

**PERCEIVED CLIMATE CHANGE AND FOOD AND NUTRITION SECURITY IN  
THE BIBIANI-ANHWIASO BEKWAI DISTRICT IN THE WESTERN REGION OF  
GHANA**

**BY**

**ABIGAIL AYORKOR ARMAH**

**(10309188)**

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

**INTEGRI PROCEDAMUS**

**JULY, 2016**

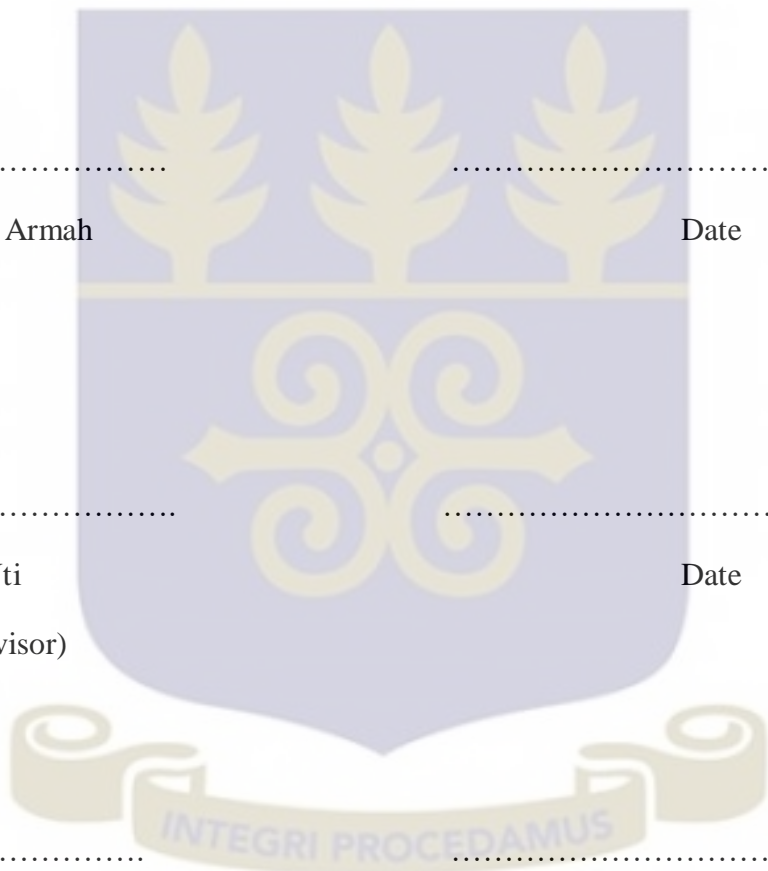
## DECLARATION

I, Abigail Ayorkor Armah hereby declare that, this piece of work is the result of my own efforts and idea in the Department of Nutrition and Food Science, University of Ghana, under the supervision of Prof. Christina Nti and Dr. Gloria Ethel Otoo. No previous submission for a degree has been done here or elsewhere, besides, the works of others which served as source of information have been duly acknowledge by making reference to the authors.

.....  
Abigail Ayorkor Armah  
(Student) Date

.....  
Prof. Christina Nti  
(Principal Supervisor) Date

.....  
Dr. Gloria Ethel Otoo  
(Co-Supervisor) Date



## DEDICATION

I dedicate this work to God Almighty who has been my greatest source of strength and support throughout this study and to my parents and siblings for the support and inspiration.



## ACKNOWLEDGEMENT

I am most grateful to God Almighty for the grace to finish this project work safely and successfully. Glory and praise be to his Most Holy Name.

My appreciation also goes to the African Climate Change Adaptation Initiative (ACCAI) for funding this work. I am most grateful.

I am deeply grateful and thankful to my hardworking supervisors Prof. Christina Nti and Dr. Gloria Otoo as well as Prof. Matilda Steiner-Asiedu for their wisdom, support and guidance.

I would also like to acknowledge my family for the immense support and inspiration. God bless you all.



## TABLE OF CONTENTS

DECLARATION .....	i
DEDICATION.....	ii
ACKNOWLEDGEMENT.....	iii
TABLE OF CONTENTS .....	iv
LIST OF TABLES .....	viii
LIST OF FIGURES .....	ix
ACRONYMS AND ABBREVIATIONS .....	x
OPERATIONAL DEFINITIONS.....	xi
ABSTRACT .....	xii
CHAPTER ONE.....	1
1.0. INTRODUCTION.....	1
1.1. Rationale.....	3
1.2. Main Objective .....	3
1.3. Specific Objectives .....	3
CHAPTER TWO .....	5
2.1. Maternal & Child Malnutrition .....	5
2.2. Food Insecurity and Nutritional Status .....	6
2.3. Prevalence of Food / Nutrition Insecurity .....	7
2.4. Causes of Food and Nutrition Insecurity .....	8
2.5. CLIMATE CHANGE.....	10
2.5.1. How the Climate is changing?.....	10
2.5.1.1. Changes in Temperature .....	10
2.5.1.2. Changes in Precipitation .....	11
2.5.2. Causes of Changes in the Climatic Conditions .....	12
2.5.2.1. Natural Causes of Climate Change .....	12
2.5.2.2. Anthropogenic Causes of Climate Change .....	13
2.5.3. Climate Change in Africa .....	14
2.6. IMPACTS OF CLIMATE CHANGE .....	15
2.6.1. Impacts of Climate Change on Food Production.....	15
2.6.2. Climate Change and Dietary Consumption Patterns .....	16
2.6.3. Impacts of Climate Change on Food and Nutrition Security .....	17

Conceptual Framework.....	20
2.7. COPING STRATEGIES .....	21
2.7.1. Negative Coping Strategies .....	21
2.7.2. Positive Adaptive Strategies.....	22
CHAPTER THREE.....	25
3.0. METHODOLOGY .....	25
3.1. Study Design.....	25
3.2. Study Area .....	25
3.3. Target Population.....	27
3.3.1. Inclusion and Exclusion Criteria .....	27
3.4. Sample and Sampling Procedure .....	27
3.4.1. Sample.....	27
3.4.2. Sampling Procedure .....	28
3.5. Data Collection .....	28
3.5.1. Instruments for data collection .....	28
3.5.2. Quantitative Data Collection .....	28
3.5.3. Qualitative Data Collection .....	38
3.5.4. Analysis of Findings for Qualitative Data.....	40
3.6. Quality Control .....	40
3.7. Ethical Considerations .....	40
CHAPTER FOUR.....	41
4.0. RESULTS .....	41
4.1. Quantitative Results .....	41
4.1.1. Socio-demographic Characteristics of Study Participants.....	41
4.1.2. Assessment of Climate Change.....	45
4.1.3. Awareness of Climate Change .....	47
4.1.4. Household Dietary Consumption Patterns.....	48
4.1.5. Perceived Climate Change and Household Dietary Consumption Patterns .....	49
4.1.6. Predictors of Household Dietary Diversity.....	50
4.1.7. Coping Strategies Used to Offset the Negative Impacts of Climate Change .....	50
4.1.8. Perceived Climate Change and Food Security.....	52
4.1.9. Predictors of Household Food Insecurity .....	53
4.1.10. Nutritional Status of Mothers and Children in the Study .....	54

4.1.11. Perceived Climate Change and Nutritional Status of Study Participants .....	56
4.1.12. Predictors of Nutritional Status .....	57
4.1.13. Food Security and Nutritional status .....	60
4.2. Qualitative Results .....	62
4.2.1. Key Informant Interviews .....	62
4.2.2. Focus Group Discussion .....	73
CHAPTER FIVE .....	85
5.0. DISCUSSION .....	85
5.1. Background Information .....	85
5.2. Awareness of Climate Change .....	87
5.3. Perceived Climate Change and Dietary Diversity .....	88
5.4. Coping Strategies used to offset the Negative Impacts of Climate Change .....	90
5.5. Perceived Climate Change and Household Food Security.....	92
5.6. Perceived Climate Change and Nutritional Status.....	93
5.7. Policy Implications of Findings.....	95
5.8. Challenges and Limitations of this study .....	95
CHAPTER SIX.....	97
6.0 CONCLUSION AND RECOMMENDATION.....	97
6.1 Conclusion.....	97
6.2 Recommendations.....	98
REFERENCES .....	99
APPENDICES .....	105
Appendix 1: Scoring of Climate Change Awareness Based on Responses to Climate Change Awareness-Related Questions .....	105
Appendix 2: Scoring of Perceived Climate Change Based on Responses to Perceived Climate Change -Related Questions .....	106
Appendix 3: Responses to Climate Change Awareness Related Questions .....	107
Appendix 4: Proportion of Study Participants who had Perceived Climate Change.....	109
Appendix 5: Changes in Food Consumption Patterns as a Result of Climate Change..	109
Appendix 6: Proportions of Study Participants Consuming Foods from the Various Food Groups.....	110
Appendix 7: Average yearly frequency of food consumption from the various food groups five years ago and currently (in days).....	110
Appendix 8: Consent Form .....	111

Appendix 9: Research Questionnaire..... 115  
Appendix 10: Focus Group Discussion Interview Guide..... 126  
Appendix 11: Key Informant Interview Guide – Agricultural Extension Officers ..... 127  
Appendix 12: Key Informant Interview Guide – Farmers ..... 129



**LIST OF TABLES**

Table 4.1 Socio-demographic Characteristics of Participants..... 42

Table 4.2 Household Characteristics..... 44

Table 4.3 Household dietary diversity scores..... 48

Table 4.4 Dietary Consumption Patterns: Food Groups Consumed by  $\geq 50\%$  of Households 49

Table 4.5 Relationship between Perceived Climate Change and Dietary Diversity..... 49

Table 4.6 Predictors of Low Dietary Diversity ..... 50

Table 4.7 Coping Strategies Adapted to Offset the Negative Impacts of Climate Change .... 51

Table 4.8 Household Food Insecurity Prevalence ..... 52

Table 4.9 Relationship between perceived climate change and food security ..... 52

Table 4.10 Predictors of Food Insecurity ..... 53

Table 4.11 Mothers’ Nutritional Status..... 54

Table 4.12 Nutritional status of children under 5years ..... 55

Table 4.13 Relationship between perceived climate change and nutritional status of participants..... 56

Table 4.14 Mean anthropometric and biochemical profile of participants based on perception of climate change ..... 57

Table 4.15 Predictors of Mother’s Nutritional Status as Indicated by their BMI..... 58

Table 4.16 Predictors of Child Malnutrition ..... 59

Table 4.17 Mean anthropometric and biochemical profile of participants by household food security status..... 60

Table 4.18 Relationship between food security and nutritional status ..... 61



## LIST OF FIGURES

Figure 2.1 Relationship between climate change and food and nutrition insecurity. (Adapted from: ACF, 2012; Gruber & Kepler, 2012; UNS-SCN, 2010).....	20
Figure 3.1: Maps showing location of the Bibiani-Anhwiaso Bekwai District in the Western Region of Ghana .....	26
Figure 4.1 Average minimum temperature (°C) from 1986 to 2015 in the Bibiani-Anhwiaso Bekwai District .....	46
Figure 4.2 Average maximum temperature from 1986 to 2015 in the Bibiani-Anhwiaso Bekwai District in the Western Region of Ghana.....	46
Figure 4.3 Changes in rainfall patterns in the Bibiani-Anhwiaso Bekwai District from 1986 to 2015.....	47
Figure 4.4 Awareness of Climate Change among Study Participants .....	48
Figure 4.5 Proportion of malnourished and well-nourished children.....	55
Figure 4.6 Schematic representation of farmers’ perception of how climate change affects food and nutrition security in the Bibiani-Anhwiaso Bekwai District from qualitative studies .....	84



## ACRONYMS AND ABBREVIATIONS

ACF: Action Against Hunger

BMI: Body Mass Index

FAO: Food and Agriculture Organization

GDHS: Ghana Demographic and Health Survey

GHS: Ghana Health Service

GSS: Ghana Statistical Service

HDD: Household Dietary Diversity

HDDS: Household Dietary Diversity Score

IFAD: International Fund for Agricultural Development

MUAC: Mid-upper Arm Circumference

SD: Standard Deviation

SPSS: Statistical Package for Social Sciences

UNICEF: United Nations International Children's Emergency Fund

UNS-SCN: United Nations System Standing Committee on Nutrition

US-EPA: United States Environmental Protection Agency

WFP: World Food Program

WHO: World Health Organization



## OPERATIONAL DEFINITIONS

**Anthropometry:** The study and technique of taking body measurements, especially for use on a comparison or classification basis. It refers to the measurement of the human individual for the purposes of understanding human physical variations.

