family or friends)
2. Send children to work for food
3. Regrouping of family members to save money
4. Trade some possessions to finance in profits generating activities
5. Barter exchange

Food preservation methods: Analysis of food preservation methods were done by creating three categories and then generating frequencies and percentages for the categories. The three categories were; drying, dry and apply chemical, dry and put into traditional barn. All the food crops are dried first and then choices are made either to apply storage chemical such as commando on them or put the food crops into a traditional barn or leave them after drying. The major staples produced in the four communities are, millet, sorghum, rice, beans, Bambara beans, groundnuts, maize, soya beans and sweet potatoes. They also cultivate vegetables such as pepper, tomatoes, onions, aleefu, ayoyo, kenaf (bitor leaves).

Changes in household food consumption patterns: Pearson chi square was used to analyse the association between specific food crops that were consumed less by study participants and the reasons why they were being consumed less in relation to climate change impact.

Household dietary diversity: The information obtained using 24-hour dietary recall, was used to fill FAO dietary diversity questionnaire for each household. The FAO (2011) household dietary diversity score (HDDS) was used to assess the number of food groups consumed by a household per day. HDDS categorization was then used to evaluate dietary diversity and quality of diet among the individual households. The seventeen food groups used in collecting the data were regrouped into twelve food groups according to the FAO (2011) standards.

The categories were Low, Medium and High. Households belonging to the Low dietary diversity categories consumed less or equal to three different food groups. The Medium dietary diversity category included households that consumed between four and five different food groups and the High dietary diversity category included households that consumed greater than six different food groups.

Women dietary diversity score (WDDS) was also used to determine how diverse food consumption patterns were among the individual women. The seventeen food groups were regrouped into nine food groups according to the FAO (2011) standards and then categorized into three as Low, Medium and High. Women belonging to the Low dietary diversity categories consumed less or equal to three of the food groups. The Medium dietary diversity category included women that consumed between four and five different food groups and the High dietary diversity category included women that consumed greater than six different food groups.

Household food security data: Household Food Insecurity Access Scale (HFIAS) version 3 by FANTA III (Coates *et al*, 2007) was used in categorizing the Household Food Security data. The four (4) categories according to the prevalence scale of HFIAS were, Food Secure, Mildly Food Insecure, Moderately Food Insecure and Severely Food Insecure.

i. For a household to be Food secure, the household should answer yes to only one of the nine questions.
ii. To be mildly food insecure, a household should answer yes to three questions.
iii. For a household to be moderately food insecure, the household should answer yes to four questions.
iv. And for a household to be severely food insecure, a household should answer yes t to five questions.

Frequencies and percentages were generated for the categories before modeling it in binary logistic regression with decreased rainfall and increasing temperature, mother's age, mother's educational level, income, family size, number of under five years children in the household to determine the correlation between the variables and household food security.

Anthropometric data: Anthropometric measurements for children below five years of age were analysed using WHO Anthro Plus version 3.2.2 software to establish their nutritional status. The anthropometric indicators includes height- for- age, weight- for- height and weight- for- age.

Z-Score values of ± 1SD, ±2 SD and ± 3SD were selected for stunting, wasting, underweight and normal for the under five years old children based on (WHO, 2010) standards. All the values reported are under < - 2 SD to classify low weight-for age (WAZ), low weight-for height (WHZ) and low height-for age (HAZ) as moderate undernutrition.

The mid-upper arm circumference (MUAC) indicator was categorized into three according to WHO (2009) cut-off points. These categories were; severely wasted <11.5cm, moderately wasted 12.5-13.5cm and normal >13.5cm.

The body mass index (BMI) of mothers were analysed by creating four categories according to WHO (2000) standards for underweight, normal, overweight and obese. The BMI cut-off values for the four categories were (<18.5kg/m²: underweight, 18.5kg/m²-24.9kg/m²: normal, 25kg/m²: overweight and ≥30kg/m²: obese). The formula below was used to determine the BMI cut-off values and to assess the nutritional status of the women in the study population.

Formula for BMI (kg/m²) = $\frac{\text{Weight (kg)}}{\text{Height (m}^2\text{)}}$

The categories of the anthropometric measurements for the children were then modeled in binary logistic regression with decreased rainfall and increasing temperature together with mother's age, mother's educational level, income, family size, number of under five years children in the household in order to determine the association between the variables and that of the nutritional status of the children under five years.

BMI categories of the mothers were analysed using multinomial logistic regression with same variables to determine correlation between the variables and maternal BMI.

Anaemia data: Prevalence of anaemia was analysed by creating four categories; normal, mild, moderate and severe anaemia according to WHO (2011) standards. The four (4) categories were:

Children 6-59 months of age: 11.0g/dL or higher (normal), 10.0g/dL-10.9g/dL (mild), 7.0g/dL-9.9g/dL (moderate) and <7.0g/dL (severe).

Non-pregnant women: 12.0g/dL or higher, 11.0g/dL-11.9g/dL, 8.0g/dL-10.9g/dL and <8.0g/dL.

Frequencies and percentages were generated to establishing how many people belong to each category.

***Climate change and crop yields data*:** The means of climate change variables rainfall and temperature were used to plot time series graphs together with crop yields data to determine their trends and the impact of rainfall and temperature on crop yields in the Bongo district over 20 years period .

3.4.2 Qualitative Data

The audio recordings were given to an independent person to transcribe verbatim. After transcription, the transcripts were reviewed by another independent person. The review process involved listening to the voice recordings and comparing it with the transcripts that were produced from these voice recordings. Samples of the transcripts were again reviewed and a codebook developed from them. The codebook contained the codes to be used in coding the data, their definition, instances to use that codes and examples. The codebook covered the main themes and

sub-themes that emerged from the data. The codebook was then transformed into parent nodes and child nodes in Nvivo 10 software. The transcripts were at this point imported into Nvivo 10 for analysis. Thematic content analysis was assumed for the interpretation of the qualitative data.

Thematic content analysis involves four interrelated steps consisting of reading through textual data, identifying themes in the data, coding those themes, and then interpreting the structure and content of the themes (Guest, Macqueen, & Namey, 2012). Using this strategy, each transcript was opened within the Nvivo platform, and line-by-line reading through the transcripts was done. In doing that relevant aspects of statements made by respondents were coded unto their corresponding nodes as free nodes initially. However, as the coding progressed, the relationships between nodes emerged and these nodes were then transformed into tree nodes to reflect the relationships between nodes. This was done until all the transcripts were coded. The nodes browser was at this point reviewed to observe the relationship between nodes.

3.5 Ethical Issues

Ethical clearance was obtained from the Ethical Review Committee of the College of Basic and Applied Sciences (CBAS) of the University of Ghana, Legon.

Participants consenting: At the household level, the purpose of the research and issues concerning anonymity, confidentiality, benefits, risks and freedom to partake or withdraw from the study at will, had been made clear to the women and individual written informed consent was obtained from the women and guardians of all children that were involved in the study in the presence of a witness to certify that they understood and have consented to partake in the study.

The purpose of the research was explained to the focus group participants at the venue of the discussion. They were made aware of confidentiality, anonymity, benefits and freedom to participate or withdraw at any time from the discussion. They were registered and individual signatories taken on a volunteer informed consent form to attest to their willingness to participate in the discussion. The researcher explained to the key informants the purpose of the research, they were assured of confidentiality and their anonymity. They were also told how the study will benefits them and the community as a whole. The approved consent forms are shown in Appendix 4.

CHAPTER FOUR

4.0 RESULTS

This chapter describes the results of the study under the following sub- headings: Socio - demographic characteristics, awareness of climate change in the study area, coping strategies and food preservation methods, household food security, household consumption patterns and dietary changes and nutritional status of women and children in the households. The analysis was done using mixed methods and the results are presented as such.

4.1 BACKGROUND CHARACTERISTICS OF PARTICIPANTS

A total number of 246 mother-child pairs were involved in the study. The minimum age of the mothers was 17 years whiles the maximum was 50 years. Table 4.1 shows that, the mean maternal age was 28.3 with a standard deviation of 7.4. Majority (86.2%) of the women were married or cohabiting and more than a quarter of them (39.8%) had no formal education. At least 15.9% of them had secondary or tertiary education. Almost all the participants were Frafras (98%). Christianity was the dominant religion practiced by the participants (81.7%). More than half of the women were predominant farmers (73.2%) while 3.3% were in the formal sectors earning monthly salaries. The mean monthly income of the women was GH₵ 42.8 with a maximum income of GH₵ 500.00 but almost quarter of them (17.6 %) earned nothing. More than half (54.9%) of the children's population were male while the female formed 45.1%. Their mean age was 24.2 months, with the minimum and maximum ages being two (2) and forty-eight (48) months respectively. More of the children 37.8%, fell within the <12 month's category while the least number 16.3%, were within the 37-59 months category.

Table 4. 1: Background characteristics of participants (N=246)

Variable	n (%)
Child's characteristics	
Age categories (months)	
<12	93(37.8)
12-24	70 (28.5)
25-36	43(17.5)
37-59	40(16.3)
Child's age (months) x ± SD	24.2 ± 14.3
Sex	
Male	135 (54.9)
Female	111 (45.1)
Maternal characteristics	
Mother's age (years) x ± SD	28.3 ± 7.4
Marital status	
Single	21 (8.5)
Married/Cohabiting	212 (86.2)
Widowed/Divorced	13 (5.3%)
Education	
None	98 (39.8)
Primary	44 (19.1)
JHS/Middle School	62 (25.2)
Sec/Ter/Vocational	39 (15.9)
Primary Occupation (maternal)	
Salaried worker	8 (3.3)
Artisan/ Traders	51 (20.7)
Farmers	180 (73.2)
Student	7 (2.8)
Secondary occupation (maternal)	
None	173 (70.3)
Farmers	53 (21.5)
Others	18 (7.3)
Ethnicity	
Frafra	241 (98)
Others	5 (2)
Religion	
Christian	201 (81.7)
Traditionalist	30 (12.2)
Muslim	15 (6.1)
Monthly income (maternal) x ± SD	42.8 ± 79
Monthly income of household head x ± SD	77.7 ± 136.8

4.2 CLIMATE VARIABLES IN THE BONGO DISTRICT

The annual means of rainfall and temperature for 30 years period were plotted against the years to establish the trend of rainfall and temperature. From the graph, rainfall has been decreasing at -0.2729 mm approximately -0.3mm per annum. Whiles maximum temperature has shown a marginal increase of 0.0046°C, the minimum temperature however has shown a little decrease over the years with -0.037°C as shown in Figure 4.1 and 4.2 respectively.

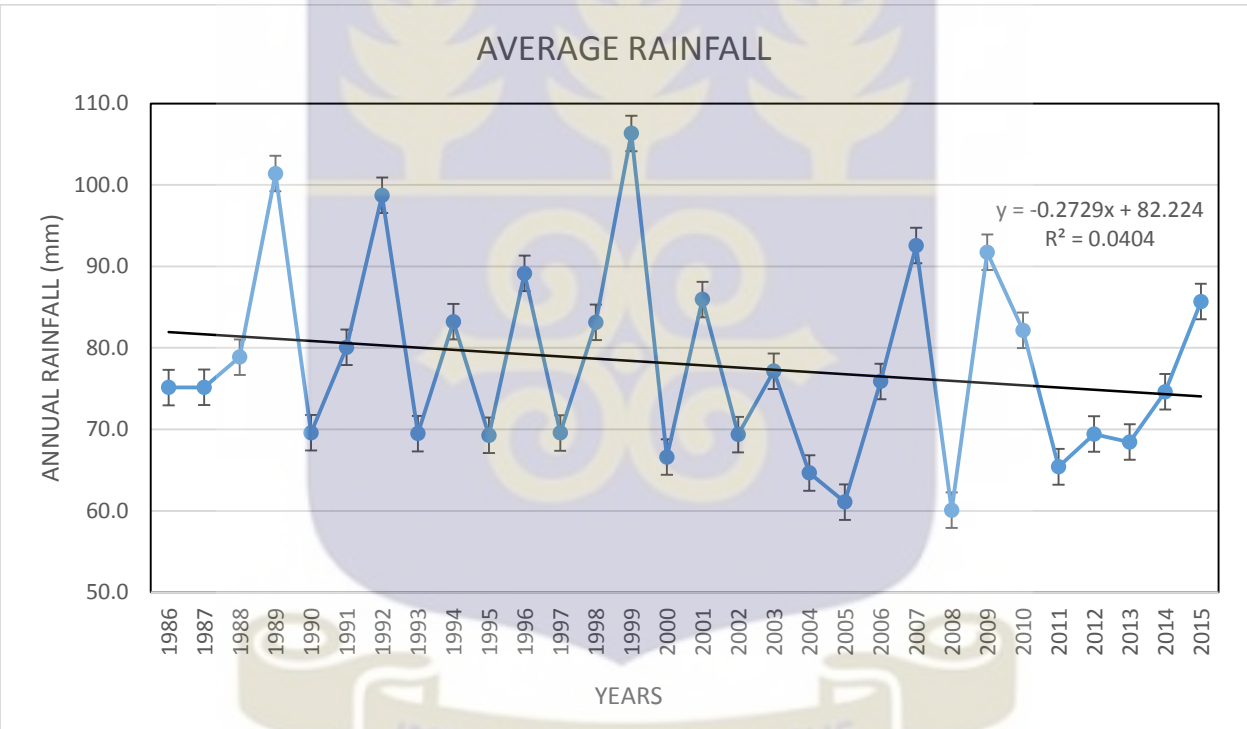


Figure 4.1: Average rainfall trend from 1986-2015 within Bongo District (GMet, 2015) data.

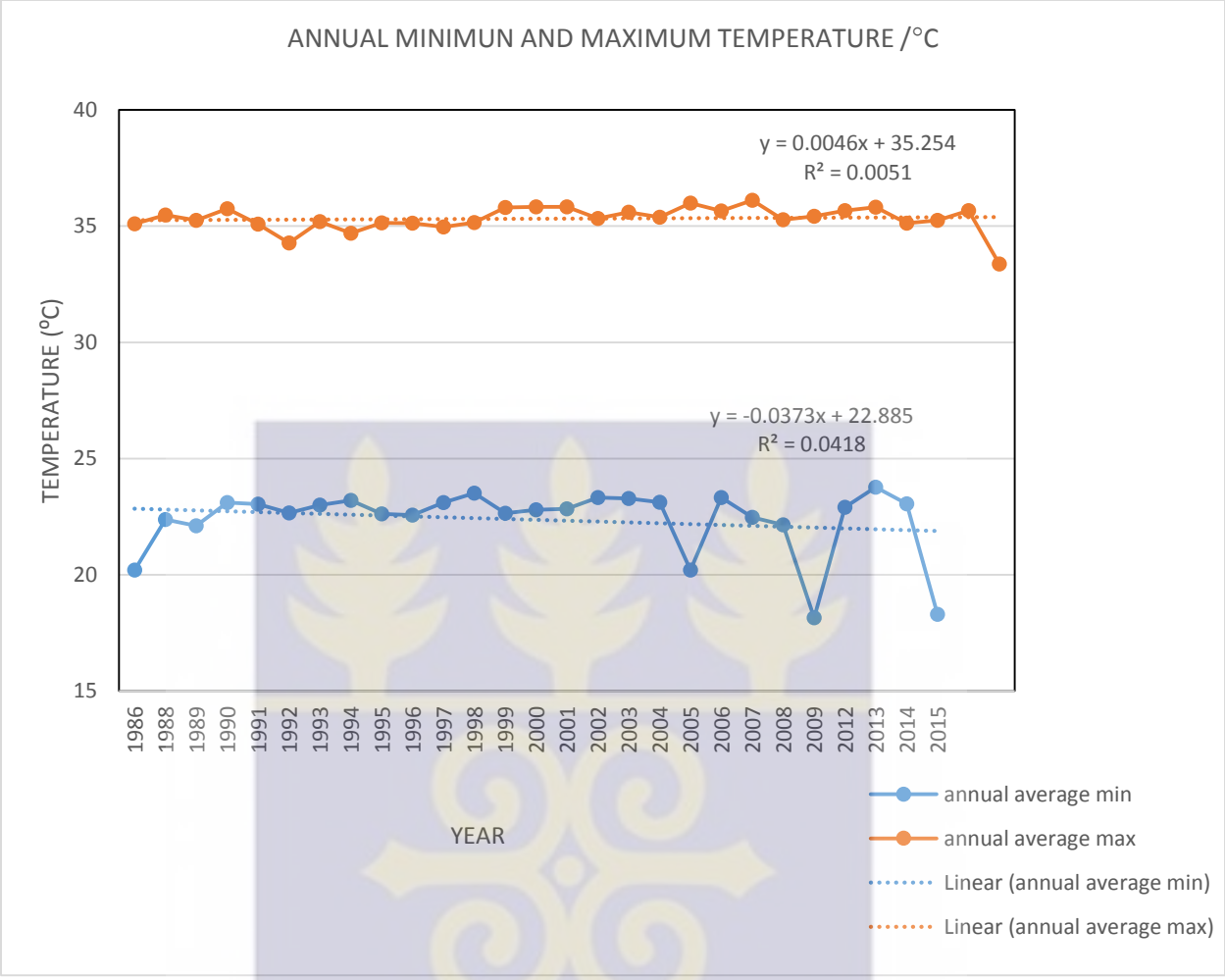


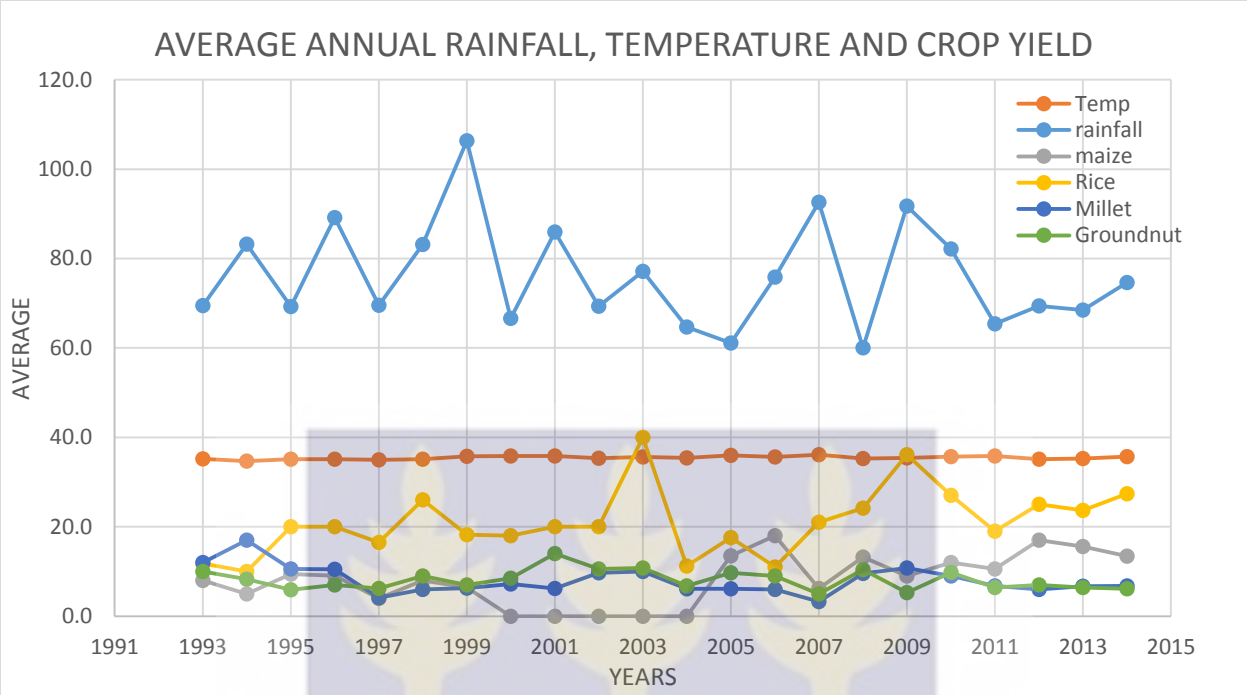
Figure 4.2: Average minimum and maximum temperatures trends in the Bongo District (GMet, 2015) data

4.3 IMPACT OF CLIMATE VARIABLES ON FOOD CROP YIELDS IN BONGO DISTRICT

The climate variables having impact on food crops grown in the district were decreasing rainfall and maximum temperature. Some of the major crops grown the district included millet, maize, rice, sorghum, groundnut and cowpea. Changes in maximum temperature in relation to crop yield was marginal (Figure 4.3) over the past 30 years. But rainfall variability affected crop yields considerably over the same period. For instance in the year 1999, when average rainfall increased

to about 108mm, the yields of rice increased from 1.8 Ton/Ha to about 2.5 Ton/Ha. Over the same period, millet yields doubled from 0.4 Ton/Ha to about 0.8 Ton/Ha. The yields of groundnut also increased from about 0.5 Ton/Ha to about 1Ton/Ha whiles yields of maize more than doubled from 0.4 Ton/Ha to about 0.9Ton/Ha.

However, as mean rainfall decreased sharply in 2011 from about 90mm to about 62mm, the yields of rice dropped with a difference of a 0.9 Ton/Ha. Rice yields decreased from 2.8 Ton/Ha to about 1.9 Ton/Ha. Millet yields were halved from 1 Ton/Ha to about 0.5 Ton/Ha over the same period. Groundnut yields dropped to almost halve from 0.8Ton/Ha to about 0.5Ton/Ha. Maize yields also decreased from 1 Ton/Ha to about 0.7 Ton/Ha thus a difference of 0.3 Ton/Ha. Again when average rainfall decreased from about 65mm in 2012 to about 63mm in 2013, all the crops experienced decreased in yields. Rice dropped from 2.5 Ton/Ha to about 2.2 Ton/Ha. Maize yields decreased from 1.8 Ton/Ha to about 1.6 Ton/Ha whiles millet and groundnut have also experienced decreases.



The values of crop yields were multiplied by 10 before plotting to enable their values fit on the same graph with the climate variables (temperature and rainfall).

Figure 4. 3: Relationship between climate variables and crop yields (GMet, 2015; MOFA, 2014) data

4.4 AWARENESS OF CLIMATE CHANGE IN THE STUDY AREA

Two categories were created to determine the level of climate change awareness in the study area. The categories include adequate and inadequate awareness. More than half of the respondents (62.6%) were adequately aware of climate change in the study area. However 92 participants representing 37.4% in the inadequate category, were not aware of climate change in the study area. Table 4.2 profiles awareness level of participants and the changes observed in climatic variables over the years. Participants were also asked whether they have observed any changes over time in rainfall and temperature patterns and the type of change they have observed. Approximately (89.4%) observed decreasing rainfall. On temperature, majority (84.7%) said it has been

increasing over the past five years. Various causes of climate change were mentioned by the participants (Table 4.3). About 36.2% attributed the cause to cutting of trees, whiles 31.7% ascribed it to burning of bushes. More than a quarter of them (25.2%) said they do not know what causes climate change.

Table 4.2: Level of awareness and observed changes in climate variables (N=246)

Variables	n (%)
Awareness	
Adequate	154 (62.6)
Inadequate	92 (37.4)
Changes observed in rainfall	
Yes	236 (95.9)
No	10 (4.1)
Types of change (N= 236)	
Increasing rainfall	25 (10.6)
Reduced rainfall	211(89.4)
Changes observed in temperature	
Yes	209 (85)
No	37 (15)
Types of change (N=209)	
Increasing temperature	177 (84.7)
Reducing temperature	32 (15.3)

Table 4.3: Causes of climate change in the study area (N= 246)

Variables	n (%)
Cutting of trees	89 (36.2)
Bush burning	78 (31.7)
Poor rains	7 (2.8)
Fumes of car	2 (0.8)
The gods	8 (3.3)
I don't know	62 (25.2)

4.5 HOUSEHOLD FOOD CONSUMPTION PATTERNS AND DIETARY CHANGES IN RELATION TO CLIMATE CHANGE

Participants were asked whether they no longer consumed or consumed in lesser quantities some foods crops as a result of climate change impact, about a half (57.3%) of them responded yes while (42.7%) said no. Those who said yes were further asked to mention the specific foods crops that have been affected by the impact of the changing climate and in which way climate change has affected these food crops. Using Pearson chi square, a significant association was observed between reasons given as climate change effects on the food crops and the specific crops mentioned to be affected with a significant p-value of 0.001 as shown in Figure 4.3.

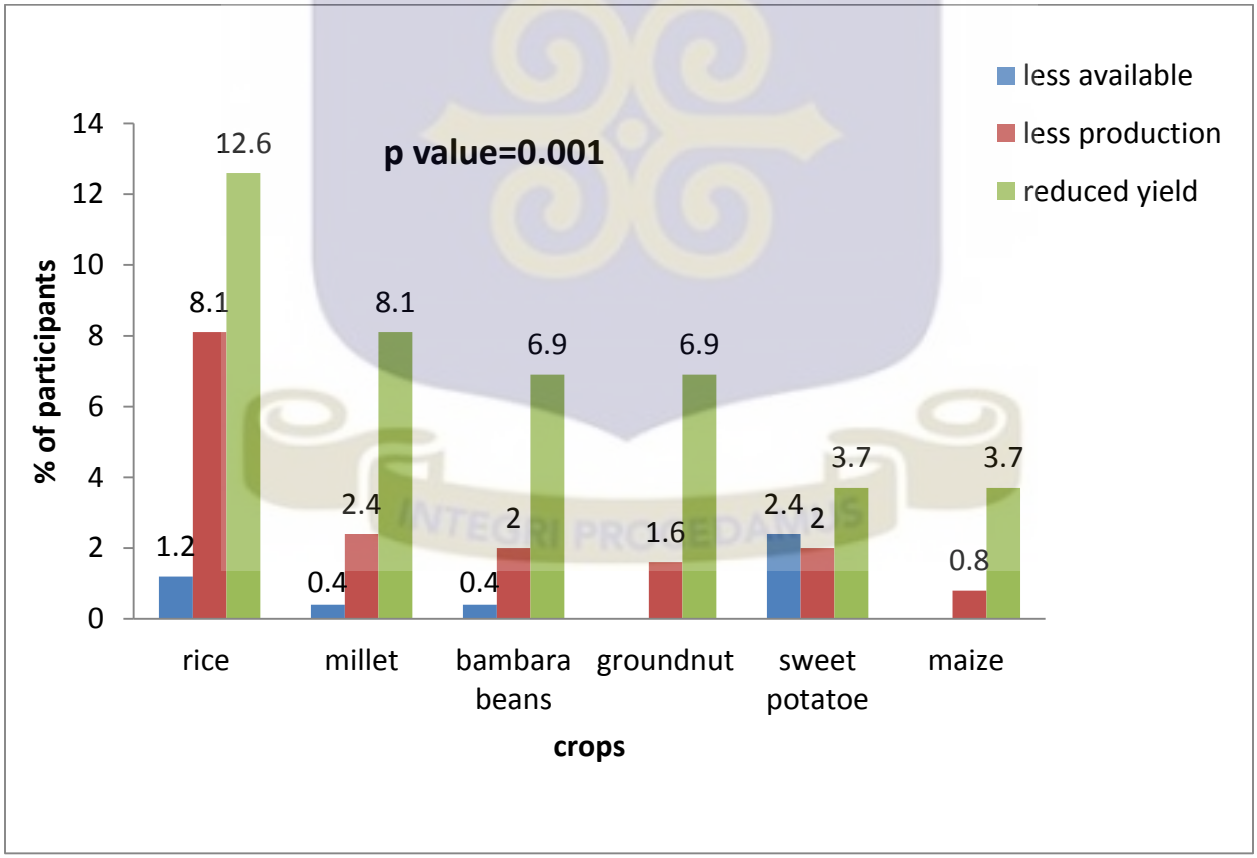


Figure 4.4: Association between reasons given for consuming less quantity of some food crops and the specific food crops in relation to climate change

4.5.1 Household dietary diversity patterns

FAO (2011) household dietary diversity score (HDDS) and HDDS categorization was used to determine how diverse food consumption patterns were among the households. Table 4.4 shows that, about 11.4% of the households have low dietary diversity whiles majority (63.4%) representing 156 households have medium dietary diversity.

Women dietary diversity score (WDDS) were also used to determine how diverse food consumption were among the individual women. The results showed that majority of the women (67.9%) consumed between four and five diverse food groups thus belonging to the medium dietary diversity category whiles 17.1% has low dietary diversity as shown in table 4.4.

Table 4.4: Household dietary diversity patterns (N=246)

Variables	n (%)
Household Dietary Diversity Score	
Low	28 (11.4)
Medium	156 (63.4)
High	62(25.2)
Women Dietary Diversity	
Low	42 (17.1)
Medium	167 (67.9)
High	37 (15)

4.6 HOUSEHOLD FOOD SECURITY AND COPING STRATEGIES

4.6.1 Household food security

Based on the four categories created using the prevalence scale of household food insecurity access scale (HFIAS) Coates *et al*, 2007, only 0.8% representing two households, were food secured. Almost all the households were severely food insecure (99.2%) as shown in Table 4.5.

4.6.2 Coping Strategies

The list of coping strategies were regrouped under three main categories namely; quality and quantity, aids and emergency and saving cost. Table 4.5 shows that, almost all the respondents (89.4%) said the coping strategy they would employ during food shortage was limiting quality and quantity of diet while a minority (2.8%) said they would use cost saving strategies.

Table 4.5: Household food security and coping strategies adopted (N= 246)

Variable	n (%)
Household Food Security	
Food Secure	2 (0.8)
Moderately Food Insecure	5 (2)
Severely Food Insecure	239 (97.2)
Coping Strategies	
Quality and Quantity	220 (89.4)
Aid and Emergency	24 (9.8)
Saving Cost	7 (2.8)

4.6.3 Determinant of household food insecurity among the participants

The binary logistic regression model used in Table 4.6 shows that, the odds of decreasing rainfall was 3.96 times most probable to cause food insecurity among the households compared with increasing rainfall. The odds of no formal education among the women was 4.54 times highly associated with food insecurity compared to women who have formal education. Larger household sizes (≥7) were highly correlated with food insecurity with the odds of 3.11 compared to smaller household sizes (< 7).

Table 4.6: Adjusted and unadjusted odds ratios of rainfall and Temperature impact on household food insecurity

Variables	Food Insecurity	
	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Maternal age		
17-24	1	1
25-30	1.24 (1.03- 1.51)	1.90 (0.96- 1.59)
31-34	0.31 (0.56- 1.69)	0.13 (0.02- 1.02)
≥35	1.92 (0.19- 19.13)	1.50 (1.21- 1.87)
Education		
Educated	1	1
No education	9.31 (0.81- 107. 04)	4.54 (0.53- 39.01)
Household size		
<7	1	1
≥7	5.12 (3.25- 8.07)	3.11 (1.76- 5.50)
Income		
<Ghc20	1.16 (0.99- 1.36)	1.09 (0.22- 5.32)
≥Ghc20	1	1
Number of under 5[3]		
≤ 2	1	1
≥3	2.57 (2.12- 3.13)	1.51 (1.12- 2.05)
Decreasing Rainfall[1]		
Yes	4.67 (0.99- 21.82)	3.96 (0.56- 27.81)
Increasing Temperature[2]		
Yes	1.96 (0.34-11.31)	1.02 (0.12- 9.83)

Binary logistic regression adjusting for the other factors shown in the table
Food security was a reference variable
[1] *Perceived decreased rainfall*
[2] *Perceived increasing temperature*
[3] *Number of under five years old children in each household*

4.7 HOUSEHOLD FOOD PRESERVATION METHODS

Participants were asked how they preserve their food crops after harvesting. About a half (52.3%) said they sun dry their crops while 13.8% said they store the food crops in the traditional barn after drying as shown in Figure 4.6.

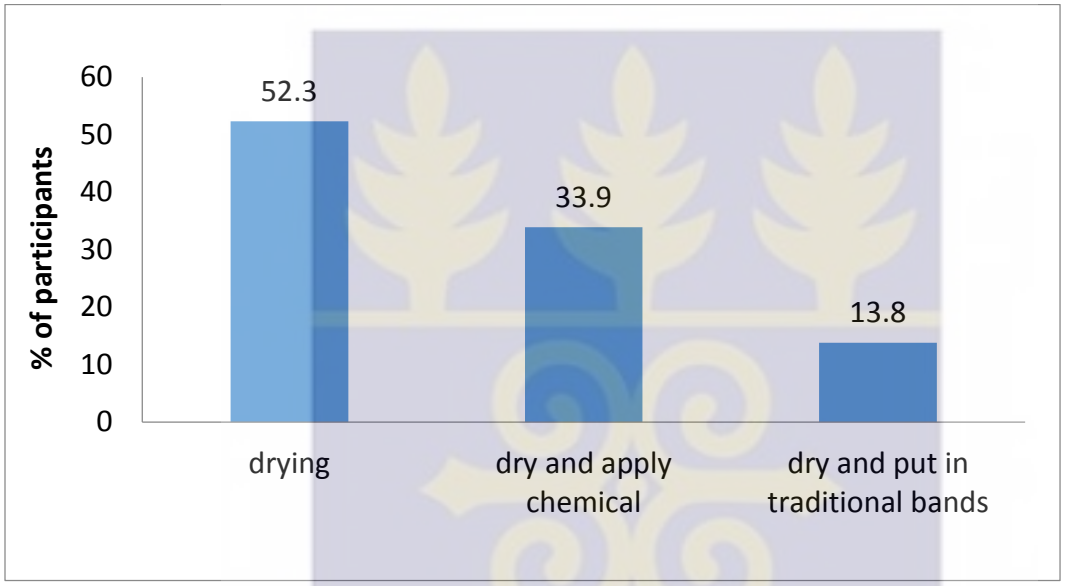


Figure 4.6: Household food preservation methods

4.8 NUTRITIONAL STATUS OF WOMEN AND CHILDREN IN THE HOUSEHOLDS

Based on the WHO (2010) standards, weight and height of the women were measured for the calculation of their body mass index (BMI). Figure 4.7 shows that, more than half of the women (61.4%) had normal BMI, while 24.4% representing 60 of the women were overweight. About 9% were obese.