**Climate Change:** A change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer

**Food and Nutrition Security:** This exists when all people at all times have physical, social and economic access to food which is consumed in sufficient quantity and quality to meet their dietary needs and food preferences, and is supported by an environment of adequate sanitation, health services and care for an active and healthy life.

**Household:** Refers to one person who lives alone or a group of persons, related or unrelated who share food or make common provisions for food and other essentials for living.

**Well nourished:** Refers to the child who is not underweight, stunted or wasted.

**Malnourished:** Refers to the child who is underweight, stunted, wasted or has any two or all

**Underweight:** Refers to having low weight for age (below -2 SD) mainly due to chronic under nutrition or acute malnutrition for children below 5 years and BMI less than 18.5 kg/m<sup>2</sup> for adults.

**Wasting:** Refers to having low weight-for-length or height (below -2 SD) mainly due to acute malnutrition

**Stunting:** Refers to having low length or height-for-age (below -2 SD) mainly due to chronic malnutrition

## ABSTRACT

Climate change has the potential to increase food insecurity and exacerbate malnutrition in small scale farming households through its impacts on crop yield and income. Using a mixed-methods design, a cross-sectional study was carried out in the Bibiani-Anhwiaso Bekwai District in the Western Region of Ghana among 210 farming households with children less than 5 years old with the objective of examining associations between perceived climate change and food and nutrition security. A semi-structured questionnaire was used to collect data on perceived climate change, awareness of climate change, household food security and coping strategies used to offset the negative impacts of climate change. A 24-hour household dietary recall was used to assess household dietary diversity (HDD) and dietary consumption patterns and anthropometric and biochemical measurements were used to assess the nutritional status of study participants. Four focus group discussions and 11 key informant interviews were carried out to find out about awareness of climate change in the study area, impact of climate change on dietary consumption patterns and coping strategies adapted to offset the negative impacts of climate change. Results from the quantitative study showed that 72% of the participants had perceived changes in weather patterns. Majority (94%) of the participants were food insecure and households that had perceived climate change were 11 times more likely to be food insecure than those that had not ( $p = 0.001$ ). Sixty-one percent of mothers interviewed had normal BMI (between 18.5 to 24.9 kg/m<sup>2</sup>) and 87% were non-anaemic. Underweight, stunting and wasting were of high public health significance among children below 5 years. Approximately 29% of the children were underweight, 36% stunted, 10% wasted and 58% anaemic. There were no significant differences in the nutritional status and dietary diversity of participants from households that had perceived climate change compared to those that had not. Results from the qualitative study showed that participants had observed less predictable weather patterns which had negative impacts on crop yield, food security and dietary diversity. The main coping strategies adapted to offset the negative

impacts of climate change include watering crops with water from other sources aside rain water, , adjusting planting seasons, diversification of livelihoods and storage of food among others. Participants however mentioned that the alternate water sources usually got dried up during long periods of drought The study therefore recommended an introduction of irrigation projects and educating farmers on modern and improved adaptive strategies to offset the negative impacts of climate change on food crop production.



## CHAPTER ONE

### 1.0. INTRODUCTION

Climate change is a threat to the fight against malnutrition. According to Carty & Magrath (2013), the world faces a real and imminent risk of major setbacks in efforts to combat hunger because of climate change. The number of climate-related disasters such as drought, floods and cyclones have increased over the years (ACF, 2012). It is anticipated that climate change will increase the risk of hunger and undernutrition over the next few decades with most of the human suffering and economic damages caused by climate change affecting the world's poorest households (ACF, 2012; UNS-SCN, 2010).

Carty & Magrath (2013) stated that the changing climate is already jeopardising gains in the fight against hunger and it looks set to worsen. Climate change threatens the production and distribution of food especially among households of small scale farmers and amplifies threats to livelihoods and food security through its direct impacts on food availability, access, quality and utilization (Thompho, 2014). Food security exists when all people, at all times, have physical and economic access to sufficient, safe, nutritious food to meet their dietary needs and food preferences for an active life (Pangaribowo *et al.*, 2013). Thus, by affecting availability, access to and utilization of food, climate change negatively impacts on food security.

A person is considered to be nutrition secure when he or she has a nutritionally adequate diet and the food consumed is biologically utilized such that adequate performance is maintained in growth, resisting or recovering from disease, pregnancy, lactation and physical work (Pangaribowo *et al.*, 2013). Thus, nutrition security implies more than just access to adequate food. It requires access to appropriate micronutrients, safe water, hygiene and sanitation,

access to quality health-care services, and improved household and community practices in child care, food hygiene and preparation and environmental health (UNICEF, 2008). UNS-SCN (2010) however stated that climate change will affect nutrition through different causal pathways that impact food security, sanitation, water and food safety, health, maternal and child health care practices and many other socioeconomic factors.

FAO (2015) stated in their report that, climate change will exacerbate the crisis of undernutrition through three main causal pathways including household access to sufficient, safe and adequate food, care and feeding practices and environmental health and access to health services. Although climate change affects everyone, developing countries will be hit harder by its impacts than developed countries and the world's most food insecure regions will be hit hardest of all especially women and children within these regions. Low-income countries in tropical and sub-tropical regions are also likely to endure sharp changes in annual rainfall and climatic conditions that will put them at risk of greater food insecurity, especially in Africa and South Asia (Carty & Magrath, 2013). Ghana is considered to be vulnerable to the impacts of climate change largely due to its dependence on rain fed agricultural production.

Recent projections indicate that by 2050, climate change would lead to a 10 to 20% increase in the number of hungry people and 21% increase in the number of malnourished people more than would have been observed without climate change with sub-Saharan Africa (SSA) being the most affected if current climate change trends continue (Dyg *et al.*, 2011; WFP, 2012). Already about 3.2 million Ghanaians are food insecure or vulnerable to becoming food insecure with about 8 in 10 children under 5 years of age and 7 in 10 women of reproductive age, suffering from some form of undernutrition (GHS, 2013).

Thus, the impact of climate change on food and nutrition security in Ghana over the years is likely to worsen if no appropriate strategies are adopted ahead of time to cope with the stresses posed on the country's agricultural sector and other factors that affect food and nutrition security.

### **1.1. Rationale**

Climate change poses threats to food and nutrition security through its negative impacts on household access to sufficient, safe and nutritious food, care and feeding practices as well as environmental health and access to health service (FAO, 2015).

Previous studies on the impact of climate change on food security and child malnutrition have projected a decline in energy availability and approximately 20% increase in child malnutrition as a result of climate change (Lloyd *et al.*, 2011; Nelson *et al.*, 2009).

In Ghana, though a number of studies have focused on climate change and its impacts on food production, very few studies have been carried out to find possible associations between perceived climate change and food and nutrition security. This study will therefore bridge the information gap and identify coping strategies for the negative impacts of climate change on food and nutrition security.

### **1.2. Main Objective**

The main objective of this study was to examine associations between perceived climate change and food and nutrition security, with emphasis on women and children below five years, in the Bibiani-Anhwiaso Bekwai District.

### **1.3. Specific Objectives**

The specific objectives were to:

1. Investigate the awareness of climate change in the study area

2. Assess associations between perceived climate change and household dietary consumption patterns
3. Assess associations between perceived climate change and household food security
4. Identify household coping strategies used to offset the negative impacts of climate change
5. Assess associations between perceived climate change and the nutritional status of women and children in the Bibiani-Anhwiaso Bekwai District



## CHAPTER TWO

### 2.0. LITERATURE REVIEW

#### 2.1. Maternal & Child Malnutrition

Malnutrition has devastating consequences for both children and women of reproductive age. In children, it leads to more severe childhood illnesses, stunted physical growth, poor educational outcomes and death (Benson and Shekar, 2006; Levinson and Bassett, 2007). It is a major contributor to the worldwide burden of diseases and an underlying cause of about 6 million child deaths worldwide with low and middle income countries bearing the brunt of the problem (Levinson and Bassett, 2007). In women of reproductive age, undernutrition has been linked with poor pregnancy outcomes (Black *et al.*, 2013).

According to UNICEF (2011), malnutrition is directly caused by inadequate food intake and disease. These come about as a result of inability of households to access foods that are safe and nutritious in sufficient quantities; inadequate maternal and child care and feeding practices; and poor household access to health services and unhealthy environment (Tirado *et al.*, 2012). Tirado *et al.* (2012), in their review stated that the basic causes of undernutrition can be linked to environmental, economic and socio-political contextual factors, with poverty playing a major role. Lack of public investment in improved agricultural practices and technologies such as irrigation and inadequate or poorly managed public water storage and sanitation infrastructure makes households that depend on climate sensitive resources for their livelihoods vulnerable to the negative impacts of climate change, particularly, changes in temperature and precipitation (UNICEF, 2011). Reports by ACF (2012); Tirado *et al.* (2012) and UNS-SCN (2010) indicate that, climate change is a major threat to development and food security and it lessens the effectiveness of current efforts to reduce hunger and ensure nutritional well-being.

## 2.2. Food Insecurity and Nutritional Status

Food insecurity refers to uncertain availability or ability to access foods that are nutritionally adequate and safe for consumption in socially acceptable ways or their availability and accessibility in limited amounts (Saaka and Osman, 2013). According to the Food and Agriculture Organization (FAO, 1997), the ability of a household to provide sufficient, safe and nutritious food which meets the dietary needs of its members is one of the main prerequisites for ensuring good nutritional status. Food insecurity serves as a major determinant factor of malnutrition (Saaka and Osman, 2013).

Matheson, *et al.* (2002) in a study to examine the interrelationships between food security at the household level, food supplies, children's food intake and their weights among 5<sup>th</sup> grade children, found that food security was negatively associated with children's body mass index (BMI). They concluded in their study that the observed lower BMIs among food-insecure children could be attributed to short-term inadequate food intake that usually occurred at intervals as a result of food shortage in the households prior to receiving household income. They also reported a decline in energy intake and consumption of meat among children from most of the households that were classified as food insecure prior to payday.

In another study to verify associations between food insecurity and nutritional status of children under 5 years old in Brazil, Santos and Gigante (2013) found that compared to food secure children, those living with some form of food insecurity had higher rates of stunting (low height-for-age) ( $p = 0.03$ ) even after controlling for demographic and socioeconomic factors such as household location, income, number of inhabitants of the household among others.

In Northern Ghana, a study by Saaka and Osman (2013) to examine the extent and impacts of food insecurity on nutritional status among children between 6 to 36 months and their mothers showed that children in food secure households were 46% less likely to have chronic

malnutrition compared to those from households that were food insecure (OR=0.54, 95% CI: 0.31–0.94). In their study, there was a significant association between diet quality (as measured by assessing household dietary diversity scores and food consumption scores) and BMI of mothers and stunting among children.

### **2.3. Prevalence of Food / Nutrition Insecurity**

Even though there is more than enough food supply globally to provide everyone with all the energy needed for an active and healthy life, an unacceptably large number of people around the world lack the food they need for an active and healthy life because, food is not evenly equally distributed (FAO, IFAD and WFP, 2015; FAO, 2006).