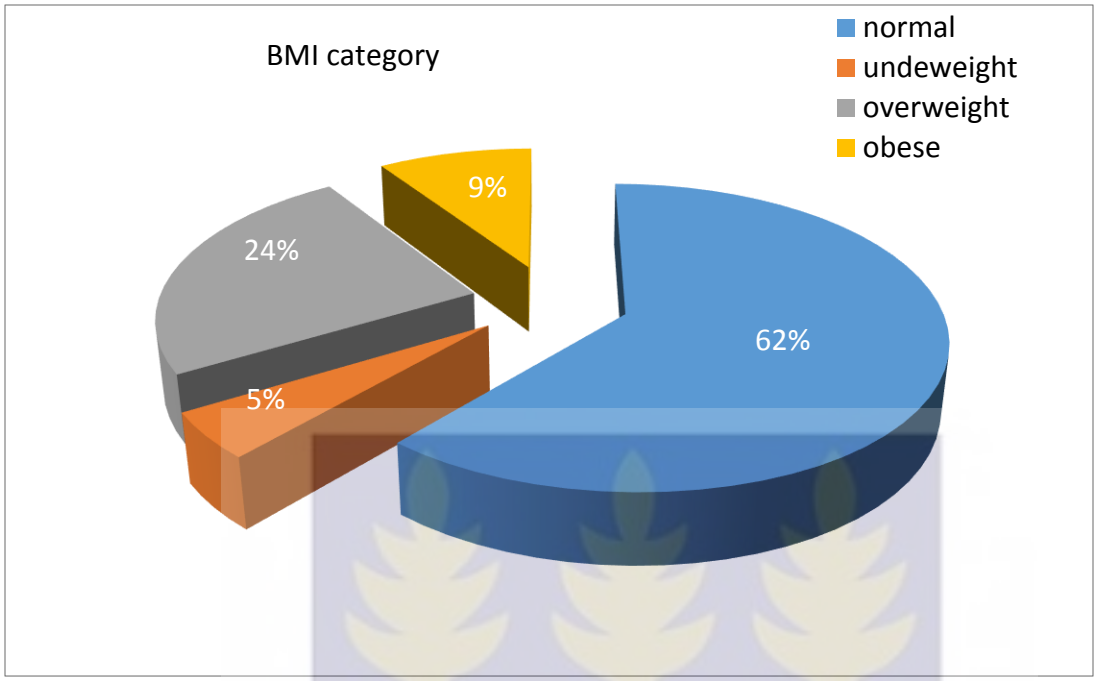


Figure 4.7: Nutritional status of mothers

4.8.1 Predictors of weight among women in the households in the study area

Women who have no formal education were more likely to become underweight compared to women who have formal education (OR = 1.24). Women with larger household sizes were more likely to become underweight compared to women with smaller household sizes with the odds of 1.34. Both low income and decreasing rainfall were 1.26 times more likely to influence women becoming underweight compared to high income earners and increasing rainfall as shown in Table 4.7.

The multinomial logistic regression model in Table 4.7, revealed that no education and decreasing rainfall but not household sizes, income, age of women, large number of under-fives year olds in the households and increasing temperature were more likely to influence women becoming overweight compared to women who have formal education (OR=1.41 and 1.31).

Table 4.7: Predictors of underweight or overweight among women

Variables	BMI*	
	Underweight OR (95%CI)	Overweight OR (95%CI)
Maternal age		
17-24	1	
25-30	0.38 (0.60- 2.39)	0.196 (0.080- 0.48)
31-34	0.44 (0.79- 2.49	0.26 (0.12- 0.59)
≥35	0.56 (0.49- 6.41)	0.56 (0.21- 1.58)
Education		
Educated	1	1
No education	1.24 (1.03-1.51)	1.41 (1.08- 1.84)
Household size		
<7	1	1
≥7	1.34 (0.73- 2.47	0.94 (0.27- 3.23)
Income		
<Ghc20	1.26 (0.36- 4.48)	0.79 (0.45- 1.41)
≥Ghc20	1	1
Number of under 5[3]		
≤ 2	1	1
≥3	0.63 (0.12- 3.27)	0.90 (0.38- 2.16)
Decreasing Rainfall[1]		
Yes	1.26(1.0.2- 1.56)	1.31 (1.13- 1.52)
Increasing Temperature[2]		
Yes	1.03(0.76- 1.41)	0.88 (0.44- 1.77)

Multinomial logistic regression model
[1] *Perceived decreasing rainfall*
[2] *Perceived increasing temperature*
[3] *Number of under five years old children in each household*
[*] *Reference category-Normal BM*

4.8.2 Nutritional status of children in the households

The children's weights and heights were also measured for the calculation of nutritional indicators in order to establish their nutritional status. The anthropometric indicators include height- for- age (HAZ), weight- for- height (WHZ) and weight- for- age (WAZ). Table 4.8 shows that, about a half (57.7%) of the children were normal while 42.3% representing 104 children were stunted. For the weight for height z-score (WHZ), the results indicated 17.5% being wasted. The trend was same for the weight for age z-score (WAZ), with about 24.4% representing 60 of the children being underweight.

The fourth nutritional indicator that was assessed for the children was mid-upper arm circumference (MUAC). The results showed that, 2% of the children were severely wasted. More than half (69.5%) of the children were normal as shown in Figure 4.8.

Table 4.8: Nutritional status children under five years (N= 246)

Variable	n (%)
Height for Age (HAZ)	
Stunted	104 (42.3%)
Normal	142 (57.7%)
Weight for Height (WHZ)	
Wasted	43 (17.5%)
Normal	203 (82.5%)
Weight for Age (WAZ)	
Underweight	60 (24.4%)
Normal	186 (75.6%)

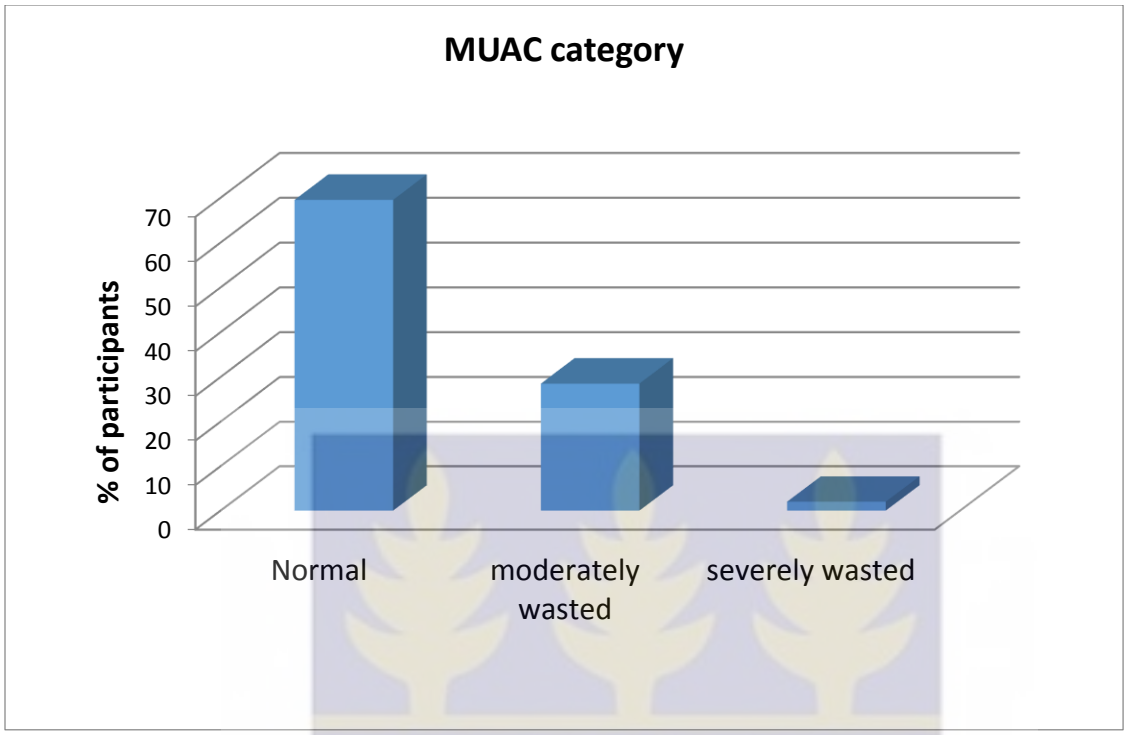


Figure 4.8: MUAC categories of the children

4.8.3 Predictors of stunting, wasting and underweight among children under five years old

Table 4.9 shows that, the odds of children becoming stunted due to decreasing rainfall was 1.21 times high compared to increasing rainfall. No formal education, low income level and large number of children under five years in the households were more likely to make children stunted with the odds ratios of 1.53, 1.49 and 1.59 compared to educated women, smaller number of under five years children in the household and higher income earners.

The odds of children becoming wasted as a result of larger household sizes were 1.33 times higher compared to the smaller household size. Children living in households that have 3 or more children under five year's olds were more likely to become wasted with the odds of 1.16 compared to households with small number (2 or less) of children under five years. The odds of children

becoming wasted as a result of the decreasing rainfall was 2.38 times higher compared with increasing rainfall.

Maternal age was highly associated with children becoming underweight (Table 4.9). The odds of mothers who were in the 31-34 age category was 3.41 times folds higher for children becoming underweight compared to women in the other age group categories. Large household size, larger number of under five years olds in households and decreasing rainfall were also associated with children becoming underweight with the odds ratios of (1.52, 1.67 and 1.02) compared to smaller household size, smaller number of under five children and increasing rainfall.

Table 4.9: Unadjusted and adjusted odds ratios of anthropometric indices of children under five years

Variables	Stunting		Wasting		Underweight	
	Unadjusted OR (95CI)	Adjusted OR (95% CI)	Unadjusted OR (95 % CI)	Adjusted OR (95 % CI)	Unadjusted OR (95 % CI)	Adjusted OR (95 %CI)
Maternal age						
17-24	1	1	1	1	1	1
25-30	1.18 (0.64- 2.19)	1.04 (0.55- 1.98)	0.75 (0.31- 1.82)	0.53 (0.24- 1.19)	0.85 (0.41- 1.79)	0.76 (0.38- 1.51)
31-34	0.59 (0.23- 1.54)	0.50 (0.19- 1.36)	6.39 (0.72- 56.76)	3.67 (0.45- 29.90)	4.27 (0.88- 20.80)	3.41 (0.74- 15.81)
≥35	0.52 (0.25- 1.09)	0.39 (0.17- 0.91)	0.93 (0.32- 2.72)	0.52 (0.22- 1.28)	0.92 (0.36- 2.35)	0.75 (0.34- 1.65)
Education						
Educated	1	1	1	1	1	1
No education	1.04 (0.62- 1.74)	1.53 (0.82- 2.86)	1.64 (1.35- 1.99)	1.42 (1.10- 1.82)	0.69 (0.38- 1.24)	0.67 (0.33- 1.37)
Household size						
<7	1	1	1	1	1	1
≥7	1.16 (0.66- 2.02)	1.10 (0.64- 1.91)	1.54 (0.74- 3.20)	1.33 (0.61- 2.87)	1.53 (0.81- 2.90)	1.52 (0.79- 2.94)
Income						
<Ghc20	1.81(1.25-2.61)	1.49 (0.87- 2.57)	0.60 (0.28- 1.28)	0.58 (0.28- 1.19)	0.82 (0.45- 1.50)	0.81 (0.43- 1.52)
≥Ghc20	1	1	1	1	1	1
Number of under 5[3]						
≤ 2	1	1	1	1	1	1
≥3	1.92 (1.45- 2.53)	1.59 (0.71 -3.58)	1.54 (0.47- 5.06)	1.16 (0.40- 3.94)	1.79 (0.65- 4.88)	1.67 (0.59- 4.79)
Decreasing Rainfall[1]						
Yes	1.44 (0.85- 1.96)	1.21 (0.63 -2.31)	2.64 (1.54- 4.53)	2.38 (0.77- 7.35)	1.21 (1.03- 1.41)	1.02 (0.37- 2.79)
Increasing Temperature[2]						
Yes	0.99 (0.47- 2.05)	1.09 (0.61 -2.43)	0.48 (0.20- 1.16)	0.36 (0.12- 0.99)	0.74 (0.03- 1.60)	0.73 (0.37- 1.47)

Binary logistic regression adjusting for other variables in the table [1] Perceived decreased rainfall [2] Perceived increasing temperature 3 Number of under five years old children in each household

4.9 PREVALENCE OF ANAEMIA AMONG MOTHERS AND CHILDREN

Blood samples were taken from 64 mothers and 64 children in the four communities to establish their anaemia status. In Table 4.10, majority (81.3%) of the women were normal while (18.7%) women were anaemic. Out of the 12 anaemic women, about 8 of them were mildly anaemic. However high anaemia incidence was recorded among the children. About 53 (82.8%) out of the 64 children were anaemic while 11 of them were normal. Out of the 53 anaemic children, 40 (75.5%) were moderately anaemic while 7 were severely anaemic as shown in Table 4.10.

The Pearson chi square (Figure 4.9) shows that the association between the age groups and the anaemia incidence was not significant. However, more anaemia incidence was recorded within the < 12 months age category. The least incidence was recorded within the 37- 59 months age group. About 32% of children in < 12 months age group were anaemic while anaemia incidence was about 11% in the 37-59 months age category.

Table 4.10: Prevalence and degree of aneamia among mothers and children (N= 64)

Variables	n (%)
Anaemia Status (Mothers)	
Normal	52 (81.3)
Anaemia	12 (18.7)
Anaemia Classification (Mothers) n= 12	
Mild	8 (66.7)
Moderate	3 (25)
Severe	1 (8.3)
Anaemia Status (Children)	
Anaemia	53 (82.8)
Normal	11 (17.2)
Anaemia Classification (Children) n= 53	
Mild	6 (11.3)
Moderate	40 (75.5)
Severe	7(13.2)

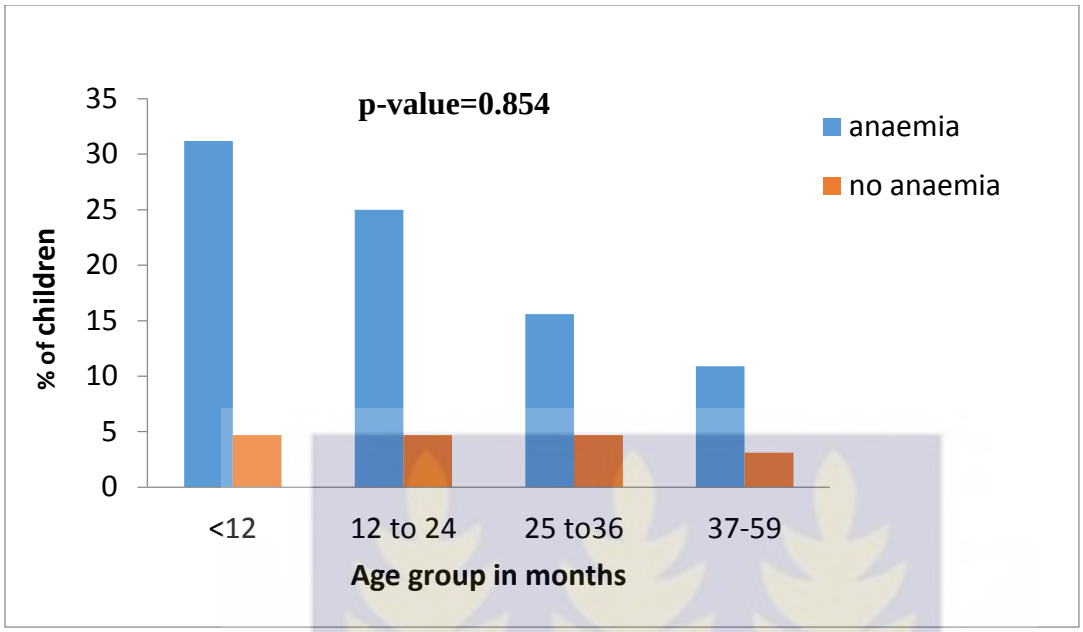


Figure 4.9: Percentage of children with Anaemia according to age

4.10 KEY INFORMANT INTERVIEW

This section presents responses from thirteen (13) key informants. Eight (8) farmers; two males each from Gurigo and Anafobiisi and two females each from Gowrie and Bogrigo. Four (4) agriculture extension officers and one (1) meteorologist. In general their perception on climate change and its impacts on food and nutrition security in their respective communities and the district as a whole was obtained. The key issues discussed were put under three broad themes. These themes were; awareness of climate change, impact of climate change on food production and copping strategies employed to mitigate the impact of climate change on households.

4.10.1 Awareness of climate change

Findings from the study revealed that there was low level of knowledge on what climate change is, most especially among the farmers. Respondents were not able to tell what climate change was. They mentioned harmattan, dryness or the changes in the moon as what climate was. The following were some of the views expressed by the respondents when they were asked, can you please tell me what you know about climate change?

"It is the changes that occur in the moon. Sometimes the moon is dark other times it is bright" (Male respondent, Anaafobiisi).