According to Barrett (2010), more than one billion people worldwide lack sufficient dietary energy availability while approximately two (2) billion people or more suffer micronutrient deficiency. Rosen *et. al.* (2008) mentioned that Sub-Saharan Africa (SSA) happens to be the world's most food insecure region and has the lowest average daily energy intake by far. They also stated that as at 2007, approximately 457 million people in SSA were food insecure. The number of food insecure people in SSA has been projected to increase to 645 million by 2017 considering the current trends (Rosen *et. al.*, 2008).

Even though Ghana has relatively lower levels of food insecurity compared to other Sub-Saharan African countries, pockets of food insecure populations exist in all 10 regions in Ghana especially in rural communities (Hedzro-Garti, 2010; Rademacher-Schulz and Mahama, 2012). Mainly on the basis of household food consumption, about 5% of the Ghanaian population (approximately 1.2 million people) were found to have inadequate access to sufficient, safe and nutritious food that would support an active and healthy life, classifying them as food insecure. An additional 2 million people were identified to be vulnerable to food insecure (CFSVA, 2009).

A survey by Marquis (2014) in the Eastern Region of Ghana indicated that 58% of rural households with infants were food insecure. This is in line with data from the GDHS (2014) which reported higher levels of undernutrition among under five children living in rural parts of the country compared to those in urban areas.

According to FAO (2006), about half of people living with food insecurity happen to be small-scale persistence farmers. Although these farmers grow food for household consumption, they have limited resources to ensure they have access to sufficient, safe and nutritious food throughout the year. This was confirmed by studies in some rural communities in Northern Ghana which concluded that even though farming households usually cultivated mainly for consumption by their households, a greater percentage of them were food insecure (Quaye, 2008).

#### **2.4. Causes of Food and Nutrition Insecurity**

Gruber & Kepler (2012), stated that the ultimate causes of food insecurity and malnutrition are social, economic, cultural and political. Some basic causes of food insecurity mentioned by Buhi (n.d.) and Gruber & Kepler (2012) include wars and civil conflicts, environmental degradation, insufficient agricultural development, poor health status, poverty and natural disasters among others.

In a meta-analysis to find out about the factors that drive food insecurity in Southern Africa, Misselhorn (2005) identified poverty, environmental stressors and conflicts, unemployment, poor human health and poor infrastructure as the main direct causes of inadequate food access which indirectly, drive food insecurity. Other short-term drivers of food insecurity identified include food prices increases and sudden decline in food production.

According to FAO, IFAD and WFP (2015), the high levels of hunger and food insecurity in Sub-Saharan Africa could possibly be a result of increasingly frequent extreme weather events and natural disasters being experienced lately which affect food production.

Lartey (2008) in a review to discuss the nutritional challenges faced by women and children in Sub-Saharan Africa stated that pervasive poverty in this region negatively affects the nutrition situation by affecting the quality of diets consumed. According to her, inadequate food intake coupled with poor nutritional quality of diets, frequent infections among young children and short inter-pregnancy intervals makes the environment in Sub-Saharan Africa ideal for malnutrition.

Poverty, poor agricultural practices, poor infrastructure as well as climate related factors such as changes in rainfall patterns have been reported to be among the main factors that negatively affect food security in Ghana (Quaye, 2008; Rademacher-Schulz, Schraven, & Mahama, 2014). In a study to assess the food security situation among some rural dwellers in Northern Ghana, Quaye (2008) identified erratic rainfall patterns, lack of knowledge of improved farming, post-harvest practices as well as lack of production credit and markets for farm produce as the major setbacks to improving food production and food security.

A similar observation was made by Rademacher-Schulz *et al.* (2014) when they undertook a study to examine the interrelationships between rainfall variability, livelihood/food security and migration in rural Savannah communities in Northern Ghana. According to their report, climate related factors such as changes in rainfall patterns, lack of modern farming equipment and techniques, poor infrastructure (particularly, bad roads) and unemployment were among the major causes of food insecurity among study participants.

## **2.5. Climate Change**

The inter-governmental panel on climate change, IPCC, (2007a) defined climate change as “a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer”. It refers to any change in climate over time, whether due to natural variability or as a result of human activity.

### **2.5.1. How the Climate is changing?**

Global climate change is a certainty which is already affecting global temperatures, regional weather patterns as well as biological and physical systems (Edame *et al.*, 2011). Over the past few decades, the earth has experienced drastic changes in its climate, attributed directly or indirectly to human activities and this puts additional pressure on already over-exploited natural resources (Edame *et al.*, 2011).

According to IPCC (2014) there has been an unequivocal warming of the earth’s climate since the 1950s, leading to many observed unprecedented changes over decades. These have led to warming of the atmosphere and ocean, diminished amounts of snow and ice, decrease in water availability in areas that are already prone to drought, increased risk of flooding as well as spread of water-borne illnesses and sea level rise (IPCC, 2014; NRC, 2010).

The frequency and intensity of extreme weather events such as hurricanes, periods of drought, heat waves and forest fires as well as extremely heavy rainfall which lead to flooding are expected to increase over the years (Gruber & Kepler, 2012).

#### **2.5.1.1. Changes in Temperature**

Surface air temperature is one of the most frequently used index of climate change (Firth and Fisher, 2012). Global temperature has been increasing over the years with the greatest temperature increase at the higher Northern latitudes (IPCC, 2007a). According to National Research Council (NRC) (2010), thermometer measurements have shown that there has been

a substantial increase in the earth's average surface temperature particularly, over the last three decades. According to McMichael *et al.* (2004) recent reports indicate an increase in global land and sea temperature of about  $0.6 \pm 0.2^{\circ}\text{C}$  since the mid-19<sup>th</sup> century with the greatest change occurring since 1976. This was in line with a study by Hansen *et al.* (2006) who in their study to compare observed temperature change with predictions of global climate change made in the 1980s observed a  $0.2^{\circ}\text{C}$  increase in temperature per decade since the past 30 years as was predicted. IPCC (2007) report from Working Group One (WGI) also indicated with strong evidence that there had been a significant increase in global surface temperature of  $0.74 \pm 0.18^{\circ}\text{C}$  over the past century which had been accompanied by more heat waves.

Projections of future climate change anticipate that apart from the already observed increase in global temperature, there would likely be an additional  $1.1$  to  $6.4^{\circ}\text{C}$  ( $2.0$  to  $11.5^{\circ}\text{F}$ ) increase over the 21st century (National Research Council, 2010).

#### **2.5.1.2. Changes in Precipitation**

With the current increase in global temperature, variations in precipitation and moisture in the atmosphere have also been observed (US-EPA, 2016; Dore, 2005). Patterns of precipitation have changed with already dry regions becoming drier while temperate areas are becoming wetter (McMichael *et al.*, 2004).

As global temperature increases and the air becomes warmer, more moisture evaporates from land and water into the atmosphere and normally, this is expected to lead to an increase in precipitation. However, the extra precipitation is not evenly spread globally, leading to a decrease in precipitation in some regions as a result of shifts in air and ocean currents caused by climate change (US-EPA, 2016).

According to Dore (2005) & Gruber & Kepler (2012), since the beginning of the 20th century, there has been an increase in precipitation globally by about 2 percent (2%). However, most regions within the tropics and sub-tropics experience a decrease in precipitation.

In their study in rural Savannah communities in Northern Ghana Rademacher-Schulz *et al.* (2014) mentioned that 92% of the participants reported to have perceived changes in rainfall patterns over the last 20 to 30 years. Most of them had observed shortened rainy season with longer dry spells and an increase in extreme weather events particularly drought.

Rademacher-Schulz and Mahama (2012) in their study in the Northern Region of Ghana indicated that 87% of the participants reported they had perceived more droughts over the past 10 to 30 years, with 44.3% reporting increased flooding and 35.8% reporting more heavy rains. The participants in this study reported that the climate in the study district had become less predictable.

### **2.5.2. Causes of Changes in the Climatic Conditions**

Multiple lines of evidence in the weather, ecosystems and oceans indicate that the earth's climate is changing. Global temperature is determined by the balance between energy entering and leaving the earth. When the earth absorbs energy from the sun, it warms up, and it cools when the absorbed energy is reflected back to space (US-EPA, 2015). Many factors, both natural and human factors have effects on the earth's energy balance (US-EPA, 2016).

#### **2.5.2.1. Natural Causes of Climate Change**

Natural factors external to the climate system such as volcanic eruptions, solar output, and the earth's orbit around the sun have the ability to affect the earth's climate. However, these factors do not contribute much to the current changes observed in climatic conditions. According to US-EPA (2015), natural factors such as volcanic eruptions and natural changes in the concentration of greenhouse gases can account for the changes in climatic conditions

prior to the 1700s, however, they cannot account for the changes in climatic conditions being observed lately. Anthropogenic factors are likely to be the main causes of the rapid change in climate being experienced currently (US-EPA, 2015).

### ***2.5.2.2. Anthropogenic Causes of Climate Change***

According to US-EPA (2016), most of the warming experienced during the twenty-first century has been caused by human emissions of greenhouse gases. Greenhouse gases such as carbon dioxide, methane and water vapour act as a partial blanket for the long wave radiations coming from the surface of the earth by absorbing energy and slowing down or preventing the loss of heat to space. This causes an increase in the earth's surface temperature (IPCC, 2007; US-EPA, 2016). Human activities contribute much to climate change mainly through the release of greenhouse gases especially carbon dioxide (CO<sub>2</sub>) into the atmosphere which trap heat close to the earth's surface (US-EPA, 2015).

According to Gruber & Kepler (2012), the effects of industrialisation since the last 250 years have brought about clear changes in the climate. Human activities including combustion of fossil fuels such as coal, oil and natural gases for heat and energy, clearing forests, fertilizing crops, storing waste in landfills, raising livestock, and producing some kinds of industrial products among others drastically change the chemical composition of the global atmosphere by releasing greenhouse gases, especially carbon dioxide (IPCC, 2007). According to Edame *et al.* (2011) there has been a 35% increase in the amount of carbon dioxide in the atmosphere as a result of human activities. Emissions such as methane (CH<sub>4</sub>) and nitrous gas (N<sub>2</sub>O) which occur in the process of decomposing waste deposits and hydro-chlorofluorocarbons (HCFCs) and sulphur hexafluoride (SF<sub>6</sub>) from industry, air conditioners, coolants and high-voltage power lines are also greenhouse gases which alter the composition of the atmosphere (Akudugu *et al.*, 2012).

Also, non-sustainable forestry and agriculture contributes significantly to climate change by contributing over 30% to current annual total emission of greenhouse gases (GHG) through deforestation and conversion of forests into farmlands among others (Edame *et al.*, 2011; Gruber & Kepler, 2012).

All of these climate alterations coincide with rapid increase in global population and the use of forest lands for food production, infrastructural development and networks to help meet the increasing need for food and settlement areas (Akudugu *et al.*, 2012).

### **2.5.3. Climate Change in Africa**

Africa is commonly identified as one of the regions that is most vulnerable to climate variability and change. This situation is further aggravated by the low adaptive capacity of most African countries to deal with the impacts of climate change (IPCCWGII, 2007; Thompson *et al.*, 2010). According to United Nations Environment Programme (2007), Africa would be the most severely struck continent by the impact of climate change even though it contributes relatively little to greenhouse gas emissions.

The earth's spherical nature causes more solar energy to arrive in the tropics than at higher latitudes for a given surface area (IPCC, 2007b). Several factors including Africa's geographical position, its heavy dependence on climate sensitive resources as well as its limited ability to adapt to the changing climatic conditions make Africa particularly vulnerable to the impacts of climate change. This will be worsened by high poverty rates and the existing low levels of development within the continent (IPCC, 2007; United Nations Environment Programme, 2007; World Bank, 2009).

According to World Bank (2009), most of African economies as well as the poor within this continent depend on climate sensitive sectors. Rain-fed agriculture, one of the main sectors severely affected by the changing climate because of its high sensitivity to droughts and

floods, employs about 70% of the African population while contributing about 30% to gross domestic product (GDP) with just about 5% of the cultivated land in this region being irrigated (World Bank, 2009).

## **2.6. Impacts of Climate Change**

### **2.6.1. Impacts of Climate Change on Food Production**

Agriculture is one of the most threatened sectors by climate change particularly within the tropics (Edame *et al.*, 2011). According to Gruber & Kepler (2012), changes in vegetation periods, precipitation and wind patterns, rising temperatures, soil erosion, alterations in water availability, increasing spread of and vulnerability to pests and plant diseases, invasive species and the loss of agro-biodiversity all make conditions more difficult for agricultural production.

The increasing frequency, severity and unpredictable nature of extreme weather events will also worsen the vulnerability of the agricultural sector to the negative impacts of climate change (Akudugu *et al.*, 2012; World Bank, 2009). These will lead to an increase in crop failures, livestock deaths as well as crop pests and diseases. It will also negatively impact on the suitability of land for different types of crops and undermine food security by affecting availability of food for consumption (Edame *et al.*, 2011). McMichael *et al.* (2007) also stated that yield in rain-fed agricultural production is likely decrease by about 50% as a result of the changes in climatic conditions.

In his review to assess the implications of climate change on the livelihoods and food security situation of rural dwellers, Akudugu *et al.* (2012), stated that a 1°C to 3°C increase in temperature could reduce food crop production, particularly, production of cereal crops in dry regions such as Africa while severe temperature increase beyond 3°C could reduce crop production globally.

Joshi *et al.* (2011), in a study to assess the effect of observed climate variables on yield of major food-crops including rice, wheat, maize, millet, barley and potato in Nepal, found that food crops grown in summer such as maize and millet were adversely affected by changes in some climatic variables. The study observed a 0.3°C increase in summer maximum temperature each year from 1978 to 2008 and indicated that maize yield showed negative relation with summer maximum temperature such that further increase in summer maximum temperature would result in a sharp decline in maize yield. From their study, it was observed that increase in both summer rainfall and maximum temperature led to a suppression of yield by 106kg/ha and 30 kg/ha for maize and millet respectively.

Another study by Rowhani *et al.* (2011) in Tanzania to examine the relationship between seasonal climate and crop yields with emphasis on maize, sorghum and rice reported that by 2050, projected seasonal temperature increases by 2°C would lead to a decline in the yield of maize by 13%, sorghum by 9% and rice yield by about 8%. Thus, the changing climate will negatively affect crop yield and food availability.

### **2.6.2. Climate Change and Dietary Consumption Patterns**

Through its impact on food production, climate change will reduce the availability of certain foods for consumption and reduce the capacity of vulnerable households to purchase a diversity of foods (Edame *et al.*, 2011). These will affect the food choices and dietary consumption patterns of poor households who will be forced to change their food basket, consume less variety of foods needed to satisfy their nutritional needs or spend a greater percentage of their income on food when prices of preferred and nutritious food items increase as a result of decreased availability (UNS-SCN, 2010; Edame *et al.*, 2011).

In a study to estimate excess mortality caused by dietary changes related to agricultural production and weight-related risk factors, Springmann *et al.*, (2016) projected that by 2050, climate change will lead to a 3.2% ± 0.4% decrease in the food available for individual

consumption globally, a  $4.0\% \pm 0.7\%$  decline in individual fruit consumption and  $0.7\% \pm 0.1\%$  decline in individual intake of red meat. Smith and Olesen (2010), stated that the changing climate will cause a yield decline for the most important agricultural crops including rice, maize, wheat and soybeans, leading to additional price increase. This is in line with a review by McMichael *et al.* (2007) who stated that some developing countries were likely to experience a 5-10% loss of overall cereal production as a result of changes in weather conditions. Similarly, studies by Rowhani *et al.* (2011) and Joshi *et al.*, (2011) observed significant decrease in the yield of some cereals including maize and millet. These will result in higher feed prices which will in turn result in increased meat prices, resulting in slight decline in meat consumption and a substantial decrease in cereal consumption (Smith and Olesen, 2010). This is confirmed by findings from a study in the Upper West Region of Ghana by Rademacher-Schulz and Mahama (2012) which indicated that 37% of the participants reported decline in animal production as a result of changes in temperature and rainfall patterns.

### **2.6.3. Impacts of Climate Change on Food and Nutrition Security**

According to ACF (2012), climate change and climate related events and disturbances serve as threats to the fight against hunger and undernutrition. By directly impacting on agriculture, climate change makes most households who depend on it for their livelihoods food insecure (ACF, 2012; Akudugu *et al.*, 2012; Edame *et al.*, 2011).

Rademacher-Schulz *et al.* (2014) stated in their study that most of their participants reported that decline in crop yield and animal production as a result of changes in rainfall patterns affected the economic situation in their households while food prices increased each year and this made it very difficult for them to purchase food from the market. They also found that 75% of these respondents did not have enough food to meet the dietary needs of their households (thus, they were food insecure) and 69% of them did not have enough money to

buy food during the lean season while about 85% of these respondents reported experiencing food shortage during the past 5 to 10 years. According to their report, the farmers stated that the current changes in rainfall patterns had negative effects on their food security situation. Since the farming households were highly dependent on rain-fed agricultural production, the changes in rainfall patterns severely affected food availability and access in their households (Rademacher-Schulz *et al.*, 2014).

According to Akudugu *et al.* (2012), food can be effectively utilized when it is properly processed, stored and used and adequate nutritional knowledge, appropriate care and feeding practices as well as quality health and sanitation services are employed. Besides its impact on household access to sufficient, safe and adequate food, climate change exacerbates the crisis of undernutrition by impacting on care and feeding practices; environmental health and access to health services as indicated in Figure 2.1 below (FAO, 2015). By reducing household income generation, climate change will decrease the ability of small-scale farming households to access a variety of foods and also reduce their ability to access appropriate healthcare services as a result of lack of financial resources (UNICEF, 2011). By increasing the workload of women from small scale farming households who would now spend more time caring for crops and ensuring they have adequate harvest, climate change will negatively affect their ability to provide adequate care for infants and young children, increasing the risk of undernutrition as shown in figure 2.1 (ACF, 2012).

By negatively affecting food availability, accessibility and utilisation, climate change poses threats to food stability (Carty & Magrath, 2013). Projections on the impact of climate change have indicated a decrease in energy availability with a rise in the number of hungry people and approximately 20% increase in malnutrition among children under 5 years old solely due to climate change by 2050. Sub-Saharan Africa will be the most affected if current climate change and development trends continue (Dyg *et al.*, 2011; WFP, 2012; Smith and Olesen,

2010 ). Similar findings were reported by Lloyd *et al.* (2011), who reported that as a result of the negative impacts of the changing climate on crop production, moderate and severe stunting will increase by up to 29% and about 23% respectively in Sub-Saharan Africa, compared to a future with no climate change.



### Conceptual Framework

Figure 2.1 below presents a framework showing the relationship between climate change and food and nutrition insecurity

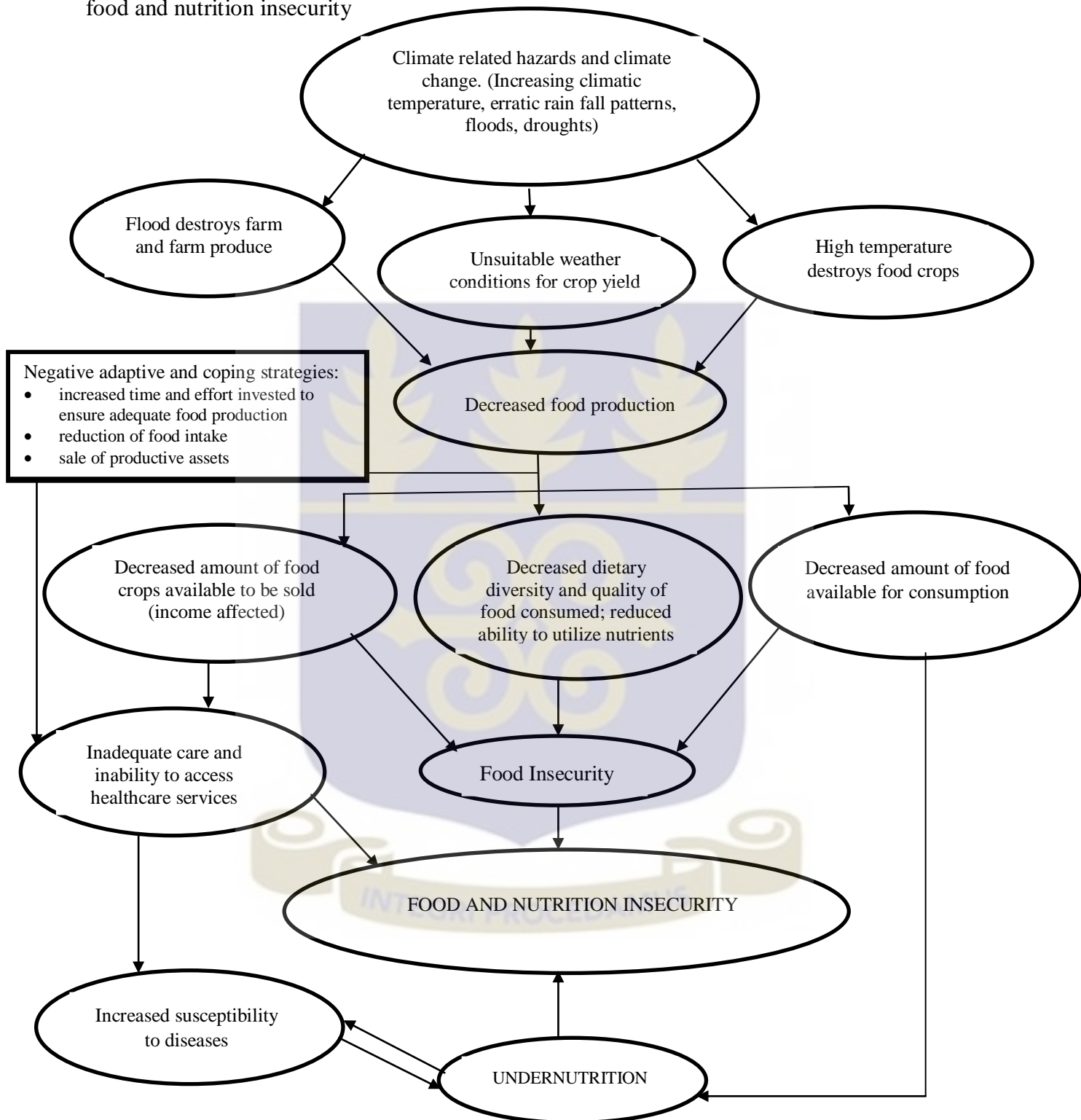


Figure 2.1 Relationship between climate change and food and nutrition insecurity. (Adapted from: ACF, 2012; Gruber & Kepler, 2012; UNS-SCN, 2010)

## **2.7. Coping Strategies**

### **2.7.1. Negative Coping Strategies**

According to ACF (2012), the effects of climate change have already irreversibly affected many populations and their livelihoods, with the poorest and already food insecure people being the most affected. Most of these people live in areas that are prone to weather- and climate-related disasters and also depend on climate sensitive resources (ACF, 2012).

According to ACF (2012), climate change has the potential to rid small-scale farmers and other agricultural workers who depend on climate sensitive resources for their income off their livelihood assets as well as access to natural resources and also weaken their ability to employ lasting solutions to cope with the negative impacts of climate change (ACF, 2012). These negatively affect their income and ability to access nutritious food to feed their households, increasing their risks of undernutrition.