"Me I don't know oo but people have been saying when our crops are dying then the climate has changed" (Female respondent, Bogrigo).

"Hmmm I know the climate has to do with the weather but I don't know if I can say climate change is the change in the weather" (Agric extension officer, Bongo).

However, some of the technical officers were abreast with what climate change was when asked the same question.

"……it is rainfall, temperatures, humidity and so forth. Climate change of an area therefore is the variation or the change in those things that I already mentioned and how it has changed over the period of 30 years" (Male respondent, meteorological office, Bolga).

The study further explored respondents' knowledge on how the climate has been changing in their respective communities. Findings showed that there was high level of awareness of various changes that were occurring in the four communities. Respondents identified irregular rainfalls, high temperatures, too much heat, drying of rivers, and many more. But the most talked about change that was observed was delayed rainfall/reduced rainfall. The statement below put the views of the participants into perspective when they were asked, how is the climate in this community changing?

"Now we keep shifting the sowing time because you don't know when the rain will come, it delays and stop early too" (Male respondent Gurigo).

"The time I was a child I never experienced much heat than it is now. Now there is too much heat but little rainfall" (Female respondent, Gowrie).

"……formerly planting starts in April, and by June we use to harvest the early millet and by October the late millet and most of the crops are then harvested too, but because of the change in the rainfall pattern nowadays, we plant late. When you plant late the rains stops early and most of the crops do not mature well resulting in low yield. And consequently into food insecurity" (Agric extension officer).

"Of late it look like we have late beginning of rainfalls, compare to former years if I could recall, 10- 5 years ago, the rains set in earlier say March or April there about but now it start around June or even July and is decreasing. Temperatures are also warmer now compare to former times. Around this time we should be experiencing very cold weather now but it warmer than it used to be" (Meteorological officer).

However many of the respondents were not able to mention what the actual cause of climate change is as they attributed the cause to various things including non-observance of taboos, God being angry with them and having sex in the open. But few of them knew what causes climate change. These were some of the answers given when respondents were asked in your opinion what do you think is causing climate change?

"Climate change is caused by human behavior which has made God angry. Some years ago it was a taboo to have sex in an open space. But now people often do it outside. This has made God to punish us by changing the climate" (Male respondent, Anaafobiisi).

"We were told it is global warming but we don't also know what is causing the global warming" (Agric extension officer).

"It is caused by the way we do farming these days. We cut down many trees that is why the climate is changing" (female respondent, Gowrie).

"Bush burning, obsolete vehicles, electronic equipment that we use now disturbs the ozone layer causing the climate to change" (Agric extension officer).

4.10.2 Impact of climate change on food crop production

With regards to the impact of climate change on food crop production, respondent reported the impact of rainfall and temperature on their food crops, and which of their crops were mostly affected. Respondents were of the general view that the extreme weather had had bad influence on their food crop production making them to have low yields. The views expressed by the farmers were highly acknowledged by the technical officers. The following responses illustrate their views, when asked, how was the changing climate affecting food crop production in your community?

"When I was young we do farming with joy because you will harvest plenty and nobody will go hungry till another farming season. Now am 62 years when you farm you get just a little so how can I seriously farm " (Male respondent, Anaafobisii).

"Ten years ago when I plant maize and millet on the small land around this my house, I harvest plenty for food so that we can sell those we grow on the bigger land outside my house but now even the big farm is not yielding talk of the land around my house.. It is not only me, everybody in this community is suffering from bad harvest" (Male respondent, Gurigo).

"It is affecting food production negatively now. People in this community used to have abundant food especially the cereals but now by December, most houses have to start buying food from the market or starve most of the times" (Agric extension officer, Bongo).

On the effect of rainfall and temperature, it spontaneously emerged that low or delayed rainfall and high temperature were the climate variables that were contributing to farmers having poor harvest. Below were their views on the question, how are rainfall and temperature affecting food crop production in this community?

"The dry season has become longer than before. We use to record rainfall in March but now we do not get rains early" (Female respondent, Gowrie).

"Formally the rains comes in March but now it start in May even June sometimes September or October. When the rains comes in June by October then it stops. So those crops that need long period to grow, have little rains so they die (Agric extension officer, Bongo).

"Because of very high temperature, when I even fetch water and pour it on my vegetables and maize they still die" (Male respondent, Anaafobiisi).

All the respondents stated that the most crops that are affected by climate change are the cereals and the legumes making them less available because of poor yields. This was what they said when asked, which food crops are mostly affected by the climate change in this community?

"Almost all the crops but the cereals and the legumes are the most affected. With the legumes if there is no rain around the poding time, the crops does not perform well. Millet too will have small size grains" (Agric officer, Bongo).

"Groundnuts, beans and millet are the ones most affected" (Female respondent, Gowrie).

4.10.2.1 Effect of climate change on food consumption patterns in the households

Regarding how climate change has impacted on the availability of food for consumption in the various communities, respondents were of the general view that climate change has made life difficult for them especially the farmers as they cannot eat three square meals a day. The following

were the answers provided to the question, how is the changing climate affecting the availability of food crops for consumption in this community?

"We don't get enough food to eat because the yield is not high we cannot eat three times in a day because we don't get enough food" (Male respondent, Anaafobiisi).

"It is not simple for my household because of the poor harvest these days. We buy from the market to support what is available we just don't have enough to eat" (Female respondent, Bogrigo).

"*Yields are affected and because yields are affected, the little that they harvest does not take them anywhere. A lot of the households finish what they harvest in October by December" (Agric extension officer, Bongo).*

4.10.3 Coping strategies employed to mitigate the impact of climate change on households

Findings from the study revealed that various coping strategies were employed in the communities to reduce the impact of climate change on the households. Respondents stated that some people migrates to towns and cities for greener pastures, some reduce the size of their meals and others skip meals. This was how they illustrate their views when asked, in case there is poor harvest or less food for the household what do people do?

"Some people do not eat in the morning and afternoons, they only eat in the evenings" (Female respondent, Gowrie).

"……. we do not eat full bowls of t.z again. The women cut it down so that everybody can get some to eat."(Male respondent, Gurigo).

"There is also seasonal migration to some part of the northern region, northern region harvest their crops later than us, and to Brong Ahafo and Kumasi for menial jobs" (Agric officer, Bongo).

4.10.3.1 Methods of food preservation to prevent food shortage

Evidence from the study showed that although many preservation methods were being practiced in the various communities, the most common methods used were, drying, putting dried crops in traditional barns or drying and putting crops in a sack or treat with chemicals. The following were the responses when asked, how do people preserve their food crops to prevent shortage of food in the households in this community?

"After harvesting, we dry and then keep our food in barns" (Female respondent, Gowrie).

"I store some of my food in sacks and treat it with storage chemicals. I also keep my millet in that local barn over there" (Male respondent, Gurigo).

"In this community most of us keep the millet in barns and store the groundnuts and beans in sacks" (Female respondent, Bogrigo).

"They have this traditional barns which are locally made (build) with clay and sticks. They put the crops there after drying and fetch it small small for the women when they need it. Especially the millet and the corn. Some of them use this traditional pots for storage of the cereals and the legumes, some just store them in sacks after drying them" (Agric extension officer, Bongo).

The technical officers mentioned same preservation methods as the farmers revealed such as drying, putting in barns, and storage in sacks. Chemical storage and botanical storage were discussed too although they said they were discouraging the famers from using the chemical storage. This was how they illustrate their view on same question;

"Some use botanical preservation. Botanical preservation is the one that they use the leaves of trees the succulent ones, mix it with the food they want to store especially neem tree leaves. It is done to cereals and legumes" (Agric extension officer).

"They have this traditional barns which are locally made (build) with clay and sticks. They put the crops there after drying and fetch it small small for the women when they need it. Especially the millet and the corn. Some of them use this traditional pots for storage of the cereals and the legumes, some just store them in sacks after drying them" (Agric extension officer, Bongo).

4.11 FOCUS GROUP DISCUSSIONS

Focus group discussions were held to assess the impact of climate change on food and nutrition security on a broader perspective from farmers. These discussions were conducted in Anaafobiisi, Bogrigo, Gurigo and Gowrie. The significant issues discussed were outlined under three broad themes. These include awareness of climate change, impact of climate change on food production and copping strategies employed to mitigate the impact of climate change on households.

4.11.1 Awareness of climate change in the communities

The general knowledge of respondents on what climate change is, was low across the four communities. Almost all participants could not tell what climate change is except one female participant from Gurigo who attempted to answer the question although most of them admitted the climate is changing. Answers such as I don't know, maybe it is when the harmattan is strong, it is the wind or the high sunshine dominated the discussion. These were some of the views expressed by respondents on climate change when they were asked, what do you know about climate change?

"Truly I don't know what climate change is. I only know that the weather is not the same. The sunshine has increased, we have less rain now (Male respondent Gowrie).

I think climate change is when the harmattan is very strong and we can't even talk for fear that our lips will crack……"(Female respondent Gurigo).

"It is all about the irregular rainfall pattern in our community" (Female respondent, Gurigo).

Furthermore, the study sought the opinions of participants on the type of changes observed in the various communities in relation to climate change. Findings showed that almost all the participants were aware of the changes occurring in their communities. Participants were able to identify several types of climatic changes occurring nowadays in their communities. These includes, irregular rainfalls, high temperatures, too much heat and rivers drying up and strong winds blowing. But the most discussed change observed was delayed rainfall. The statements below put the views of the participants into perspective when they were asked, how is the climate in this community changing?

"I think because of this climate change, the Gurigo river has dried up. That river used to be our source of water for cooking, drinking and fishing. Now everything has changed, no rain, only high sunshine" (Female respondent, Gurigo).

"In the olden days, my grandparents used to start farming in March but now we don't because rainy season has shifted to June and it does not rain much as it used to be" (Female respondent, Anaafobiisi).

"Some years ago, it used to be very cold at this time; from December to February but it has just become very warm even in January. The heat is just too much. This may be because of changes in the weather and climate" (Male respondent, Bogrigo).

"Climate change is about how the wind has recently become severe. The wind is always blowing strongly especially during periods of rainfall. It is likely there is too much air in the sky." (Female respondent, Anaafobiisi).

With regards to the causes of climate change, many respondents believed that it was their disobedience to the god's that is why they were being punished. Some also believed that it was because the youths have become disrespectful and also because of their many sins. It was apparent that most participants were aware that the climate is changing in their communities but what was causing the change was misconstrued. Below was how they expressed their views when asked, what is causing this climate change in your community?

"Now our daughters don't get married before they become pregnant. They end up giving birth in the shrines. Since the shrines are responsible for giving us rain and keeping the climate normal, they have changed the climate so that when the sun burn us and we don't get rainfall we will change for better" (Female respondent, Gurigo).

"We commit too much sin, people kill each for money and others have sex in the bush. A lot of us said we are Christians now so we won't send our sacrifice to the shrine. Why won't the god's punish us by changing the climate" (Male respondent, Gowrie).

4.11.2 Impact of climate change on food crop production

Findings from the study showed that the farms of most participants were affected by the changing climate resulting in low yield of food crops. Participants identified poor weather patterns as the cause of having low yields. It was also revealed that climate change has reduced people's interest

in farming due to the lower yield of food crops they get after investing energy, money and time for several months. This was how they expressed their views when they were asked, how has the changing climate affected your farming activities and the food crops grown in this community over the past five years?

"Our yields have reduced. The land does not yield anymore. We don't harvest much so we can't even sell any for money so we buy other things including fertilizer. A lot of people go hungry now including my house people" (Female respondent, Gurigo).

"I even want stop farming but if I stop me and my children will go hungry. We harvest so little now due to bad weather and we don't have money to buy fertilizer too" (Male respondent, Bogrigo).

The study also revealed that the impact of climate change might have been severe on the crops due to other factors such as the rocky nature of the land in Bongo district and the sudden appearance of some new types of grasses which are resistant to any local treatment the farmers knew. These grasses compete with their crops and sometimes kill the crops in the process or give them low yields. This was how the participants put their statement into perspective.

"We have lost much of the agricultural land. This community is rocky and because of the poor rainfall, we can't farm on some parts of our lands"(Female respondent, Anaafobiisi).

"Because of climate change we are seeing new types of grasses on our farms which is affecting the yield of the crops that we cultivate" (Female respondent, Anaafobiisi).

Per the effect of rainfall and temperature on the food crops grown in the various communities, the interview showed that erratic rainfall in Bongo district was the cause of crop failure. All the respondents overwhelmingly acknowledged poor rainfall patterns and high temperature to be the contributing factor to why their food crops have being failing leading to low yields. Some of their views are illustrated below in response to the question, how have the rainfall patterns and temperature affected your food crop production?

"Rainfall is very irregular in our community. This time, we do not get the rain early as it used to be. Our crops are always failing us because they do not get water" (Female respondent, Gurigo).

"The soil living organisms are dead because of high temperature. Because of this, we don't get better yield" (Male respondent, Gowrie).

"Because of high temperature, I stopped doing vegetable farming. The sun just burn all the vegetables I grow, life has become very difficult because of this high temperature" (Male respondent, Bogrigo).

The food crops grown in the four communities are millet, sorghum, rice, maize, sweet potatoes, beans, Bambara beans and groundnuts. Vegetables such as okro, kenaf (bitor leaves), aleefu and ayoyo, tomatoes, onions and pepper are also cultivated. Below were some of the responses from the participants when they were asked, which of the food crops are mainly affected by the changes in the weather pattern in this community?

"Rice, millet, and beans are the most affected because they need regular rainfall to do well" (Male respondent, Bogrigo).

"Early millet, sorghum, rice, beans, Bambara beans and groundnuts are the crops that are affected by this changes in the weather" (Female respondent, Gurigo).

4.11.2.1 Effect of climate change on food consumption patterns in the households

From the study the most used word with regards to the effect of climate change on household food consumption is not having enough food to eat. Majority of the participants revealed that they do not get enough food to eat in their households due to low yields. Below was how some of the respondents put their views into perspective as they provide answers to the question, in which ways has the changing climate affected the type of food people eat and the way they eat over the years?

"Sometimes I don't eat in the morning myself but I give to my children to eat and go to school. The harvest is mostly poor and we don't get enough. Now when you cultivate rice it doesn't yield well" (Female respondent, Anaafobiisi).

"I don't cook plenty because I don't get better yield from the crops I grow. I don't eat plenty like I used to eat. What I do is that, I do not eat in the afternoon" (Female respondent, Gurigo).

4.11.3 Coping strategies employed to mitigate the impact of climate change on households

The study shows that participants employed several methods to survive. These includes selling of their animals so they get money to purchase food, traveling to Bolga, Kumasi or Accra to work for money, depending on relatives for assistance, reducing their meals both in quantity and number of meals eaten per day and also buying from the market to support themselves. The following statements were how the participants illustrated their views when they were asked, how do people in this community cope when harvest is poor?

"We travel to places like Kumasi or Accra to work for money during the dry season so that we can use it to buy more food to support the little that we harvest" (Female respondent, Anaafobiisi).

"In my house the grown-ups eats once a day when we don't have enough food but the children eat in the morning and in the evening" (Female respondent, Gurigo).

"We ask for support from family members so that we can purchase foodstuffs when the harvest is poor or if you have animals you sell them so you can buy food." (Male respondent, Bogrigo).

"For my family we cultivate more beans and Bambara beans which are very good. Normally we eat more of the beans and the Bambara beans during food shortage. When you eat it you take plenty water and you do not get hungry early" (Male respondent, Bogrigo).

4.11.3.1 Methods of food preservation to prevent food shortage in the households

The research revealed different food preservation methods that participants have been using including, drying, putting in sacks or traditional barns after drying, adding chemicals and botanical preservation. However, the most practiced methods were drying, putting in a sack or traditional barns. The illustration below put their expressions into perspective when they were asked, with the current changes in the weather, how do people in this community preserve their food crops in order to prevent shortages in the various households?

"I mostly dry what I harvest and put it in barns. If I have money, then I buy the treated sacks and put them inside." (Male respondent, Gowrie).

"We also boil the leaves of neem trees in water and use the water to sprinkle on the beans, millet or maize so that it is not spoilt"(Male respondent, Bogrigo).

"I dry my food crops and put the groundnut in a pot. As for the millet after drying I hipped them on a mat in the storeroom or sometimes in the barn" (Female respondent, Anafobiisi).

CHAPTER FIVE

5.0 DISCUSSION

This was a cross-sectional survey conducted using mixed methods to examine the impact of climate change on food and nutrition security among households with emphasis on women and children below five years of age in the Bongo district of the Upper East region of Ghana. The study also included assessment of the participants' haemoglobin level. This study was conducted to provide information that would be useful in developing implementable policies on climate change impacts on food and nutrition security.