People facing such disasters usually have no choice but to adopt negative ways of coping such as reducing the quantity, and quality of food consumed, consumption of less preferred foods and the sale of productive assets. These weaken their resilience and increase their vulnerability to climate-related crises and food and nutrition insecurity as shown in figure 2.1 above (ACF, 2012; Edame *et al.*, 2011).

The negative impacts of climate change on food crop production and food availability are likely to affect rural households that practice rain-fed subsistence farming so severely that, they will be compelled to make food distribution choices among all household members. Such households may be compelled to reduce the number of meals consumed by all household members per day or resort to preferential distribution of food to some household members, especially adult males who are assumed to need it more to enable them to work hard and contribute more to maintaining the household and meeting the needs of its members (Edame *et al.*, 2011).

Rademacher-Schulz *et al.* (2014) in their study in Northern Ghana stated that in order to deal with the problem of food insecurity in times when they have less food available, most of their participants reported that they sold some assets, reduced their food consumption or had to migrating to other places in search of greener pastures.

In her study, Quaye (2008) noticed that though most farming households produced food for consumption within their households, they had very low food reserves and could not meet the dietary needs of their households all year round. These food insecure farming households in order to support themselves resorted to collection of wild foods, market purchase of foods, in-kind (food) payments, obtaining support from friends and relatives, sale of valuable household assets and livestock as well as wage labour to earn some income from other sources. Some also resorted to reduction of the number of meals served each day, reduction of the portions/ sizes of meals and consumption of less preferred foods. Frequency of food intake was reduced from three to two while the portions/sizes of meals served were also reduced drastically in most cases.

### **2.7.2. Positive Adaptive Strategies**

According to World Bank (2009), climate variability has been an issue that many African countries have been living with and adapting to over centuries. It has however, received much focus due to the recent increase in the incidence of extreme weather events such as droughts and floods together with the consensus that Africa is the most vulnerable continent with the least ability to cope with the changes in climatic conditions (World Bank, 2009).

Disruptions in global and local food supplies caused by climate change can be avoided through efficient irrigation. This can lead to productivity gains that would improve the lives of a large percentage of the rural population in Africa ( Edame *et al.* 2011; World Bank, 2009).

According to Edame *et al.* (2011), encouraging agro-biodiversity and growing a diversity of plants as well as raising different varieties of animals will strengthen resilience to changes in environmental conditions and stress. Thus, practicing mixed crop-livestock and conservation farming focused on sustainable land, soil moisture, and biomass management technologies on the vast majority of land used for rain-fed agricultural production would be helpful in boosting productivity and sequestering significant amounts of carbon in soils. This would contribute to the mitigation of greenhouse gases and also potentially provide additional financial resources to small-scale farmers (World Bank, 2009).

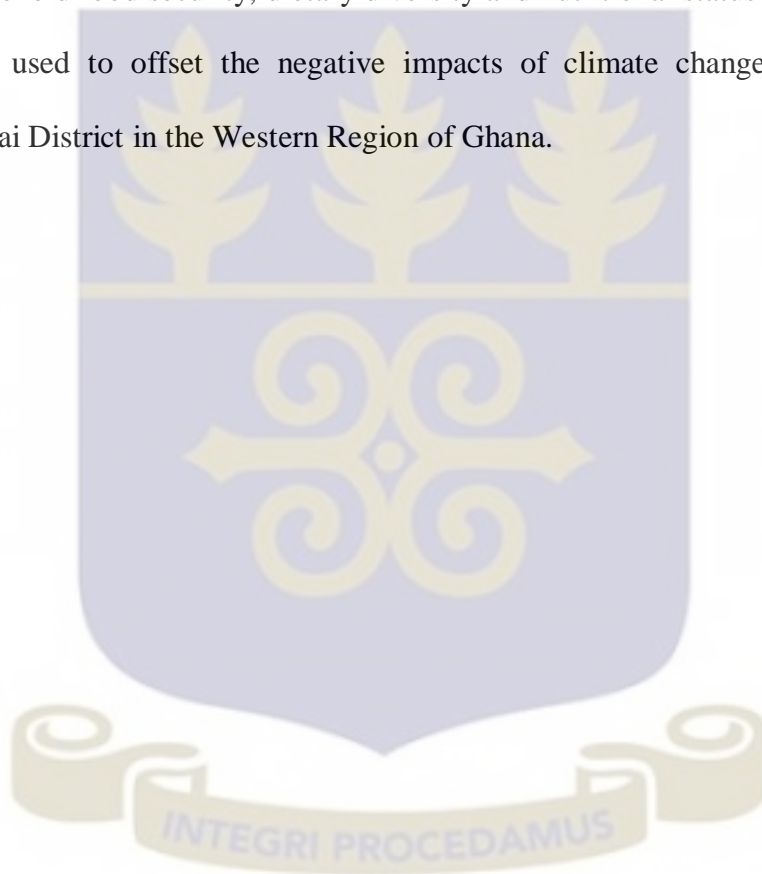
Also, development and use of crop varieties and breeds that are adapted to changing climatic conditions are useful ways to avoiding the disruptions in food availability caused by climate change (Edame *et al.*, 2011).

In order to reduce vulnerability to the negative effects of climate change on food and nutrition security, diversification of livelihoods is essential as this increases household income and can cushion farming households from the shocks and stress of the impacts of climate change. (Gruber & Kepler, 2012). According to Owusu *et al.* (2011), most rural farm households are able to cushion themselves from the effects of food crop shortage resulting from low productivity and crop harvest failures by participating in non-farm activities which serve as alternative sources of income. In their study to examine the impacts of non-farm work on farm household income and food security status, Owusu *et al.* (2011) found a positive statistically significant effect of non-farm work on household income and food security status of participating households.

In Tanzania, a study by Lyimo *et al.* (2013) indicated that small scale farmers adapted to the negative impacts of climate change by increasing cultivation in wetlands, increasing cultivation of drought resistant crop as well as diversifying their livelihoods to help them

raise their income and ensure adequate access to food. Similar strategies were also adapted by rural farmers in Northern Ghana in a study by (Rademacher-Schulz *et al.*, 2014).

In conclusion, though climate change has been found to have negative impacts on food crop production and food availability, there is limited data available on the impacts of climate change on food and nutrition security in Ghana. This current study therefore provides information on awareness of climate change and associations between perceived climate change and household food security, dietary diversity and nutritional status as well as coping strategies being used to offset the negative impacts of climate change in the Bibiani-Anhwiaso Bekwai District in the Western Region of Ghana.



## CHAPTER THREE

### 3.0. METHODOLOGY

#### 3.1. Study Design

Using a mixed-methods design, a cross-sectional study was carried out in the Bibiani-Anhwiaso Bekwai District in the Western Region of Ghana. This study design was used because only a small sample of mothers with children below five years in the Bibiani-Anhwiaso Bekwai district were studied to determine associations between perceived climate change and food and nutrition security at one point in time.

#### 3.2. Study Area

The Bibiani-Anhwiaso Bekwai District is located in the north-eastern part of the Western Region of Ghana (Figure 3.1). It covers about 8.6% (873 sq km) of the total land area of the Western Region. Farming is the major occupation in this district and serves as the means of livelihood for approximately 80% of the population. The district forms part of the equatorial rainforest and has moist semi-deciduous forests producing various tree species. The annual mean temperature in the district is 26°C. The district experiences bimodal rainfall with averages between 1200mm and 1300mm annually. Households in four farming communities in this district namely Basenkele, Lineso, Fahiakobor and Adukrom were included in the study.

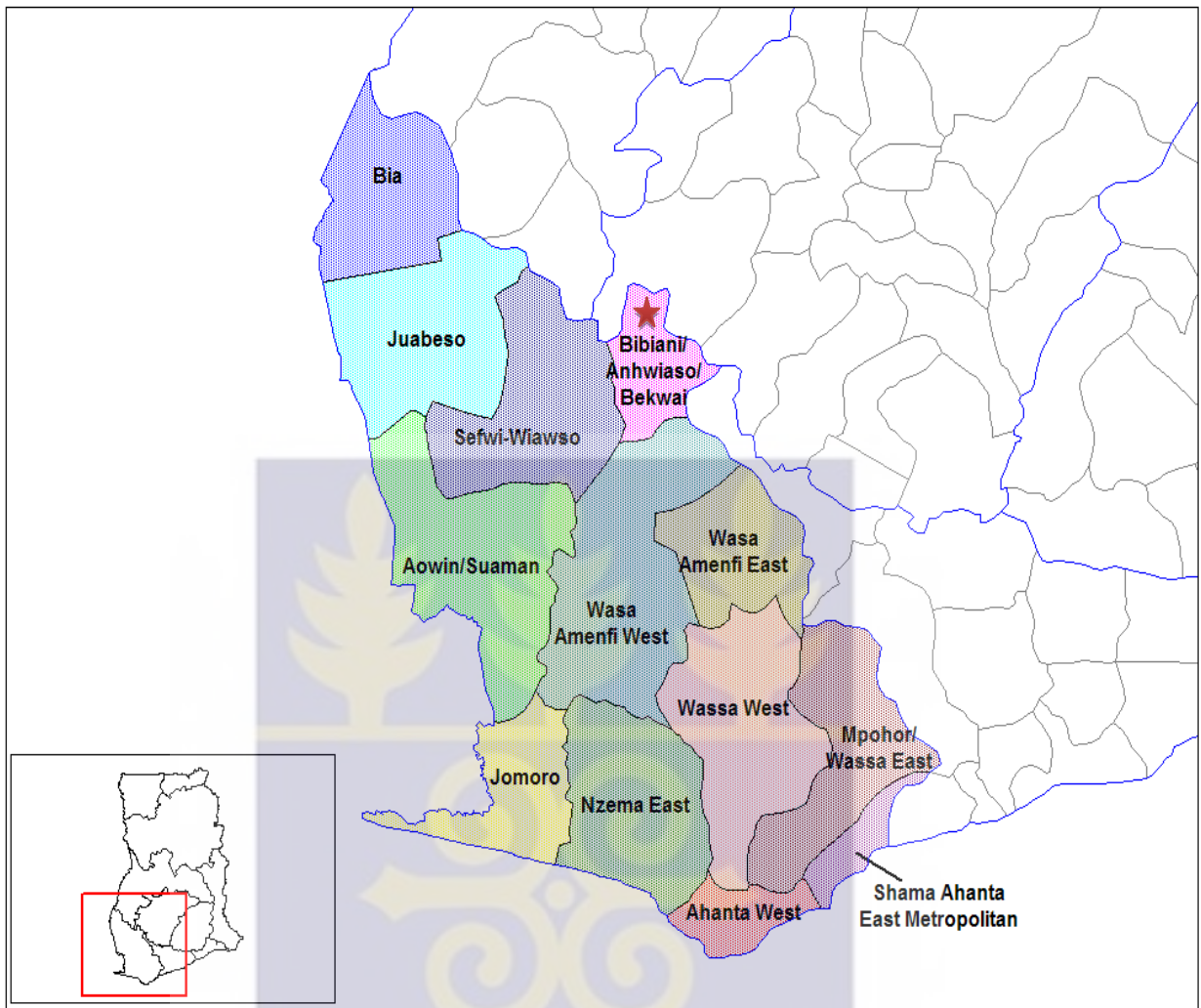
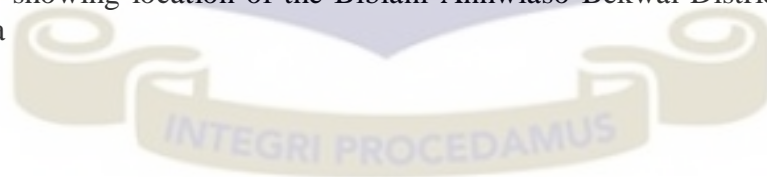


Figure 3.1: Map showing location of the Bibiani-Anhwiaso Bekwai District in the Western Region of Ghana



### 3.3. Target Population

The target population was households with adult women and children less than five years old who were involved in small scale staple crop production within the Bibiani-Anhwiaso Bekwai District in the Western Region of Ghana.