5.1 TRENDS OF CLIMATE CHANGE IN THE BONGO DISTRICT

In this study using rainfall and temperature variability over a period of thirty (30) years as a proxy for climate change in the district, revealed there was a - 0.3mm decrease in rainfall per annum and 0.005°C increase in maximum temperature. The decreasing trend in the rainfall pattern observed is consistent with the findings documented in the Ghana Policy Journal (2013) which stated that there has been drastic variations in the rainfall patterns after the 19960's. Ghana experienced high rainfall during 1960s after which it drastically reduced in the later part of 1970s and early 1980s. Accumulation of this resulted in the low level of rainfall observed in the country between 1960 and 2006 with mean decline of 2.3mm (GPJ, 2013). Ghana's average yearly temperature is predicted to rise by 1.03.0°C by the end of 2060s, and 1.55.2°C by 2090s, with warming drastically increasing in the northern regions than the coastal regions (GPJ, 2013).

These findings were confirmed by both key informants and the focus group discussion participants when they were sharing their views on how the climate in the district has been

changing in the district. *"Of late it look like we have late beginning of rainfalls, compare to former years if I could recall, 10- 5 years ago, the rains set in earlier say March or April there about but now it start around June or even July and is decreasing. Temperatures are also warmer now compare to former times. Around this time we should be experiencing very cold weather now but it warmer than it used to be" (Meteorological officer).*

"I think because of this climate change, the Gurigo river has dried up. That river used to be our source of water for cooking, drinking and fishing. Now everything has changed, no rain, only high sunshine" (Female respondent, Gurigo).

Darko and Atozona in their study in 2013, explained that northern Ghana is the most susceptible to the erratic weather pattern caused by climatic alterations when compared to other regions in the country owing to its drier and poorer nature. This could be a possible reason for the trends observed in the rainfall patterns and in the maximum temperature over the years in the Bongo district which inevitably impact food security negatively.

5.2 LEVEL OF AWARENESS OF CLIMATE CHANGE IN THE STUDY AREA

Awareness of changes in the atmospheric variables greatly impact on how farmers handle climatic threats and opportunities. The accuracy of their knowledge on these matters and their responses to the climatic threat is important in shaping their adaptation alternatives, the methods to be employed and the adaption outcomes (Pauw, 2013; Debela *et. al.,* 2015). A study conducted by Mutimba *et. al.* (2010) indicated that awareness of climate change especially among rural Kenyans is low. About 44% of Kenyans whose livelihood are dependent on the weather patterns have no knowledge on the climate variability and any alternatives to mitigate its impact. But contrary to

the findings of Mutimba *et. al.* (2010), the level of awareness of climate change among the study participants in this study was high. More than half (62.6 %) of the participants in the household survey were aware of the changing climate in the various communities.

This was corroborated by key informants and focus group discussion participants. This was how they put their views into perspective on awareness of climate change. *"Some years ago, it used to be very cold at this time; from December to February but it has just become very warm even in January. The heat is just too much. This may be because of changes in the weather and climate" (Male respondent, Bogrigo).*

"In the olden days, my grandparents used to start farming in March but now we don't because rainy season has shifted to June and it does not rain much as it used to be" (Female respondent, Anaafobiisi).

However, there were divergence results as to what the causes of climate change could be in the study area. Whereas majority (67.9%) of participants from the household survey attributed the causes of climate change to manmade activities such as bushing burning and cutting of trees in the area, many of the participants in both key informant interviews and the focus group discussions thought their sin and disobedient to God was what was causing the climate to change although few of them agreed with what the household participants stated. The divergent views as reported by the people are stated below.

"It is caused by the way we do farming these days. We cut down many trees that is why the climate is changing" (female respondent, Gowrie).

"Climate change is caused by human behavior which has made God angry. Some years ago it was a taboo to have sex in an open space. But now people often do it outside. This has made God to punish us by changing the climate" (Male respondent, Anaafobiisi).

"Now our daughters don't get married before they become pregnant. They end up giving birth in the shrines. Since the shrines are responsible for giving us rain and keeping the climate normal, they have changed the climate so that when the sun burn us and we don't get rainfall we will change for better" (Female respondent, Gurigo).

While findings from the focus group discussions were in sync with that of the Asia foundation (2012), the results from the household survey were in contrast with same. In their study 46% of the respondents believe that it is God who is changing the climate whiles 31% believe that the action of human beings brought about the changes in the climate. Clearly, superstition continues to be a major determinant within the African context and may partly explain the behaviours observed which science cannot explain.

Many reasons could be ascribed to the findings in this study, either due to educational level of the household participants since more than half (60.2%) of them have some level of formal education, or they might have access to information through the use of technology. Research conducted among small scale farmers in Africa shows that formal educational level of farmers have impact on the way they observe the impact of the changing climate (Mustapha *et. al.*, 2012). Where as many of the focus group participants and key informants who were famers may not have access to new technology such as mobile phones and computers and perhaps may not have formal education,

could be the possible reason for their misconstruing the causes of climate change. Rural households with inadequate access to weather reports are most likely to misconstrue the alterations in the weather patterns especially extreme atmospheric conditions to be non-observance of sacraments and cultural practices (Nyanga *et. al.,* 2011).

5.3 COPING STRATEGIES EMPLOYED BY PARTICIPNATS

Climate change threats on livelihoods and agriculture production have made indigenous people in all places to develop knowledge and skills to help them sustain life in the changing environment. These coping strategies enable them to modify the detrimental effect of the changing climate on livelihoods and life (Field, 2012). Investigation into the copping strategies employed by participants in this study showed that majority (87.4%) reduced the quality and quantity of their diet during shortage of food periods. The findings were similar to results of many studies. For instance a study by the United Nation's Standing Committee on Nutrition found out that weather associated threats consistently push households to adapt to some negative coping mechanisms such as decreasing the quantity and quality of meals, decreasing health and education expenditures in order to acquire food and the sale of vital personal assets (UNSCN, 2010). Another study conducted in Uganda in 2013, showed that reduced crop yields resulting from erratic rainfall have limited peoples access to sufficient food hence some families eat once a day and in food scarcity situations women reduce their own food so as to feed their children and men (MRFCJ, 2013). Also a research conducted by Quaye in 2008 revealed several coping strategies including reduction in the number of meals per day adopted by families in the Upper East region during food shortage periods. About 97% reduced number of meals served per day, while 71.3% sold their fowls to purchase food.

These results were validated by that of the focus group discussion participants and the key informants. "*We do not eat full bowls of TZ again. The women cut it down so that everybody can get some to eat."(Male respondent, Gurigo).*

"Some people do not eat in the morning and afternoons, they only eat in the evenings" (Female respondent, Gowrie).

"We ask for support from family members so that we can purchase foodstuffs when the harvest is poor or if you have animals you sell them so you can buy food." (Male respondent, Bogrigo).

The type of coping strategies adapted by the participants reflects their socio-economic status. The mean monthly income of participants was GH₵ 43.00 which is less done $11.00 per month. This low income status could be as a result of the nature of their occupation where more than half (73.2%) of the women were peasant farmers. This suggests that most of the participants would not be able to afford wide variety of nutritious food. They could only eat what they grew. Significantly, changes in weather patterns could lead to price hikes in major staple crops. The poorest people whose incomes are affected by reduced crop yields end up spending larger portion of their earnings to purchase foodstuff and would have to make extra effort to meet their nutritional requirement (WFP, 2012a). In Yemen for instance, about one-quarter of the population borrow money to purchase food due to poverty under difficult climate change scenarios hence increasing the debt toll on households (WFP, 2012c). The resultant impact of these coping strategies could be poor health and loss of revenue (Porter *et. al.*, 2014).

5.4 HOUSEHOLD FOOD CONSUMPTION PATTERNS AND DIETARY CHANGES IN RELATION TO CLIMATE CHANGE

Observations from this study showed that as rainfall decreased the yields of certain crops decreased as well. For instance in 2011 when mean rainfall decreased from about 90mm to about 62mm, the yields of rice dropped with a difference of a 0.9 Ton/Ha. Rice yields decreased from 2.8 Ton/Ha to about 1.9 Ton/Ha, millet yields were halved from 1 Ton/Ha to about 0.5 Ton/Ha over the same period. Groundnut yields were almost halved from 0.8Ton/Ha to about 0.5Ton/Ha and the yields of maize decreased from 1 Ton/Ha to about 0.7 Ton/Ha (Figure 4.3). This could explain why about a half (57.3%) of the participants consumed less of these crops over the previous five years. In addition, chi-square analysis (Figure 4.4) done between specific crops whose consumption was reducing in the households and reasons given for the reduction shows a significant association (P = 0.001). This reduction in crop yields could also be the reason for the choice of most frequent coping strategies adopted by majority of the participants (reduction in quality and quantity of diet). Since their main meals are prepared from millet, maize and groundnut and these are less available due to low yields.

This is consistent with the findings of the World Food Programme (2012a) and Springmann *et. al.* (2016). Observations of WFP suggest that weather variability could have effect on calorie consumption through its impact on food security most especially from drought. The cumulative effect is change in dietary diversity and decrease in food consumption with persisting adverse impact on stunting. The impacts of climate change are predicted to decrease the quantity of harvested foods which may result in the rise of food prices leading to reduction in food consumption. This could increase the number of people suffering from malnutrition most especially the vulnerable. Interestingly World Food Programme's research in the Northern regions

of Ghana evidently indicated that, poor households are most likely to consume poor or low nutrient diets due to the impact of climate change on food crop production. To them food consumption is not eating for good health but eating to survive (WFP, 2012b).

The above findings were substantiated by the key informants and the focus group discussion participants. *"We don't get enough food to eat because the yield is not high we cannot eat three times in a day because we don't get enough food" (Male respondent, Anaafobiisi).*

"*Yields are affected and because yields are affected, the little that they harvest does not take them anywhere. A lot of the households finish what they harvest in October by December" (Agric extension officer, Bongo).*

5.5 HOUSEHOLD FOOD SECURITY

Food insecurity is one of the greatest difficulties that the continent of Africa faces. According to World Food Programme, majority of the food insecure people reside in the poorest and low areas of Asia, Latin America and Africa, where anthropogenic conditions and the changing climate will most likely worsen the current danger to food security (WFP, 2012a). Results from this study showed that almost all (97.2%) of the households were food insecure. Majority (89.4%) perceived that rainfall over the past five years had been decreasing. While 84.7% of the participants' also perceived increasing temperature of the same period. Similarly, data from Ghana Meteorological Agency (GMet) on rainfall and temperature from 1986 to 2015 has confirmed the perceptions of the participants as rainfall variability was decreasing at – 0.3mm and maximum temperature increasing marginally at 0.005°C per annum. These climate variables are the major determinants of crop production hence food security and could explain why greater number of the households

were food insecure. The findings complement what Rosegrant *et. al.* (2008) stated in their study. It was evidence in their findings that the changing climate alone could lead to the rise in number of most food insecure in Africa up to 170 million people by 2080. Statistics in Ghana also shows that 2 million of the population are at risk of becoming food insecure and majority of these people are situated in Northern, Upper East and Upper West Regions (Ahwoi, 2011).

Findings from the focus group discussions and the key informant interviews upheld similar views of low crop yields. *"Ten years ago when I plant maize and millet on the small land around this my house, I harvest plenty for food so that we can sell those we grow on the bigger land outside my house but now even the big farm is not yielding talk of the land around my house.. It is not only me, everybody in this community is suffering from bad harvest" (Male respondent, Gurigo).*

"Our yields have reduced. The land does not yield anymore. We don't harvest much so we can't even sell any for money so can we buy other things including fertilizer. A lot of people go hungry now including my house people" (Female respondent, Gurigo).

"Because of high temperature, I stopped doing vegetable farming. The sun just burn all the vegetables I grow, life has become very difficult because of this high temperature" (Male respondent, Bogrigo).

Further analysis done to access the impact of climate change on food insecurity among the households showed that those who experienced decreased rainfall were more likely to be food insecure (OR =3.96; CI= 0.56 – 27.81). The reasons for this could be that these people might have had low crop yields already due to the impact of the weather hence may not have sufficient food

available for consumption. Other associated factors to household food insecurity were the educational level of the participants, the number of household members and women who were 35 years and above (Table 4.6). The odds of women who were 35 years and above were 1.5 times more likely to be food insecure (OR= 1.5; CI = 1.21- 1.87; P = 0.05).

The relationship between no formal education and food insecurity could be due to their inability to access or apply information on appropriate farming technology which could help improve their crop yields leading to low yields hence they are more food insecure. With low crop yields, larger households are faced with the challenge of food availability which could translate into reduction in the quantity for consumption hence food insecurity. At 35 years and above, the strength of women for active farming could have been reducing making them unable to cultivate food crops on a large scale. This, coupled with extreme weather conditions such as decreasing rainfall and increasing temperature could have resulted in having less crop yields and consequently become food insecure. In accordance with a report by WFP (2012), climate change through its extreme weather events such as drought, floods and increase temperatures may prolong growing seasons of crops and erratic rainfalls can adversely impact on availability of food through variation in crop yields as well as loss of productive land for agriculture purposes.

5.6 NUTRITIONAL STATUS OF WOMEN AND CHILDREN IN THE HOUSEHOLDS

5.6.1 Nutritional status of women in the households

Many developing nations are experiencing nutrition transition which affects patterns of nutritional behaviour including over consumption of energy dense cheap foods such as carbohydrates and oils

which are being incorporated into indigenous diets even among the rural folks. These are factors which can highly determine underweight, overweight and obesity among women (Keding *et. al.*, 2013). The related health problems connected with overweight and obesity in developing countries is alarming. It has been projected that more than one billion adults were overweight and 475 million were obese worldwide and majority of these lives in Latin America, Africa and Asia (Little *et. al.*, 2016).

In this study, more than half (61.4%) of the women had normal body mass index (BMI), thus having BMI between 18.5kg/m² and 24.9kg/m². About 5% were underweight, 24.4% were overweight and 9% were obese, combing the latter two, participants with BMI above 25kg/m².were 33.4% which was more than a quarter of the participants. The findings are comparable to a research done by Keding *et. al.* (2013) in three rural districts of Tanzania. Assessing BMI among 210 women aged 17 to 45 years in central and northeastern Tanzania, they found 71% of the women to be normal, 16% overweight, 6 % obese and 7% underweight. Another research conducted in rural regions of southern India found similar trends. BMI examination among the rural women shows 14.9% of them were overweight and 16.1% were obese (Little *et. al.*, 2016).

The high BMI being recorded among women even within rural settings must raise a serious concern because overweight and obesity are risk factors of several non-communicable diseases such as high blood pressure, strokes, cardiovascular diseases and metabolic syndrome (Chan & Woo, 2010). These are rapidly becoming a public health issues in both low- income and middle income nations who apart from losing its active man power to these illnesses, have to spend substantial amount in treating them (Chan & Woo, 2010).

But this could be nutrition transition occurring due to rural-urban migration (Popkin *et. al.*, 2012). Migration was reported by the focus group discussion participants and the key informants to be part of the coping strategies employed by many of the women in Bongo. They travel down to cities during the long dry season in search of menial jobs to support their families back home. They might have picked up some of the nutritional behaviours in the cities such consumption of fast foods which are heavy laden with cheap oils, lot of sugar, and mainly carbohydrate based (Popkin *et. al.*, 2012). Another possible reason could be due to less physical activity. After food crops are harvested in September, they might have been engaged in less strenuous work making them sedentary hence adding on weight.

Further analysis performed to evaluate the impact of climate change on the weight of the women in the household showed that decreasing rainfall and low income were associated with underweight and overweight among the women whereas larger household size was associated with underweight only (Table 4.7). The possible reasons for this could be that larger households would not be able to eat adequately under decreasing rainfall which might have decreased their crop yields also. Low socio-economic status implies less access to adequate nutritious diet. Which could make the women underweight due to starvation or overweight due to over consumption of unhealthy foods.

The adverse impact of climate change will be most felt by the poor and the highly susceptible which includes women and children in the neglected areas. This stem from their greater exposure to climate change disasters and their direct reliance on natural resources that are sensitive to the changing climate coupled with low ability to adapt and cope with the stress of the changes in the

weather patterns (UNSCN, 2010). Also socio-economic status is likely to influence the outcome of odds of undernutrition or overnutrition (Little *et. al.,* 2016).

5.6.2 Nutritional status of children under five years in the households

In most developing nations, undernutrion remains a leading public health problem but has been given less attention. Research specified that in all developing nations, almost 165 million children below 5 years are stunted thus having low 'height-for-age' (WFP, 2012). Results from this study shows that 42.3% of the children under five years were stunted, 24.4% were underweight and 17.5% were wasted (Table 4.8).

Findings in this study were consistent with a compilation of undernutrion among children aged 0-59 months in some selected Africa countries by Sanderson and Auricht (2012). They established that, stunting rate in Burundi was 57.7%, underweight was 28.8% and wasting 5.8%. The rates in Rwanda and Malawi in the same year were not too different; stunting in both countries were 44.2% and 47.7%, underweight was 11.4% and 12.8% respectively. Wasting in both countries were 2.8% and 4.0%. Similarly, stunting rates in Ethiopia and Mozambique 44.4% and 42.6%, underweight was 28.7% and 14.9% whiles wasting was 9.7% and 5.9% respectively. In another study findings shows that, almost half (47%) of all children below five years old in Yemen are persistently malnourished whiles another 13% experienced acute malnutrition (WFP, 2012c).