#### 3.3.1. Inclusion and Exclusion Criteria

##### *Inclusion Criteria*

A household was considered to be eligible to participate in this study if:

- There was a mother with a child (or children) less than five years old
- The household was resident in the district for at least 5 years
- The household was involved in staple crop production

##### *Exclusion Criteria*

A household was excluded from the study if the mother or the child less than 5 years old was suffering from some form of sickness that affects feeding. Pregnant women were also excluded from the study because their BMI would be affected by the pregnancy.

### 3.4. Sample and Sampling Procedure

#### 3.4.1. Sample

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

$$n = \frac{Z^2 P(1-P)}{d^2}$$

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=5% = 0.05 (prevalence of food insecurity in Ghana (MoFA, n.d.) and d=3% = 0.03, the formula gives a sample size of 203 which was rounded up to 210.

### **3.4.2. Sampling Procedure**

Four farming communities within the district (Basenkele, Lineso, Fahiakobor and Adukrom) were selected using purposive sampling (Four communities that were mainly into small scale staple crop production within the district were selected). Fifty-two (52) households each were selected from two of the farming communities (Lineso and Fahiakobor) and 53 households each from the other two farming communities (Basenkele and Adukrom).

Convenience sampling was used to obtain participants who met the eligibility criteria and were willing to participate in the study. The researcher explained the purpose of the study to eligible potential participants in their households after they came back from the farm or on non-farming days and those who were willing to participate were recruited into the study.

## **3.5. Data Collection**

### **3.5.1. Instruments for data collection**

The instruments used for data collection included a semi-structured questionnaire, a 24-hour dietary recall, a dietary history questionnaire, biochemical assessment of nutritional status and anthropometry. Question guides with semi-structured questions were also used for qualitative data collection.

### **3.5.2. Quantitative Data Collection**

#### **3.5.2.1. *Instruments for quantitative data collection***

##### **i. The semi-structured questionnaire**

A pre-coded semi-structured questionnaire was developed in relation to the objectives of the study. It consisted of both open-ended and close-ended questions and was used to obtain information on:

- **Background characteristics of respondents**

Background data collected included: household size, educational background, sex, age and occupation of household members, household head's income and mother's marital status.

- **Awareness of climate change in study area**

Data were collected on participants' knowledge about climate change, causes of climate change, impacts of the changing climate and observed changes in climatic conditions in the study area. Twelve questions were asked in all about awareness of climate change and the response to each question was scored 0 for inappropriate responses and 1 for questions that were answered appropriately as shown in **Appendix 1**.

- **Perceived climate change**

Data were collected on whether participants had observed changes in temperature and rainfall patterns, types of changes observed, effects of these changes on crop production and effects of changes in temperature and rainfall patterns on types and quantity of food consumed. Eight questions were asked in all concerning perceived climate change and the response to each question was scored 0 for responses that indicated participants had not observed any change in weather conditions and its effects over a period of time and 1 for responses that indicated participants had observed some changes as indicated in **Appendix 2**.

- **Impacts of climate change on household food consumption patterns**

Data were collected on foods no longer consumed and foods no longer consumed in the quantities that participants used to consume them because of the impacts of climate change.

- **Coping strategies used to offset the negative impacts of climate change**

Data were also collected on what households usually do to offset the impacts of climate change on food crop production and food preservation methods used to prevent food shortage in the household. The food insecurity coping strategy questionnaire was also used to identify coping strategies that most households usually adapt when there was less food available.

- **Household food security**

Using the FAO household food insecurity access scale (HFIAS) questionnaire (Coates, Jennifer & Bilinsky., 2007), data were collected on household food security (Appendix 1).

**ii. Dietary intake**

A 24-hour dietary recall and dietary history questionnaire were used to collect data on dietary intake. Participants were asked to recall all foods their households ate in the past 24 hours. This was used to determine the dietary diversity of the various households.

Using dietary history questionnaires, participants were provided with a list of foods commonly consumed within the district and asked to recall how often they used to consume those foods over the past five years and currently. Changes that had occurred over time as a result of climate change with regards to the foods listed were noted. These were used to assess possible dietary changes and changes in household food consumption patterns that had occurred as a result of climate change.

**iii. Anthropometry**

A Charder HM200 P Portstad Portable Stadiometer was used to measure the height of caregivers and children who were two years old or more while an infantometer (ShorrBoard IC-2) was used to measure the length of children less than two years old. A Seca 881 U digital scale was used to obtain data on weight and mid-upper arm circumference (MUAC) tapes were used to measure the MUAC of children less than five years old. Data on anthropometry were obtained for only one mother-child pair per household. In households where there were two or more children less than 5 years old, one child was selected by ballot. Standard procedures were followed as outlined in the anthropometric procedure manual of the centre for disease control and prevention [CDC] (CDC, 2007) in taking all anthropometric measurements.

**iv. Biochemical assessment**

A quarter of the sample (women and children) was randomly selected by ballot for the assessment of haemoglobin concentration. Haemoglobin concentrations were measured

according to standard methods using a URIT-12 Haemoglobin Meter. This was used to assess iron deficiency prevalence among the study participants.

### **3.5.2.2. Pre-test**

The questionnaires for data collection were pretested among 10 eligible individuals living in communities which were not part of the selected study communities. This enabled the researcher to determine the clarity of the questions and also estimate the amount of time to allocate 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 before data collection commenced.

### **3.5.2.3. Procedure for Quantitative Data Collection**

A familiarization visit was made to the various study communities before data collection began where the researcher contacted the Chiefs and Elders in the various communities to obtain permission to carry out the research in the communities. With the help of key informants in each of the communities, the researcher identified eligible potential participants, explained the purpose of the study as well as the possible risks and benefits to them and assured them of the confidentiality of the responses. Potential participants who were willing to participate in the study were made to sign consent forms and recruited into the study. Questionnaires were administered by interviewing participants in Akan, Ewe or any other language participants were comfortable with. The height (or length for children less than 2 years old) and weight of all participants were taken and haemoglobin concentration of quarter of the sample size was taken. Participants were made to ballot (pick a “yes” or “no”) and those who picked “yes” had their haemoglobin concentrations (Hb) and that of their participating child measured and noted.

Upon completion, the researcher expressed gratitude for the respondents’ time, patience and contribution and each participant received gifts worth Ghc5.

#### 3.5.2.4. *Data Analysis*

Data entry, cleaning and analysis were done using Statistical Package for Social Sciences (SPSS) version 16.0. Descriptive statistics such as means and standard deviations for continuous variables and frequencies and percentages for categorical variables were computed.

The WHO Anthro software was used to convert the weight, height and age of the children under 5 years to the growth indices: weight-for-age, weight-for-height and height-for-age z-scores and compared with WHO growth standards. Children with z-scores below -2 standard deviation of the median reference weight-for-age (WAZ), weight-for-height (WHZ) and height-for-age (HAZ) z-scores were classified as underweight, wasted and stunted respectively.

A child below 5 years old is considered to be underweight if he or she has weight-for-age below -2SD of the median reference weight-for-age mainly due to chronic under nutrition or acute malnutrition. Similarly, a child below 5 years old with weight-for-length or height below negative two standard deviations (-2SD) of the median reference weight-for-length or height mainly due to acute malnutrition is considered to be wasted and a child whose length or height-for-age is below negative two standard deviations (-2SD) of the median reference length or height-for-age mainly due to chronic malnutrition is considered to be stunted (WHO, 2010). The children in this study were further classified as either being well nourished or malnourished. Children who were either stunted, wasted or underweight or classified under any two or all three of these categories were classified as being malnourished while children who were neither wasted, stunted nor underweight were classified as being well-nourished.

Weights and heights of adults were transformed into Body Mass Index (BMI) using the formula: weight in kilograms divided by height in meters squared. The World Health Organization (WHO, 2011) classification of nutritional status in adults according to Body

Mass Indices (**Table 3.1**) was used to classify the BMI of respondents. The World Health Organization (WHO, 2011) anaemia cut-offs were also used to classify haemoglobin concentration of respondents as indicated in **Table 3.2**.

**Table 3. 1: Classification of nutritional status of adults based on BMI**

<b>Classification</b>	<b>BMI (Kg/m<sup>2</sup>)</b>
Underweight	< 18.50
Normal range	18.50 – 24.99
Overweight	25.00 – 29.99
Obese	≥30

**Table 3. 2: WHO anaemia cut-offs**

<b>Population</b>	<b>Non –Anaemia (g/dl)</b>	<b>Anaemia (g/dl)</b>		
		<b>Mild</b>	<b>Moderate</b>	<b>Severe</b>
Children 6 - 59 months of age	≥11.0	10.0-10.9	7.0-9.9	<7.0
Non-pregnant women (≥15years)	≥12.0	11.0-11.9	8.0-10.9	<8.0

Categorical variables of BMI, weight for height z-score (WHZ), weight for age z-score (WAZ), height for age z-score (HAZ), mid-upper arm circumference (MUAC) and haemoglobin concentrations were used to determine nutritional status and prevalence of malnutrition among study participants.

### **Scores for climate change awareness**

As indicated in **Appendix 1**, twelve (12) questions were asked in all about awareness of climate change and the response to each question was scored 0 for inappropriate responses

and 1 for questions that were answered appropriately. The highest attainable score was 12 and the minimum, 0.

Scores of respondents were classified as follows:

- a. Respondents with scores from zero (0) to 6 were classified under low awareness of climate change because participants with such scores were unable to give appropriate responses to questions concerning what climate change is, its causes and changes observed in temperature and rainfall patterns.
- b. Respondents with scores from 7 to 9 were classified under average awareness of climate change because even though they were able to give appropriate responses to questions about what climate change is, its causes and changes observed in temperature and rainfall patterns, they were not able to give much information on some possible impacts of climate change.
- c. Respondents with scores from 10 to 12 were classified under high awareness of climate change because they were able give appropriate responses to questions about what climate change is, its causes, changes observed in temperature and rainfall patterns and some possible impacts of climate change.

#### **Scores for perceived climate change**

Eight questions were asked in all concerning perceived climate change and responses to these questions were scored, 0 for responses that indicated participants had not observed any change in weather conditions and its effects over a period of time and 1 for responses that indicated participants had observed some changes (**Appendix 2**).

The highest attainable score for perceived climate change was 8 and the least was 0. Scores for perceived climate change were classified as follows:

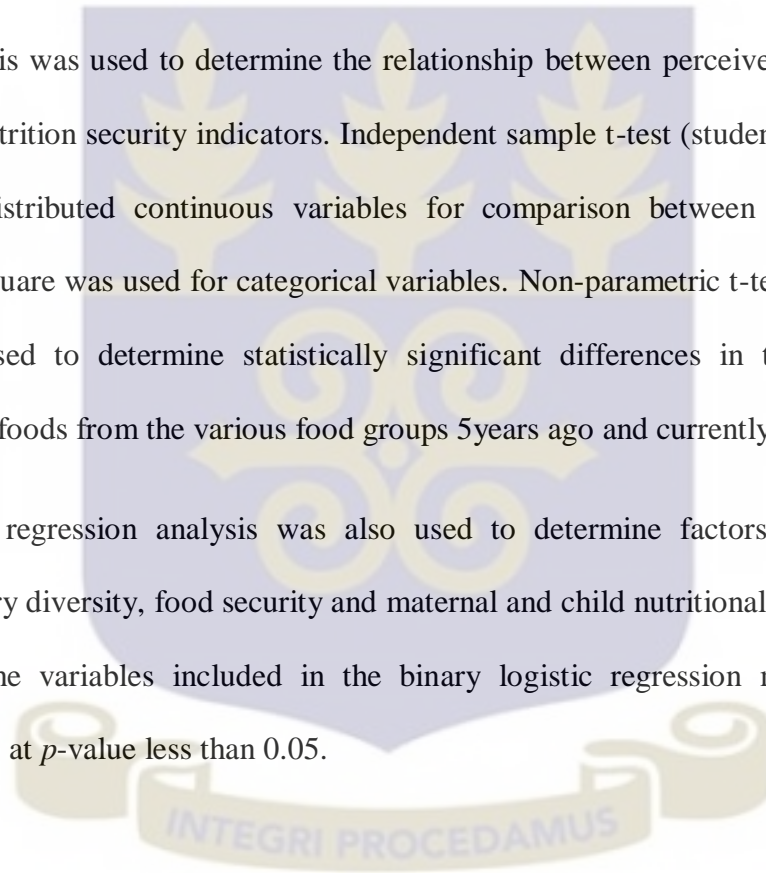
- a) Respondents with scores below five (5) were classified under “climate change not perceived” because based on their responses, it was less likely that they may have

observed changes in temperature and rainfall patterns within the district which had affected their diets or eating patterns.