The results of this study were far above the national undernutrition rates established by Multiple Indicator Cluster Survey (MICS) conducted in Ghana in 2011. MICS indicated that about 30% of children below five years were stunted, 16% were underweight and 7% were wasted. Another

disparity to findings in the present study were that of Ghana Demography and Health Survey (GDHS) in 2014. GDHS's results shows that out of 118 children below five years in Upper East region, 14% were stunted, 10.8% were underweight and 9% were wasted (GDHS, 2014).

The outcomes of the nutritional indicators among the children in this study were very distressful and indicates critical public health problem which requires rapid and stringiest measures from all the bodies concern to alleviate the problem and help save the future of the next generation. The percentages of stunting, underweight and wasting in this study were all within World Health Organizations established prevalence cut-off values for public health significance. According to WHO values, stunting ≥ 40% indicates very high prevalence rate among the population, underweight between 20-29 % shows high prevalence and wasting ≥ 15% specifies critical public health issue (WHO, 2010).

Comparing the malnutrition rate among mothers and children in this study and its public health consequences, we could suggest that feeding and care practices were inadequate hence contributing to the high percentage of children who were undernourished. According to UNSCN, malnutrition either due to macro- or micro-nutrient insufficiencies is caused by inadequate dietary intake and illnesses resulting from food insecurity. It could also be due to inadequate maternal and child health practices and poor access to potable water and safe food and good sanitation (UNSCN, 2010).

Additional analysis done to assess the impact of climate change on the nutritional status of children in the study associated decreasing rainfall, maternal age 31-34, low income, larger household size

and mothers who had no formal education to stunting, wasting and underweight among the children (Table 4.9). At 31-34 years, women are very active and might be involved in farming activities since majority were farmers and could not have adequate time to care or feed their children. It could be a possible reason why their children were wasted. Wasting connotes current or acute nutritional status where children fail to gain sufficient weight for their height which could be consequences of poor food intake or severe illness. Underweight among the children may be predicting chronic as well as acute malnutrition due to insufficient care practices.

Largely, formal education or illiteracy play a critical role in how parents care for their children, the latter could have more devastating effect on the growth of children. Those women might not have had access to adequate information or might not understand the effect of some of their care practices on the development of their children. Hence might have over a long period not been properly feeding the children with nutritious diets in a hygienic environment which could be a contributing factor to the children becoming stunted signifying past growth failure or chronic malnutrition.

Moreover, within a larger household size and many children below five years of age, with little resources such as money and food which could be the resultant effect of low crop yields due to decreasing rainfall, there could be reduction in quality and quantity of available food for consumption by all household members. This could account for the choice of most frequent coping strategy adopted by majority of the households (reduction of quality and quantity of diets). It could be a possible explanation to why children whose mothers have low income and yet have many children below five years of age become stunted, wasted and underweight. Another possible

explanation could be that the children were born during extreme climatic conditions such as decreasing rainfall and increasing temperature which might have affected crop yields negatively so the women could not get enough food to feed the children over a period of time leading to stunting, wasting and underweight.

For instance, in Niger, the probability of becoming malnourished was stated to have more than double for children between the ages of 1-2 years who were born during long spell of dryness. There is also 55.5% risk of these children experiencing undernutrition as far as they are born during climate change crises regardless of the areas where they are born (WFP, 2012a). In Ethiopia, 35.5% of children born in climatological disaster locations are most likely to become malnourished and another 41% will most likely become stunted (WFP, 2012a).

Furthermore, the multitask roles played by women make it quite difficult in terms of apportioning time. Farming activities doubles the workload of women with the changing climate degrading many lands and drastically impacting food security, women spent more time tilling lands hence having reduced time left for caring for their children (GIZ, 2013). In the Northern part of Ghana, the capacity of women as food producers and care providers is greatly threatened under climate change regimes as women have to trek far distances in search of potable water, land and wood for home chores and for agricultural purposes. Many women who could not engage in the search for these vital resources end up having serious issues with their husbands resulting in divorce (Akudugu *et. al.*, 2012).

5.7 PREVALENCE OF ANAEMIA AMONG MOTHERS AND CHILDREN

Anaemia hinders health and well-being of women and escalates the hazards of maternal and neonatal negative outcomes. Importantly the consequences of anaemia on the development and total well-being of children are dreadful and must not be treated lightly. Children below two years of age having severe anemia as a result of iron deficiency, are at higher risk of death and those under two years having mild form of anaemia even if corrected, could have their cognitive permanently damaged which leads to reduced learning capacity and short memory. Children who have anaemia on average have IQs that are two points lower per every 10 g/L decrease in hemoglobin (www.k4health.org).

In this study, haemoglobin level was determined for a quarter (25%) of the population (246) of the women and children. Of this 18% of the women were anaemic (Hb<12g/dl) with 8.3% being severely anaemic. Anaemia prevalence was high among the children (82.8%) with 13.2% being severely anaemic (Table 4.10). The findings in this study were parallel to that of Sanderson and Auricht (2012) in Mozambique. Their results indicated that, 70% of children between the ages of 6-59 months were anaemic with 4% being severely anaemic. The prevalence of anaemia among the women (aged 15-49) was 54% with 2% being severely anaemic.

Another study conducted by UNICEF in Northern Ghana also revealed that more than 80% of children were anaemic (UNICEF, 2011). The results in this study were also consistent with that of GDHS conducted in 2014. In their report, 39.6% of women (15-49 years) were anaemic out of 181 in Upper East region of Ghana. About 31.2% were mildly anaemic, 8% were moderately anaemic and none was severely anaemic. Furthermore, 73.8% of children aged 6-59 months were anaemic.

About 40.5% were moderately anaemic, 30.7% were also mildly anaemic and 2.6% severely anaemic (GDHS, 2014).

The anaemia prevalence documented in this study among the women (18.7%) constitute a public health significance according to WHO (2010) prevalence cut-off values (5.0-19.9%). The high prevalence of anaemia among the children (82.8%) which was ≥ 40.0% signifies severe public health problem. The high prevalence rate of anaemia among the children below five years of age could be either due to inadequate dietary consumption most especially diets rich in micronutrients such as iron and vitamin C. Inappropriate child care practices (young child feeding practices) or feeding the children in unhygienic environment with unclean utensils due to lack of education, could be a possible explanation to the high prevalence of anaemia observed among the children. In this study the results also shows that anaemia decreases with increasing age of the children and high incidence of anaemia occurred within children who were less than one year. Suggesting that as children grew they were able to feed themselves without the assistance of their mothers who might not have adequate time to spend feeding them properly.

Anaemia is another ramification of the weather extremes and its negative impact on food availability and accessibility hence inadequate consumption of foods that is rich in iron most especially in the vulnerable areas. In agreement, the World health Organization states that the principal risk factors for iron-deficiency anaemia is insufficient dietary intake of iron or poor absorption of iron from diets rich in phytate or phenolic compounds. The most susceptible to iron –deficiency anaemia are women of reproductive age, expectant women, young children and less educated people (WHO, 2010).

5.8 IMPLICATION OF THE STUDY FOR NUTRITION AND HEALTH

The results in this study have a number of critical public health implications within and beyond Bongo district. Findings demonstrated that the nutritional indicators stunting (42.3%), wasting (17.5%) and underweight (24.4%) among the children under five years, were of serious public health concern based on World Health Organization (2010) prevalence cut- off values. Besides there was high incidence of anaemia among the children. With these knowledge, health workers should intensify education on appropriate young child feeding practices and care. This could be done using local food basket which could include dark leafy vegetables rich in iron and other micronutrients. Vegetables such as ayoyo, kenaf (bittor leaves), baobab leaves and including legumes and cereals.

The study also revealed an emerging issue of double burden of malnutrition. While the children were undernourished, overweight and obesity among the mothers were increasing. Hence in addition to routine child health education, mothers should also be counseled on the implication of excessive weight gain on their health including the development of cardiovascular diseases, hypertension, diabetes and strokes.

Issues concerning family size, income generation and good environmental hygiene practices should be tackled during the counseling since they influence nutritional status of both children and adults. Also almost all the households were food insecure as showed by this study and as confirmed by the focus group discussion participants and key informants, decreasing rainfall and increasing temperature have affected crop yields. As larger number of the people in the district are farmers, new and appropriate farming technologies that could boost crop yields is essential. Understanding

the impact of climate change and its effect on human lives is very important in developing and shaping our national policy on nutrition and health.

Therefore this study may help improve the quality and intensity of nutrition education in the district. Overall, finding in this study may help inform national growth monitoring policy in assessing the magnitude of malnutrition among children below five years most especially in rural areas and for planning intervention programmes. Furthermore, in forecasting and projecting how the next decades and centuries will look like under climate change regimes in relation to food and nutrition security, data from this study may be of great value.

5.9 LIMITATION OF THE STUDY

Even though the study was done carefully based on experimental standards set by World Health Organization (WHO) and with minimized human errors, some limitations to the study were inevitable and may have implications on the results. The findings showed that almost all the households were food insecure and data gathered from household survey, key informants and focus group discussion participants attributed it to the impact of climate change in the form of decreasing rainfall and increasing temperature resulting in low crop yields. Although their perceptions were affirmed by 30 years data on rainfall which was decreasing at – 0.3mm and maximum temperature increasing by 0.005°C from Ghana Meteorological Agency in the Bongo district, we did not perform any soil fertility test neither did we collect information on the usage of agrochemical inputs such as fertilizers and improve seeds. It must be appreciated that these aforementioned elements could affect food crop production and yields (GPJ, 2013). In this regards we cannot solely attribute the decrease in crop yields to the extreme climate events alone.

In another instance, findings of the study revealed high anaemia incidence among the under five years old children in the district. But we could only assessed haemoglobin level for quarter of the participants (64 women and 64 children) due to limited financial resources. It must be reiterated that other confounding factors such as worm infestation, malaria and genetic factors such as sickle cell may have influenced the level of haemoglobin among the children which this study did not control for (GDHS, 2014).

Also this study did not measure actual household food consumption such as weighed food methods, taking into consideration available food in stock over a certain period in the determination of changes in consumption patterns. Using 24- hour recall and how climate change has impacted on their food consumption pattern to assess household food consumption may have introduced some level of bias into the findings since it was dependent on the memories of the participants.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusion

From the present study the following inferences could be made:

Awareness of climate change in the Bongo district was evident with majority (89.4%) of participants stating to have observed decreasing rainfall over the past five years which has affected crop yields.

This observed trend affected consumption patterns of participants due to food shortage, hence, most people (87.4%) reduced the quantity and quality of their food as coping strategy to make up for the reducing food stores.

Almost all (97.2%) of the study participants were food insecure and this reflected in the nutritional status of children under five years and women in the study area such that about 42.3% of the children were stunted, 24.4% underweight and 17.5% were wasted. About 33.4% of the women had BMI above 25kg/m².

The prevalence of anaemia was also high (83%) among the children under five years with the incidence higher among children < 12 months.

Clearly decreasing rainfall at a rate of – 0.3mm per annum was associated with decreasing crop yields, household food insecurity, changes in dietary consumption patterns, and nutritional status of both mothers and children in the district. Evidently, climate change has a negative impact on food and nutrition security in the Bongo district.

6.2 Recommendation

For further study

- Findings in this study should serve as baseline for future research into food and nutrition security among households in Bongo. Detailed study ought to be done to measure the effect of climate change on the actual household food consumption using other approaches such as weighed food methods and be conducted over a long period of time.
- A study into young child feeding practices in the district should be conducted to determine its relationship with anaemia and malnutrition. Also a comprehensive anaemia assessment should be done among children below five years controlling for confounding factors such malaria and worm infestation.
- In depth research should be conducted combing impact of climate change, soil fertility, agrochemical input usage and modern technology on food crop production in the district.

For policy formulation for public health practice

- Due to the consequence of undernutrition among the children under five years, immediate action should be taken to ensure thorough monitoring to assess the magnitude of malnutrition in the district over time.

- Policy makers should collaborate with NGO's that are involved in community based management of acute malnutrition to plan an intervention programme for children below five years in the district. The women should also be trained and assisted to go into small scale vegetable farming around their houses to help improve the dietary diversity of the whole household especially the children.
- In-service training for health workers especially those working in the rural communities should be provided to equip them with new skills and information on nutrition education (appropriate young child feeding practices, care and environmental hygiene).
- In view of the fact that more than a quarter of the participants did not know what the causes of climate change were, there is the need to increase awareness on the causes of climate change. Hence the meteorological department in the region should be equipped with modern amenities and technology that will help in dissemination of information on the climate with high precision.
- In the long term, communities in the district should be assisted with irrigation facilities for mechanized agriculture during the long dry season. Apart from improving food production, it will also help curb the rural-urban migration of the youth to the southern part of the country.
- Findings in this study will help in the formulation of implementable national policies that will strategically help improve nutrition and food security among women and children below five years most especially in the rural areas of Ghana.

REFERENCES

Abubakari, F., & Abubakari, F. (2015). Effects of climate changing on food crop production system in Ghana. *Academic Research Journal of Agricultural Science and Research*, *3*(4), 76-79.

ACF (2014).Available at http://www.actionagainsthunger.org/sites/default/files/publications/Briefing_paper_Who_cares_about_the_impact_of_climate_change_on_hunger_and_malnutrition_03.2014.pdf on January 2016

Ahwoi K. (October 10, 2011). Available at http://thechronicle.com.gh/climate-change-threatens-ghana%E2%80%99s-food-security/ on January 2016.

Antwi A. (2013). Climate change and food security: An overview about the issue. Available at https://www.library.fes.de/pdf-files/bueros/ghana/10518.pdf on January 2016.

Akudugu, M. A., Dittoh, S., & Mahama, E. S. (2012). The implications of climate change on food security and rural livelihoods: Experiences from Northern Ghana. *Journal of Environment and Earth Science*, *2*(3), 21-29.

Alcamo J., Dronin N., Endejan M., Golubev G., Kirilenkoc A. 2007. A new assessment of climate change impacts on food production shortfalls and water availability in Russia.*Global Environ. Change – Hum. Policy Dimens.* 17, 429–444

Beddington, J., Asaduzzaman, M., Fernandez, A., Clark, M., Guillou, M., Jahn, M., & Scholes, R. (2012). Achieving food security in the face of climate change: Final report from the Commission on Sustainable Agriculture and Climate Change.

Beddington, J. R. (2011). *The Future of Food and Farming: Challenges and Choices for Global Sustainability;[final Project Report of the UK Government Foresight Global Food and Farming Futures]*. Government Office for Science. Available at

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/288329/11-546-future-of-food-and-farming-report.pdf on March 2016.

Black, R.E., Allen, L.H., Bhutta, Z.A., Caulfield, L.E., de Onis, M., Ezzati, M., Mathers, C. and Rivera, J. (2008). Maternal and child undernutrition: global and regional exposures and health consequences. *Lancet.* 371(9608): 243-260.

Chan, R. S., & Woo, J. (2010). Prevention of overweight and obesity: how effective is the current public health approach. *International Journal of Environmental Research and Public Health*, *7*(3), 765-783.

Change, C. (2007). Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Available at www.**ipcc**.ch/publications_and_data/ar4/syr/en/contents.html on March 2016.

Coates, J., Swindale, A., & Bilinsky, P. (2007). Household Food Insecurity Access Scale (HFIAS) for measurement of food access: indicator guide. *Washington, DC: Food and Nutrition Technical Assistance Project, Academy for Educational Development*.

Costello, A., Abbas, M., & Allen, A. (2009). Managing the health effects of climate change.(vol 373, pg 1693, 2009). *Lancet*, *373*(9682), 2200-2200.

Creswell, J. W., & Clark, V. L. P. (2007). Designing and conducting mixed methods research. Sage, Thousand Oaks, California

Daniel, W. W. (1999). Biostatistics: A Foundation for Analysis in the Health Sciences, 7th edR Wiley. *New York*.

Darko, E., & Atazona, L. (2013). Literature review of the impact of climate change on economic development in northern Ghana, opportunities and activities. *Overseas Development Institute*.

Debela, N., Mohammed, C., Bridle, K., Corkrey, R., & McNeil, D. (2015). Perception of climate change and its impact by smallholders in pastoral/agropastoral systems of Borana, South Ethiopia. *SpringerPlus*, *4*(1), 1-12.

De Pinto, A., Demirag, U., Haruna, A., Koo, J., & Asamoah, M. (2012). Climate change, agriculture, and food-crop production in Ghana.

Dube, T., & Phiri, K. (2013). Rural livelihoods under stress: the impact of climate change on livelihoods in South Western Zimbabwe. *Dube, T. & Phiri, K.(2013), Rural livelihoods under stress: The impact of climate change on livelihoods in South Western Zimbabwe, American International Journal of Contemporary Research*, *3*(5), 11-25.

Edame, G. E., Ekpenyong, A. B., Fonta, W. M., & Duru, E. (2011). Climate change, food security and agricultural productivity in Africa: issues and policy directions. *International journal of humanities and social science*, *1*(21), 205-223.

FAO (2000). The state of food insecurity in the world. Available at www.**fao**.org/docrep/x8200e/x8200e00.htm on March 2016.

FAO (2008). Climate change and food security. Available at http://www.fao.org/forestry/15538-079b31d45081fe9c3dbc6ff34de4807e4.pdf. on March 2016

FAO (2011). Guidelines for measuring household and individual dietary. Available at *www.**fao**.org/fileadmin/user_upload/wa.../**FAO-guidelines-dietary-diversity2011**.pdf* on January 2016.

FAO (2012). The state of food insecurity in the world. Available at www.fao.org/docrep/016/i3027e/i3027e.pdf on March 2016.

FAO (2015). Climate change, food security and Nutrition| Global forum on food. Available at http://www.fao.org/fsnforum/activities/discussions/climate-change-and-fsn on March 2016.

FCCC, U. (1992). United Nations Framework Convention on Climate Change. 1992. *Available on the Internet: http://www. unfccc. de*. on January 2016.

Field, C. B. (Ed.). (2012). *Managing the risks of extreme events and disasters to advance climate change adaptation: special report of the intergovernmental panel on climate change*. Cambridge University Press.

Fuentes, R., and Seck, P. (2007) *The short-term and long-term human development effects of climate-related shocks:Some empirical evidence.* New York: UNDP

Gepts P, Izaurralde C, Nelson G.J, Rosenzweig C (2010). How will climate change affect agriculture? Available at https://www.soil.org/files/Science-policy/caucus/…./Climate-change.pdf on March 2016.

GAWU (2012). Climate change and its impacts on the livelihood of farmers and Agriculture workers in Ghana. Available at *library.fes.de/pdf-files/bueros/**ghana**/10510.pdf*

GDHS (2014). Key indicators. Available at www.statsghana.gov.gh/.../Ghana%20DHS%20**2014**%20-%20KIR%20-

GPJ (2013). Climate change in Ghnana: Impacts on Agriculture and Policy implications. Available at *ieagh.org/wp-content/uploads/2014/07/gpj-v5-n4.pdf* on March 2016.

Ghana MICS (2011). Available at www.unicef.org/**ghana**/**Ghana**_MICS_**Final**.pdf on March 2016.

Ghana Statistical Service (2010). Population and Housing Census District Analytical Report, Bongo District. Available at www.stats**ghana**.gov.gh/.../**2010**phc/**Census2010**_Summary_report_of_final_results.p.. on March 2016.

GIZ (February, 2013). Gender and rural development. Available at: https://www.giz.de/…./giz2012-en-gender-and rural development.pdf on March 2016.

Guest, G., Macqueen, K., & Namey, E. E. (2012). *Applied Thematic Analysis*. Thousand Oaks CA: SAGE Public.

Held, I. and Soden, B.J. (2006) Robust responses of the hydrological cycle to global warming. *J Climate.* 19, 21. 5686-5699

HLPE (June, 2012). Food security and climate change. Available at www.fao.org/.../**hlpe**/**hlpe**.../**HLPE**.../**HLPE**-Report-3-Food_security_and/ On March 2016.

IPCC (2007c). Floods and droughts- AR4 WGII Chapter 3: Available at http://www.ipcc.ch/publications_and_ data /ar4/wg2/en/ch3s3-4-3.html. on March 2016.

IPCC (2014). Climate change 2014 Synthesis report summary. Available at https:www.ipccch.df/assessment-report/AR5_SYR_Final_spm.pd. on March 2016.

Kanchanaraksa S. (2008). Cross-Sectional studies. Available at http://ocw.jhsph.edu/courses/fundepiii/PDFs/Lecture15.pdf. on April 2016.

Keding, G. B., Msuya, J. M., Maass, B. L., & Krawinkel, M. B. (2013). Obesity as a public health problem among adult women in rural Tanzania. *Global Health: Science and Practice*, *1*(3), 359-371.

Kennedy, G., Ballard, T., & Dop, M. C. (2011). *Guidelines for measuring household and individual dietary diversity*. Food and Agriculture Organization of the United Nations.

Kettlewell, P.S., Sothern, R.B. and Koukkari, W.L. (1999) 'UK wheat quality and economic value are dependent on the North Atlantic Oscillation.' *J Cereal Sci.* 29: 205-209

Le Treut, H., Somerville, R., Cubasch, U., Ding, Y., Mauritzen, C., Mokssit, A., & Prather, M. (2007). Historical overview of climate change.

Li, Y., Ye, W., Wang, M., & Yan, X. (2009). Climate change and drought: a risk assessment of crop-yield impacts. *Climate Research*, *39*(1), 31-46.

Little, M., Humphries, S., Patel, K., & Dewey, C. (2016). Factors associated with BMI, underweight, overweight, and obesity among adults in a population of rural south India: a cross-sectional study. *BMC obesity*, *3*(1), 1.

Lobell, D. B., Schlenker, W., & Costa-Roberts, J. (2011). Climate trends and global crop production since 1980. *Science*, *333*(6042), 616-620.

Mahmood, S. A. I. (2012). Impact of Climate Change in Bangladesh: The Role of Public Administration and Governments Integrity. *Journal of Ecology and the Natural Environment*, *4*(8), 223-240.

MRFCJ (2013). Available at http://www.mrfcj.org/resources/the-gender-dimensions-of-food-and-nutrition-security-in-the-context-of-climate-change-in-uganda-second-edition/ on March 2016.

Mustapha, S. B., Sanda, A. H., & Shehu, H. (2012). Farmers' perception of climate change in central agricultural zone of Borno State, Nigeria. *Journal of Environment and Earth Science*, *2*(11), 21-27.

Mutimba, S., Mayieko, S., Olum, P., & Wanyama, K. (2010). Climate change vulnerability and adaptation preparedness in Kenya. *Heinrich Böll Stiftung. East and Horn of Africa*, 61.

NCDHR (2013). Available at http://www.ncdhr.org.in/daaa-1/daaa-publication/NCDHR%20Climate%20Change%20%281%29.pdf on January 2016.

Neuman, L. W. (2002). Social research methods: Qualitative and quantitative approaches.

Nyanga, P. H., Johnsen, F. H., Aune, J. B., & Kalinda, T. H. (2011). Smallholder farmers' perceptions of climate change and conservation agriculture: evidence from Zambia. *Journal of Sustainable Development*, *4*(4), 73.

Olsen, C., & St George, D. M. M. (2004). Cross-sectional study design and data analysis. *College Entrance Examination Board*.

Pangaribowo, E. H., Gerber, N., & Torero, M. (2013). Food and nutrition security indicators: a review.

Patel, P.N., Mbagaya G.M., & Imo, B. E. (2012). Paper presented-Impact of climate change-Slide share. Available at http://www.slideshare.net/PraptiPatel8/paper-presentedimpact-of-climate. on March 2016.

Pauw, P. (2013). The role of perception in subsistence farmer adaptation in Africa: Enriching the climate finance debate. *International Journal of Climate Change Strategies and Management*, *5*(3), 267-284.

Popkin, B. M., Adair, L. S., & Ng, S. W. (2012). Global nutrition transition and the pandemic of obesity in developing countries. *Nutrition reviews*, *70*(1),

Porter, J. R., Xie, L., Challinor, A. J., Cochrane, K., Howden, S. M., Iqbal, M. M., ... & Travasso, M. I. (2014). *Chapter 7: Food security and food production systems*. Cambridge University Press.

Quaye, W. (2008). Food security situation in northern Ghana, coping strategies and related constraints. *African journal of agricultural research*, *3*(5), 334-342.

Rasul, G., Q. Z. Chaudhry, A. Mahmood, and K. W. Hyder. "Effect of temperature rise on crop growth and productivity." *Pak. J. Meteorol* 8 (2011): 53-62.

Rosegrant, M. W., Ewing, M., Yohe, G., Burton, I., Saleemul, H., & Valmonte-Santos, R. (2008). *Climate change and agriculture: threats and opportunities*.

Saaka, M., Larbi, A., Hoeschle-Zeledon, I., & Appiah, B. (2015). Child malnutrition in northern Ghana: evidence, factors and recommendations from a new study.

Sanderson, A. M., & Auricht, C. (2012).An overview of population undernutrition in a selection of countries in eastern and southern Africa. A report prepared for the Australian International Food Security Centre.

Springmann, M., Mason-D'Croz, D., Robinson, S., Garnett, T., Godfray, H. C. J., Gollin, D., & Scarborough, P. (2016). Global and regional health effects of future food production under climate change: a modelling study. *The Lancet*, *387*(10031), 1937-1946.
Sukon K, PhD, (2008).

The Asia Foundation (December, 2012). Available at https://**asiafoundation**.org/resources/pdfs/**ClimateChangeperceptionsurvey**.pdf on March 2016.

UNICEF (2011). About us-Situation of children in Ghana. Available at www.**unicef**.org/**ghana**/about_7587.html on March 2016.

UNSCN (2010). EXE4bis_ climate change and Nutrition security. Available at www.**unscn**.org/files/Statements/Bdef_NutCC_2311_final.pdf on March 2016.

USAID (January, 2008). Impact of climate change on rural livelihoods in Madagascar. Available at *pdf.**usaid**.gov/pdf_docs/Pnadp632.pdf* on March 2016.

USAID (2014). Ghana: Nutrition profile| U.S Agency. Available at https://www.**usaid**.gov/what-we-do/global-health/**nutrition**/.../**ghana-nutrition-profile** on March 2016.

Wheeler, T., & Von Braun, J. (2013). Climate change impacts on global food security. *Science*, *341*(6145), 508-513.

WFP (2009). Climate change and hunger-Responding to the challenge. Available at

*www.preventionweb.net/files/12007_**wfp**212536.pdf* on March 2016.

WFP (2010). Hunger and climate change| WFP| United Nations World Food….. Available at https://www.**wfp**.org/content/**hunger-and-climate-change**-0 on March 2016.

WFP (2012a). Climate impact on food security and nutrition- a review of existing knowledge. Available at *documents.wfp.org/stellent/groups/public/documents/.../wfp258981.pdf* on March 2016.

WFP (2012b). Comprehensive food security and vulnerability analysis in Ghana, 2012. Focus on Northern Ghana. Available at *documents.wfp.org/stellent/groups/public/documents/ena/wfp257009.pdf* on March 2016.

WFP (2012c). The state of food security and nutrition security in Yemen. Available at https://www.wfp.org/content/yemen-comprehensive-food-security-survey-2012 on March 2016.

WHO (2000). *Obesity: preventing and managing the global epidemic* (No. 894). World Health Organization. Geneva

WHO (2001). Iron deficiency anaemia: assessment, prevention and control: a guide for programme managers. Geneva

WHO (2004). The WHO Multicentre Growth Reference Study (MGRS). Available at http://www.who.int/childgrowth/mgrs/en/ on January 2016.

World Health Organization, & Unicef. (2009). WHO child growth standards and the identification of severe acute malnutrition in infants and children: a Joint Statement by the World Health Organization and the United Nations Children's Fund. *Geneva: World Health Organization*.

World Health Organization. (2010). Nutrition Landscape Information System (NLIS) country profile indicators: interpretation guide.

World Health Organization. *WHO; 2011. Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity*. WHO/NMH/NHD/MNM/11.1.

WHO (2014a). Global Nutrition Target 2025: Anaemia policy brief. Available at www.who.int/**nutrition**/publications/**globaltargets2025_policybrief_anaemia**/en/ on March 2016.

https://www.k4health.org/toolkits/anemia-prevention/anemia -causes-prevalence-impact

WHO (2014b). Climate change: An opportunity for public health. Available at www.who.int/mediacentre/commentaries/**climate-change**/en/ on February 2016.

Wüstefeld M. (25-28 March, 2013). Food and Nutrition security- UNSCN. Available at http://www.unscn.org/files/Annual_Sessions/UNSCN_Meetings_2013/Wustefeld_Final_MoM_FNS_concept.pdf on March 2016.

Yaro, J. A. (2013). Building resilience and reducing vulnerability to climate change: Implications for food security in Ghana. *A report for Friedrich Ebert Stiftung. Accra: Ghana Office*.

APPENDIX I-QUESTIONNAIRE
UNIVERSITY OF GHANA

NUTRITION AND FOOD SCIENCE DEPARTMENT

QUESTIONNAIRE ON THE IMPACTS OF CLIMATE CHANGE ON FOOD AND NUTRITION SECURITY IN TWO REGIONS OF GHANA (WESTERN AND UPPER EAST REGIONS)

Questionnaire No: …… Name of community……

Please write the number for the appropriate answer in the space provided

A. BACKGROUND INFORMATION

Maternal Information:

1. What is your age? (***Completed number of years***)…….. **mage1**
2. What is your ethnicity? **meth2**
   1)Frafra [ ] 2)Bossi [ ] 3)Akan [ ] 4) Ewe (5) Other ***(Please specify)***……
3. What is your religion? **mrel3**
1) Christian [ ] 2) Muslim [ ] 3) Traditionalist [ ] 4) Other ***(Please specify)***……
4. What is your occupation? **mocc4**
a) Primary…… b) Secondary……
5. What is your level of education? **medu5**
1) No formal education [ ] 2) Pre- school [ ] 3) Primary [ ] 4) Middle school/JSS/JH [ ]
   5)Secondary [ ] 5)Tertiary [ ] 6)Other ***(Please specify)***……
6. What is your marital status? **mast6**
1) Never married [ ] 2)Married [ ] 3)Cohabiting [ ] 4)Divorced [ ] 5)Widowed [ ]
7. What is your monthly income? ***(in new Ghc)***…… **mmin7**

Household Information:

8. How many people live in this household …… **hhsz8**
9. Who is the head of this household?
1) Myself [ ] 2)My husband [ ] 3)Someone else ***(Please specify)***…… **whhh9**
   (If mother is the household head, please skip to questions 11)
10. a) What is the occupation of the household head? **ho10a**
    i.Primary occupation…… ii.Secondary occupation……...

    b)What is the level of education of the household head
    h010b
    1)No formal education [ ] 2)Pre- school [ ] 3)Primary [ ] 4) Middle School/JSS/JHS [ ]
    5)Secondary [ ] 5)Tertiary [ ] 6)Other (Please specify)……

    c) What is the monthly income of the household head? ***(in new Ghc)***……..
    ho10c
11. a)How many children in this household are less than five years old …… **cu511a**

b) Please tell me the relationship of each person in your household who usually lives here to the household head **cu511b**

Name of household Members	Sex (Male=1 ; Female =2)	Age	Occupation	Relationship with the Household Head
i.				
ii.				
iii.				
iv.				
v.				
vi.				
vii.				
viii.				
ix.				
x.				

B. AWARENESS OF CLIMATE CHANGE IN STUDY AREA & THE IMPACTS OF CLIMATE CHANGE ON FOOD CROP PRODUCTION

12. a)Have you ever heard about climate change? 1)Yes [ ] 2)No [ ] **caw12a**

b)What do you know about climate change? **caw12b**

……

……

c. What is causing climate change? **cawl12c**

……

……..

13. a. Do you think that climate change can affect you or your household? **caw13a**
1)Yes [ ] 2)No [ ]

b. How does the problem of climate change affect you or your household? **caw13b**

……

……

14. a) Have you observed any changes in the rainfall patterns over the past five years or more? **caw14a**
1)Yes [ ] 2)No [ ] ***(If "No" skip to Q15)***

b) What changes have you observed in rainfall patterns over time? **caw14b**
1)Increasing rainfall [ ] 2)Reducing rainfall [ ] 3)Delayed rainfall [ ] 4)Too early rainfall [ ] 5)No change [ ] 6)Don't know [ ] 7)Other ***(Please specify)***……..