- b) Respondents with scores equal to or above five (5) were classified under “climate change perceived”. This is because participants with scores equal to or more than five (5) were more likely to have observed some changes in the climate characteristics used and their diets or eating patterns may have been affected by the changes in weather characteristics used at least in one way.

Bivariate analysis was used to determine the relationship between perceived climate change and food and nutrition security indicators. Independent sample t-test (student t-test) was used for normally distributed continuous variables for comparison between two groups and Pearson’s chi-square was used for categorical variables. Non-parametric t-test for two related samples was used to determine statistically significant differences in the frequency of consumption of foods from the various food groups 5years ago and currently.

Binary logistic regression analysis was also used to determine factors associated with household dietary diversity, food security and maternal and child nutritional status. **Table 3.3** below shows the variables included in the binary logistic regression model. Statistical significance was at  $p$ -value less than 0.05.



**Table 3. 3: Variables Included in Binary Logistic Regression Model to Determine Factors Associated with HDD, HFS, Mother's Nutritional Status and Child Malnutrition**

Type of variable	Variable	Coding
<b>Dependent Variable</b>	Household dietary diversity	<sup>1</sup> High dietary diversity = 0, <sup>2</sup> Low dietary diversity = 1
<b>Independent Variables</b>	Mother's age	$\geq 20 = 0, < 20 = 1$
	Marital status	With partner = 0, without partner = 1
	Household size	$< 6 = 0, \geq 6 = 1$
	Household head	Other household member = 0, Mother = 1
	Household head's level of education	Above secondary education = 0, below secondary education = 1
	Household head's income	$\geq \text{GHC} 200 = 0, < \text{GHC} 200 = 1$
	Perception of climate change	Climate change not perceived = 0, Climate change perceived = 1
<b>Dependent Variable</b>	Household food security	Food secure = 0, food insecure = 1
<b>Independent Variables</b>	Mother's age	$\geq 20 = 0, < 20 = 1$
	Marital status	With partner = 0, without partner = 1
	Household size	$< 6 = 0, \geq 6 = 1$
	Household head	Other household member = 0, Mother = 1
	Household head's level of education	Above secondary education = 0, below secondary education = 1
	Household head's income	$\geq \text{GHC} 200 = 0, < \text{GHC} 200 = 1$
	Number of income generators	$> 2$ income generators = 1, $\leq 2$ income generators = 0
Perception of climate change	Climate change not perceived = 0, Climate change perceived = 1	

<b>Dependent Variable</b>	Mother's Nutritional Status	BMI $\geq$ 18.5 = 0, BMI < 18.5 = 1
<b>Independent Variables</b>	Mother's age	$\geq$ 20 = 0, < 20 = 1
	Marital status	With partner = 0, without partner = 1
	Household size	< 6 = 0, $\geq$ 6 = 1
	Household head	Other household member = 0, Mother = 1
	Household head's income	$\geq$ GHC 200 = 0, < GHC 200 = 1
	Perception of climate change	Climate change not perceived = 0, Climate change perceived = 1
	<b>Dependent Variable</b>	Children's Nutritional Status
<b>Independent Variables</b>	Mother's age	$\geq$ 20 = 0, < 20 = 1
	Marital status	With partner = 0, without partner = 1
	Household size	< 6 = 0, $\geq$ 6 = 1
	Household head	Other household member = 0, Mother = 1
	Mother's level of education	Above secondary education = 0, below secondary education = 1
	Household head's income	$\geq$ GHC 200 = 0, < GHC 200 = 1
	Household food security	Food secure = 0, food insecure = 1
	Perception of climate change	Climate change not perceived = 0, Climate change perceived = 1

<sup>1</sup>Participants who consumed foods from more than 4 food groups were classified as having high dietary diversity; <sup>2</sup>Participants who consumed foods from four (4) or less food groups were classified as having low dietary diversity

### **3.5.3. Qualitative Data Collection**

#### **3.5.3.1. Procedure for Qualitative Data Collection**

#### **3.5.3.2. The Question Guides for Qualitative Data Collection**

Semi-structured question guides with open-ended questions were used to collect qualitative data. The questions were open ended so as to encourage general discussions and to allow the moderator some flexibility to explore specific issues raised. Major areas that were addressed using the focus group discussion and key informant interviews include:

- Awareness of climate change in the study area
- Possible dietary changes occurring as a result of climate change
- Coping strategies used to offset the negative impacts of climate change

#### **i. Key informant interviews**

With the help of key informants (who were selected with the help of community leaders) from each community, eligible potential participants who would be willing to participate in the key informant interviews were identified. The purpose of the study was explained to these potential participants and they were asked for times that would be convenient for the interviews to be conducted. Verbal consent was also sought prior to inviting them to participate in the key informant interviews.

In all, 11 key informant interviews were conducted. These included two farmers (one male and one female) who were 45 years old or more who had lived in the community for at least 10 years in each of the 4 study communities, three Agricultural Extension Officers. Key informant interviews were conducted in languages which the participants were very comfortable with (Twi, Sefwi and English).

#### **ii. Focus group discussions**

With the help of key informants from each community, eligible potential participants who would be willing to participate in the focus group discussions were identified and the purpose

of the study was explained to these potential participants. Verbal consent was also sought prior to inviting each person to participate in the focus group discussion.

Inclusion criteria for focus group discussion:

A person was considered eligible to participate in the focus group discussion only if he met the following criteria:

- He or she was 30years old or more
- Resident in the community for at least 10years
- Involved in staple crop production

One focus group discussion was carried out in each of the four selected communities and 12 people were invited to participate in each group. The focus group discussions were conducted in Twi and Sefwi to enable all participants understand the questions, contribute and express themselves freely and comfortably. The focus group discussions were held on non-farming days or days which were suitable for the participants. Each focus group discussion was facilitated by a moderator who is fluent in English and the local languages to ensure a good flow of the discussion. One assistant moderator was present to take notes and the researcher assisted with audiotaping. Each focus group was audiotaped and lasted for about 1hour.

Setting:

The focus group discussions were held in places which were easily accessible and quiet and which were not affiliated to any institutions that participants would be uncomfortable with and chairs were arranged in a circular pattern. At the end of each meeting, the researcher showed gratitude to participants and each participant received gifts worth GHC 8.00 in appreciation of their time, patience and contributions.

#### **3.5.4. Analysis of Findings for Qualitative Data**

All focus group discussions and key informant interviews were digitally recorded, transcribed verbatim and translated to English. The transcripts were then coded using NVivo 11 software. During coding, categories were developed, which then evolved into themes and sub-themes. These themes were synthesized, summarized and used in report writing. Similarities and differences across the various groups were noted.

#### **3.6. Quality Control**

To ensure quality of data, field assistants were adequately trained prior to commencement of data collection. Data collection instruments were also pre-tested in a community with similar characteristics to the study community but that was not part of the selected study communities. Questionnaires were reviewed by the researcher after being filled each day to ensure that all questionnaires are completed.

#### **3.7. Ethical Considerations**

The study protocol was submitted for review and approval by the Ethics Committee for Science College of Basic and Applied Sciences (ECBAS), University of Ghana. Potential participants of the study were given consent forms to read to ensure that they understood what the study was about very well before expressing their willingness to participate. For individuals who could not read, the content of the consent form was read and explained to them in their local language before giving their consent, in the presence of a witness.

#### **3.8. Secondary Data Collection**

Climatic data on rainfall and minimum and maximum temperature over a period of thirty (30) years were obtained from the Ghana Meteorological Agency, Accra. This was analysed using Microsoft Excel 2013.

## CHAPTER FOUR

### 4.0. RESULTS

#### 4.1. Quantitative Results

This chapter describes the results obtained in this work and the text is supported by tables and figures.

##### 4.1.1. Socio-demographic Characteristics of Study Participants

In this study, a total of 210 participants were recruited, distributed as follows: 52 participants each from Fahiakobor and Lineso and 53 participants each from Adukrom and Basenkele.

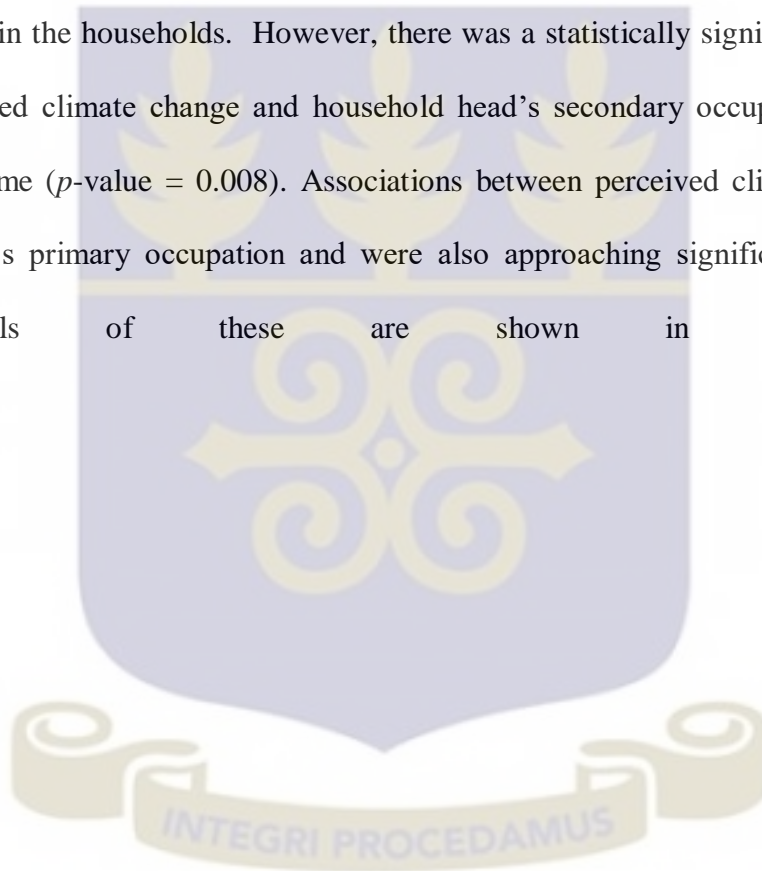
The study participants had an average age of  $30 \pm 10$  years. Majority (82%) of the participants were Akans and 90% identified themselves as Christians. With regards to their marital status, 82% had partners (that is, they were either married or cohabiting) while 18% did not have partners. Seventy-five percent (75%) of the participants had basic education while only 7% had secondary education. For most participants (77%), farming was their primary occupation and the majority (72%), had average monthly income less than GHC 200.00. there were no significant differences between mothers who had perceived climate change versus those who had not in relation to their age, ethnicity, religion, educational background and income. However, there was a statistically significant association between perceived climate change and mothers' marital status ( $p$ -value = 0.024), their primary occupation ( $p$ -values = 0.010), secondary occupation ( $p$ -value < 0.001) and the communities in which they lived ( $p$ -value = 0.001). **Table 4.1** below shows details of the main characteristics of the study participants.