15. a) Do you or anyone in this household grow food crops? 1)Yes [ ] 2)No [ ] ***caw15a***
b) Which food crops do you usually grow? **caw15b**
i)……. ii)…….
iii)…….. iv)……
v) …… vi)……

c)Do the changes affect the food crops you grow in anyway? 1) Yes [ ] 2) No [ ] **caw15c**

d)If yes, how ***(Please specify the food crops that are usually affected)***? **caw15d**

……

……’…

16. a)Have you observed any changes in temperature over the past five years or more? **caw16a**

1)Yes [ ] 2)No [ ] ***(If "No" skip to section C)***

b) What changes have you observed in temperature over time? **caw16b**

1)Increasing temperature [ ] 2)Reducing temperature [ ] 3)No change [ ] 4)Don't know[ ]

c) Do the changes affect the food crops you grow in any way? **caw16c**

1)Yes [ ] 2)No [ ]

d) If yes, how ***(Please specify the food crops that are usually affected)***? **caw16d**

……

……

C. HOUSEHOLD FOOD SECURITY

17. ***I am about to ask you a few questions about your household's experiences with food in the past four weeks. This information will help us to have a better understanding of problems facing families in this community with regards to food.*** **hhfs17**

QUESTION	RESPONSE OPTIONS	CODE
1. i) Did you worry that your household would not have enough food?	0 = No (skip to Q2) 1=Yes	
ii) How often did this happen?	1 = Rarely (once or twice) 2 = Sometimes (three to ten times) 3 = Often (more than ten times)	
2. i) Were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources such as money or food?	0 = No (skip to Q3) 1=Yes	
ii) How often did this happen?	1 = Rarely (once or twice) 2 = Sometimes (three to ten times) 3 = Often (more than ten times)	
3. i) Did you or any household member have to eat a limited variety of foods due to a lack of resources such money or food?	0 = No (skip to Q4) 1=Yes	
ii) How often did this happen?	1 = Rarely (once or twice) 2 = Sometimes (three to ten times) 3 = Often (more than ten times)	
4. i) Did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	0 = No (skip to Q5) 1=Yes	
ii) How often did this happen?	1 = Rarely (once or twice) 2 = Sometimes (three to ten times) 3 = Often (more than ten times)	
5. i) Did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	0 = No (skip to Q6) 1=Yes	

ii) How often did this happen?	1 = Rarely (once or twice) 2 = Sometimes (three to ten times) 3 = Often (more than ten)	
6. i) Did you or any other household member have to eat fewer meals in a day because there was not enough food?	0 = No (skip to Q7) 1=Yes	
ii) How often did this happen?	1 = Rarely (once or twice) 2 = Sometimes (three to ten times) 3 = Often (more than ten times)	
7. i) Was there ever no food to eat of any kind in your household because of lack of resources to get food?	0 = No (skip to Q8) 1=Yes	
ii) How often did this happen?	1 = Rarely (once or twice) 2 = Sometimes (three to ten times) 3 = Often (more than ten times)	
8. i) Did you or any household member go to sleep at night hungry because there was not enough food?	0 = No (skip to Q9) 1=Yes	
ii) How often did this happen?	1 = Rarely (once or twice) 2 = Sometimes (three to ten times) 3 = Often (more than ten times)	
9. i) Did you or any household member go a whole day and night without eating anything because there was not enough food?	0 = No 1=Yes	
ii) How often did this happen?	1 = Rarely (once or twice) 2 = Sometimes (three to ten times) 3= Often (more than ten times)	

D. COPING STRATEGIES ADOPTED TO OFFSET THE NEGATIVE IMPACTS OF CLIMATE CHANGE

18. Food insecurity coping strategies:

I am going to ask you some questions about what you and your household members did when you did not have enough food or money to buy food over the past four weeks.

How often did you have to… **cpst18**

Coping Option	**Every day**	**3–6 times/ week**	**Once or twice**	**Never**
1. Consume less quality & variety of food				
2. Reduce the meal of adults in favor of children				
3. Limit the portion of meal for all household members				
4. Reduce number of meals per day				
5. Purchase food on credit				
6. Send children to eat elsewhere (from family or friends)				
7. Send children to work for food				
8. Regrouping of family members to save money				
9. Depend on aid from family and friends				

10. Use part or all of your life savings to purchase food				
11. Sell any assets to purchase basic food items?				
12. Sell any assets to invest in income activities?				
13. Reduce health and education expenses in order to meet food needs?				
14. Take on a loan (credit) to purchase food				
15. Harvest immature crops				
16. Skip a loan payment				
17. Barter exchange				

19. What do you and your household members do to reduce the effect of the changing climate on your food crop production? **cpst19**

……

……

……

20. a) Do you preserve some of the food crops you grow? 1) Yes [ ] 2) No [ ] **cpst20**

b) How do you preserve food to prevent food shortage in your household?

Food Item	Food Preservation Technique

E. CHANGES IN FOOD CONSUMPTION PATTERNS AS A RESULT OF CLIMATE CHANGE

21. a) Are there some foods that you no longer eat because of the changes in weather conditions over time? 1)Yes [ ] 2)No [ ] **fcp21a**

b) Are there some foods that you no longer eat in the quantities you used to eat because of the changes in weather conditions over time? 1) Yes [ ] 2) No [ ] ***(If "No to "a" and "b" above, skip to question 22)*** **fcp21b**

c) If yes, please mention the affected foods and how you think they have been affected by the changes in climate over time **fcp21c**

Food	Impact of climate change
i)	
ii)	
iii)	
iv)	
v)	
vi)	
vii)	

24-HOUR DIETARY RECALL - Household Dietary Diversity Questionnaire

22. ***Please describe the foods (meals and snacks) that you ate yesterday during the day and night. Start with the first food eaten in the morning.***

(After the respondent tells you about the first thing they had to eat or drink, ask about what they ate or drank next. Write down all food and drinks mentioned by the respondent. When the respondent has finished, probe for meals and snacks not mentioned. If they had tea or coffee ask if there was milk or sugar added. Ask the respondent to mention the ingredients of any mixed dishes.)

drc22

Approximate time of eating	Type of Eating Event	Actual Foods Eaten	Quantity Consumed

When the free recall is complete, fill in this table of food groups, underline the food item consumed in the correct food group and place a "1 "in the fourth column. For any food groups not mentioned, ask the respondent if a food item from this group was consumed.

Question number	Food group	Examples	YES=1 NO=0
1	CEREALS	corn/maize, rice, wheat, sorghum, millet or any other grains or foods made from these (e.g. bread, noodles, porridge or other grain products) + *insert local foods e.g. ugali, nshima, porridge locally available grains*	
2	WHITE TUBERS AND ROOTS	white potatoes, white yams, white cassava, or other foods made from roots	
3	VITAMIN A RICH VEGETABLES AND TUBERS	pumpkin, carrots, squash, or sweet potatoes that are orange inside + *other locally available vitamin-A rich vegetables (e.g. red sweet pepper)*	
4	DARK GREEN LEAFY VEGETABLES	dark green/leafy vegetables, including wild ones + *locally available vitamin-A rich leaves such as amaranth, cassava leaves, kale, spinach etc.*	
5	OTHER VEGETABLES	other vegetables (e.g. tomato, onion, eggplant) , including wild vegetables	
6	VITAMIN A RICH FRUITS	ripe mangoes, cantaloupe, apricots (fresh or dried), ripe papaya, dried peaches + *other locally available vitamin A-rich fruits*	
7	OTHER FRUITS	other fruits, including wild fruits	
8	ORGAN MEAT (IRON-RICH)	liver, kidney, heart or other organ meats or blood-based foods	
9	FLESH MEATS	beef, pork, lamb, goat, rabbit, wild game, chicken, duck, or other birds	
10	EGGS	chicken, duck, guinea hen or any other egg	
11	FISH AND SEAFOOD	fresh or dried fish or shellfish	
12	LEGUMES, NUTS AND SEEDS	beans, peas, lentils, nuts, seeds or foods made from these	
13	MILK AND MILK PRODUCTS	milk, cheese, yogurt or other milk products	
14	OILS AND FATS	oil, fats or butter added to food or used for cooking	
15	RED PALM PRODUCTS	Red palm oil, palm nut or palm nut pulp sauce	
16	SWEETS	sugar, honey, sweetened soda or sugary foods such as chocolates, candies, cookies and cakes	
17	SPICES, CONDIMENTS, BEVERAGES	Spices (black pepper, salt), condiments (soy sauce, hot sauce), coffee, tea, alcoholic beverages OR *local examples*	

PAST AND CURRENT DIETARY HISTORY ***(FOR UPPER EAST REGION)*** **dhq23**

23. Now, I will ask you about some foods you used to eat five (5) years ago and currently that may have been affected by the weather and whether you still have access to these foods or not.

QUESTIONS About five years ago, how often did your household consume the following?	RESPONSE FOR PAST 5 YEARS						RESPONSE FOR PAST 1YEAR					How do you think changes in the weather have affected these foods? (***You can choose more than one answer***) 1 = The high temperature has made it more available 2 = The high temperature has made it less available 3 = Because it rains heavily, it is less available 4 = The heavy rains have made it more available 5 = Because there is less rain, it is less available 6 = Because there is less rain, it is more available 7 = Don't know
	Never	**Daily**	**Weekly (----/7)**	**Monthly (-----/31)**	**Occasionally (-----/per----)**	**Yearly (----/12)**	**Never**	**Daily**	**Weekly (----/7)**	**Monthly (-----/31)**	**Occasionally (-----/per----)**	
1. Cereal												
Millet												
Sorghum												
Rice												
Maize												
Other ***(Please specify)***												
2. White tubers & Roots and Plantains												
Sweet potato												
Yam												
Other ***(Please specify)***												

3. Vitamin A Rich Vegetables and Tubers												
carrots												
sweet potatoes that are orange inside												
Other ***(Please specify)***												
4. Dark Green Leafy Vegetables												
Aleefu												
Ayoyo												
Baobab leaves												
Beans leaves												
Bitor leaves												
Other ***(Please specify)***												
5. Other Vegetables												
Tomatoes												
Onion												
Garden egg												
Okro												
Green beans												
Cabbage												
Pepper												
Other ***(Please specify)***												
6. Vitamin A Rich Fruits												
ripe mangoes												
Ripe pawpaw												
Other ***(Please specify)***												
7. Other Fruits												
Mangoes												
Watermelon												
Yellow melon												
Shea fruits												

Dawadawa fruits												
Red berry												
Other ***(Please specify)***												
8. Legumes, Nuts & Seeds												
Groundnut												
Agushi (melon seed)												
Beans												
Soybeans												
Bambara beans												
Neri												
Other ***(Please specify)***												
9. Fats and Oils												
Shea butter oil												
Groundnut oil												
Soya beans oil												
Refined Vegetable oil												
Other ***(Please specify)***												
10. Red Palm Products												
Palm oil												
Palm nut soup												
Other ***(Please specify)***												

A. ANTHROPOMETRY

Infant **ianth**

Anthropometric measures	1st	2nd	mean
Length/height (cm)			
Weight (kg)			
MUAC (cm)			

Mother **manth**

Anthropometric measures	1st	2nd	mean
Height(cm)			
Weight (kg)			

BIOCHEMICAL ASSESSMENT

Mothers Hb (g/L)	
Child's Hb (g/L)	

Thank You!

APPENDIX II-FOCUS GROUP DISCUSSION GUIDE

UNIVERSITY OF GHANA

DEPARTMENT OF NUTRITION AND FOOD SCIENCE

THE IMPACT OF CLIMATE CHANGE ON FOOD AND NUTRITION SECURITY

INTERVIEW GUIDE FOR FOCUS GROUP DISCUSSION

1. What do you know about climate change?
2. How is the climate in this community changing?
3. What is causing climate change?
4. How has the changing climate affected your farming activities and the food crops grown in this community over the five (5) years?
5. What types of food crops are mainly affected by changes in the weather patterns in this community? Please mention some of the food crops that have been affected
6. In which ways has the changing climate affected the types of food people eat and the way they eat in this community over the years?
7. With the current changes in weather conditions, how do people in this community preserve their foods in order to prevent shortage of food in various households in this community?
8. How do people in this community cope when harvest is poor?
9. What do people in this community do to prevent the changes in climatic conditions from affecting their farming activities and the food crops they grow?
10. Please what will you recommend we do to help reduce/ prevent the impact of climate change on our food crops?

Thank You!

APPENDIX III-KEY INFORMANT INTERIEW GUIDE

A) Elderly Farmer

Introduction:

Questions:

1. Can you tell me what you know about climate change?
2. How is the climate in this community changing?
3. In your opinion, what is causing this climate change?
4. How is the changing climate affecting food crop production in this community?
    a. How are changes in rainfall patterns affecting food crop production?
    b. How are changes in temperature affecting food crop production?
    c. How is the changing climate affecting availability of food crops for consumption in this community?
    d. Which food crops are mostly affected? Please name the food crops
    e. How is climate change affecting food consumption patterns in this community?
5. What do people in this community do to prevent/reduce the changes in climatic conditions from affecting their farming activities and the food crops they grow?
6. How do people preserve their food crops to prevent shortage of food in households in this community
7. What do you think can be done to overcome the problem of climate change and its impact on food production?
8. In case there is poor harvest or less food for the household what do people do?
9. Are there any further recommendations that you would like to make or anything else you would like to tell me?

Thank you!

B) Meteorologist

Introduction:

Questions:

1. Can you tell me what you know about climate change?
2. How is the climate in the Bongo district changing?
    a. What changes have you observed in rainfall patterns over time in this community?
    b. What changes have you observed in temperature over time in this community?
3. In your opinion, what is causing climate change?
4. How do you think the changing climate is affecting food production in this community?
5. What do you think can be done to overcome the problem of climate change in this community?
6. Are there any further recommendations that you would like to make or anything else you would like to tell me?

Thank You!

C) Agric Extension Officer

Introduction:

Questions:

1. Can you tell me what you know about climate change?
2. How is the climate in this community/ district changing?
3. In your opinion, what is causing climate change?
4. How is the changing climate affecting food crop production in this community/ district?
    a. How are changes in rainfall patterns affecting food crop production?
    b. How are changes in temperature affecting food crop production?
    c. How is the changing climate affecting availability of food crops for consumption in this community?
    d. Which food crops are mostly affected?
5. What do people in this community do to prevent/reduce the changes in climatic conditions from affecting their farming activities and the food crops they grow?
6. How do people preserve their foods to prevent shortage of food in the households?
7. What do you think can be done to overcome the problem of climate change and its impact on food production?
8. Are there any further recommendations that you would like to make or anything else you would like to tell me?

Thank You!

APPENDIX IV-CONSENT FORM

UNIVERSITY OF GHANA

OFFICE OF RESEARCH, INNOVATION AND DEVELOPMENT

Ethics Committee for Basic and Applied Science (ECBAS)

Official Use only Protocol number

PROTOCOL CONSENT FORM

Section A- BACKGROUND INFORMATION

Title of Study:	The Impact of Climate Change on Food and Nutrition Security in Two Regions of Ghana (Western and Upper East Region).
Principal Investigator:	Professor Christiana Nti, Professor Matilda Steiner- Asiedu and Dr. Gloria E. Otoo
Certified Protocol Number	

Section B– CONSENT TO PARTICIPATE IN RESEARCH

General Information about Research

This study is being conducted by researchers from the University of Ghana, Family and Consumer Science and Nutrition and Food Science Departments to assess the impact of climate change on Food and Nutrition Security. This study is funded by the Open Society Foundations.

Your participation in this study is entirely voluntary. You should read the information below and ask questions about anything you do not understand, before deciding whether or not to participate.

- ***Purpose of the study***

The purpose of this study is to assess how climate change influences food production, food consumption pattern and nutrition of your household. What we learn from the study will help in obtaining data that can be used in developing measures to minimize the impact of climate change on food production, food consumption pattern and nutrition.

- ***Procedures***

If you volunteer to participate in this study, we will ask you questions on the following:

1. Questions about you and your household members
2. What you know about the changes in the weather patterns
3. The foods you produce and what you and your household members eat
4. How changes in the weather condition is affecting what you and your household members eat
5. What you do to reduce the negative impact of climate change.
6. We will also take you and your child's body measurements.
7. We will also prick you and your child's fingertip to take a drop of blood to see if you and your child have anaemia or not.

Benefits/Risk of the study

If you decide to participate in this study, the direct benefit to you and your household is that we will give you information on you and your child's weight and height.

There are no physical risks involved in participating in this study**.** You will only feel a little sharp pain at your fingertip where you will be pricked.

Your participation will indirectly benefit your community by helping us to gather information that can be used to develop measures to minimize the impact of climate change on food production and also improve food consumption in the district.

Confidentiality

We will not tell anybody what you say or give out any information about you. Only the people involved in this research will have access to your information. You will not be named in any oral or written reports and no individual reference will be made that could be linked to your information.

Compensation

There is no compensation and there is no cost to you for participating in this study.

However at the end of your participation, you will be given a bar of soap in appreciation of your time.

Withdrawal from Study

You can choose whether or not to be in this study. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind. You may also refuse to answer any questions you do not want to answer. There is no penalty if you withdraw from the study and you will not lose any benefits to which you are otherwise entitled.

Contact for Additional Information

If you have any questions or concerns about the research, please feel free to contact any of the following people.

Prof. Christiana Nti
Principal Investigator
Department of Family and Consumer Science
University of Ghana, Legon
Tel: 0244615310
Email: cnti@ug.edu.gh

Prof. Matilda Steiner-Asiedu
Co-Supervisor
Department of Nutrition and Food Science
University of Ghana, Legon
Tel: 0541260704
Email: tillysteiner@gmail.com

Dr. Gloria Otoo
Co-Supervisor
Department of Nutrition and Food Science
University of Ghana, Legon
Tel: 0248689464
Email: geotoo@yahoo.com

Abigail .A. Armah
Student Investigator
Department of Nutrition and Food Science
University of Ghana, Legon
Tel: 0205226434
Email: aarmah40@gmail.com

Patience Atitsogbey
Student Investigator
Department of Nutrition and Food Science
University of Ghana, Legon
Tel: 0244019542
Email: patatitso@yahoo.com

Section C- VOLUNTEER AGREEMENT

"I have read or have had someone read all of the above, asked questions, received answers regarding participation in this study, and am willing to give consent for me, my child/ward to participate in this study. I will not have waived any of my rights by signing this consent form. Upon signing this consent form, I will receive a copy for my personal records."

_____

Name of Volunteer

_____ _____

Signature or mark of volunteer Date

If volunteers cannot read the form themselves, a witness must sign here:

I was present while the benefits, risks and procedures were read to the volunteer. All questions were answered and the volunteer has agreed to take part in the research.

_____

Name of witness

_____ _____

Signature of witness Date

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual.

_____

Name of Person who obtained Consent

_____ _____

Signature of Person who obtained Consent Date