**Table 4.1 Socio-demographic Characteristics of Participants**

Variable	Total Sample	Perceived Climate Change		p-value
	N = 210 (%)	Yes (n = 151)	No (n = 59)	
Age (in years)*	30.3 ± 9.2	30.5 ± 9.5	29.2 ± 8.3	0.751
	n (%)	n (%)	n (%)	
<b>Ethnicity</b>				
Akan	172 (81.9)	122 (70.9)	50 (29.1)	0.504
Others <sup>1</sup>	38 (18.1)	29 (76.3)	9 (23.7)	
<b>Religion</b>				
Christian	189 (90.0)	136 (72.0)	53 (28.0)	0.777
Muslim	19 (9.0)	14 (73.7)	5 (26.3)	
Others <sup>2</sup>	2 (1.0)	1 (50)	1 (50)	
<b>Marital status</b>				
With partners <sup>3</sup>	173 (82.4)	130 (75.1)	43 (24.9)	<b>0.024</b>
Without partners <sup>4</sup>	37 (17.6)	21 (56.8)	16 (43.2)	
<b>Educational background</b>				
No formal education	37 (17.6)	28 (75.7)	9 (24.3)	0.319
Basic education	158 (75.2)	110 (69.6)	48 (30.4)	
Secondary education	15 (7.1)	13 (86.7)	2 (13.3)	
<b>Community</b>				
Basenkele	53 (25.2)	46 (86.8)	7 (13.2)	<b>0.01</b>
Lineso	52 (24.8)	35 (67.3)	17 (32.7)	
Fahiakobor	52 (24.8)	39 (75.0)	13 (25.0)	
Adukrom	53 (25.2)	31 (58.5)	22 (41.5)	
<b>Primary occupation</b>				
Farmer	161 (76.7)	126 (78.3)	35 (21.7)	<b>0.001</b>
Trader	25 (11.9)	13 (52.0)	12 (48.0)	
Others <sup>5</sup>	24 (11.4)	12 (50.0)	12 (50.0)	
<b>Secondary occupation</b>				
Farmer	47 (40.9)	25 (53.2)	22 (46.8)	<b>&lt;0.001</b>
Trader	52 (45.2)	46 (88.5)	6 (11.5)	
Others <sup>6</sup>	16 (13.9)	16 (100.0)	0 (0.0)	
<b>Average monthly income (GHC)</b>				
<100	80 (38.1)	51 (63.7)	29 (36.3)	0.118
100-199	71 (33.8)	55 (77.5)	16 (22.5)	
≥200	59 (28.1)	45 (76.3)	14 (23.7)	

\*mean ± S.D; <sup>1</sup>Including: Ewe (1.4%); Ga-Adangme (4.8%); Northerners (11.9%) <sup>2</sup>Including: Traditionalist (0.5%); No Religion (0.5%) <sup>3</sup>Married (76.2%); Cohabiting (6.2%) <sup>4</sup>Never married (10.9%); Widowed (2.9%); Separated (3.8%) <sup>5</sup>Including: Baker (1.5%); Seamstress (3.4%); Nurse (0.5%); Teacher (0.5%); Not working (0.5%) <sup>6</sup>Hairdresser (3.5%); Seamstress (6.1%); Cook (0.9%); Decorator (0.9%); Student (1.7%); <sup>a</sup>n=1

Most of the participants (75%) reported that their spouse was the head of household and majority of the household heads (81%) either had no formal education at all or had a maximum of basic education. Eighty-five per cent (85%) of household heads were farmers and the majority (82%) had average monthly income less than GHC500. Most households (74%) had only one child who was less than 5 years old. With regards to perceived climate change, the participating households did not significantly differ in relation to household size, head of household, level of education of household head and number of children less than 5 years old living in the households. However, there was a statistically significant association between perceived climate change and household head's secondary occupation ( $p$ -value = 0.001) and income ( $p$ -value = 0.008). Associations between perceived climate change and household head's primary occupation and were also approaching significance ( $p$ -value < 0.1). Details of these are shown in **Table 4.2.**



**Table 4.2 Household Characteristics**

Variable	Total Sample	Perceived Climate Change		<i>p</i> -value
	N = 210 (%)	Yes (n = 151)	No (n = 59)	
<b>Household size *</b>	5.0 ± 2.0	5.7 ± 2.0	5.2 ± 1.8	0.148
	<b>n (%)</b>	<b>n (%)</b>	<b>n (%)</b>	
<b>Head of household</b>				
Mother	32 (15.7)	24 (75.0)	8 (25.0)	0.145
Spouse	159 (75.2)	117 (73.6)	42 (26.4)	
Other household member	19 (9.0)	10 (52.6)	9 (47.4)	
<b>Level of education of household head</b>				
No formal education	44 (20.9)	31 (70.4)	13(29.5)	0.416
Basic education	127 (60.5)	89 (70.1)	38 (29.9)	
Secondary/ Tertiary education	39 (18.6)	31 (79.5)	8 (20.5)	
<b>Primary occupation of household head</b>				
Farmer	178 (84.8)	133 (74.7)	45 (25.3)	0.081
Driver	11 (5.2)	7 (63.6)	4 (36.4)	
Others <sup>1</sup>	21 (10.0)	11 (52.4)	10 (47.6)	
<b>Secondary occupation of household head <sup>a</sup></b>				
Farmer	32 (34.8)	18 (56.2)	14 (43.8)	<b>0.001</b>
Trader	39 (42.4)	35 (89.7)	4 (10.3)	
Driver	8 (8.7)	6 (75.0)	2 (25.0)	
Others <sup>2</sup>	13 (14.1)	13 (100.0)	0 (0.0)	
<b>Income of household head (GHC)</b>				
<200	94 (44.8)	62 (66.0)	32 (34.0)	<b>0.008</b>
200-499	78 (37.1)	54 (69.2)	24 (30.8)	
≥500	38 (18.1)	35 (92.1)	3 (7.9)	
<b>Number of children less than 5 years old</b>				
1	155 (73.8)	111 (71.6)	44 (28.4)	0.929
2	49 (23.3)	36 (73.5)	13 (26.5)	
3	6 (2.9)	4 (66.7)	2 (33.3)	

\*mean ± S.D; <sup>1</sup>Including:Trader (1.0%); Carpenter (2.0%); Plumber (0.5%); Welder (0.5%); Tailor (0.5%); Teacher (1.0%); Mining (1.0%); Mason (1.5%); Mechanic (0.5%); Fetish Priest (0.5%); hairdresser (1.0%) <sup>2</sup>Including: Carpenter (5.4%); Mason (5.4%); Teacher (4.1%); Mining (1.4%); <sup>a</sup>(n=92)

#### 4.1.2. Assessment of Climate Change

**Figures 4.1 to 4.3** show that climate change variables in the study district in terms of temperature and rainfall patterns have been changing between 1986 and 2015. From **figures 4.1 and 4.2**, average annual minimum and maximum temperatures increased by 0.7°C and 1.2°C, respectively from 1986 to 2015. The lowest average annual minimum temperature (22.7°C) occurred between 1986 and 1996 while the lowest average annual maximum temperatures 32.2°C and 32.1°C occurred in 1986 and 1991 respectively. Both minimum and maximum temperatures have been increasing gradually ever since with 2012 recording the highest maximum temperature of 33.3°C and 2015 recording the highest minimum temperature of 23.4°C.

From **Figure 4.3**, there has been a 48.4mm increase in mean annual rainfall with increasing variability in rainfall patterns from 1986 to 2015. These indicate that the climate in this district has been changing over the years and these may have implications for food and nutrition security.



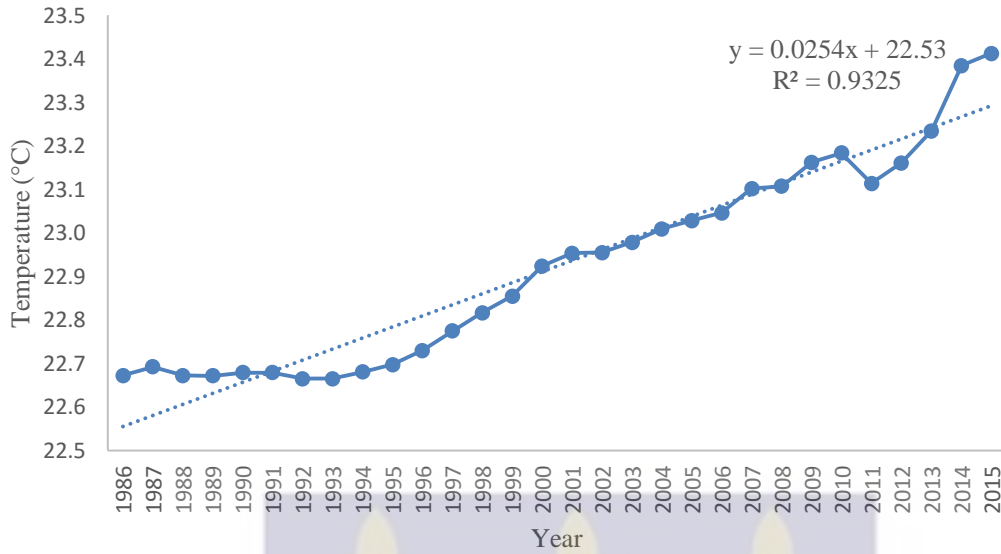


Figure 4.1 Average minimum temperature (°C) from 1986 to 2015 in the Bibiani-Anhwiaso Bekwai District

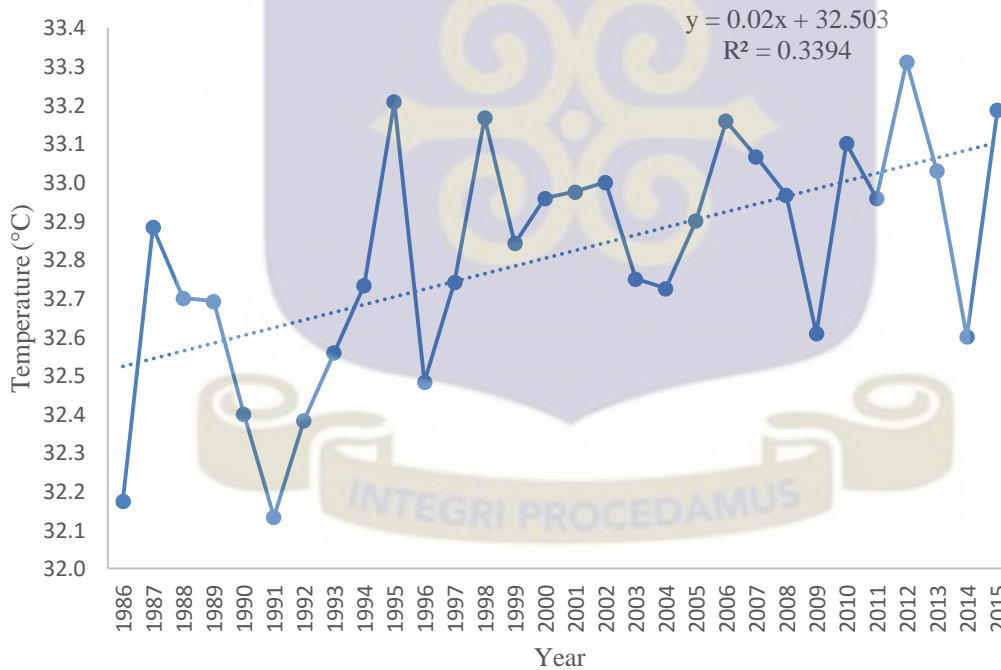


Figure 4.2 Average maximum temperature from 1986 to 2015 in the Bibiani-Anhwiaso Bekwai District in the Western Region of Ghana

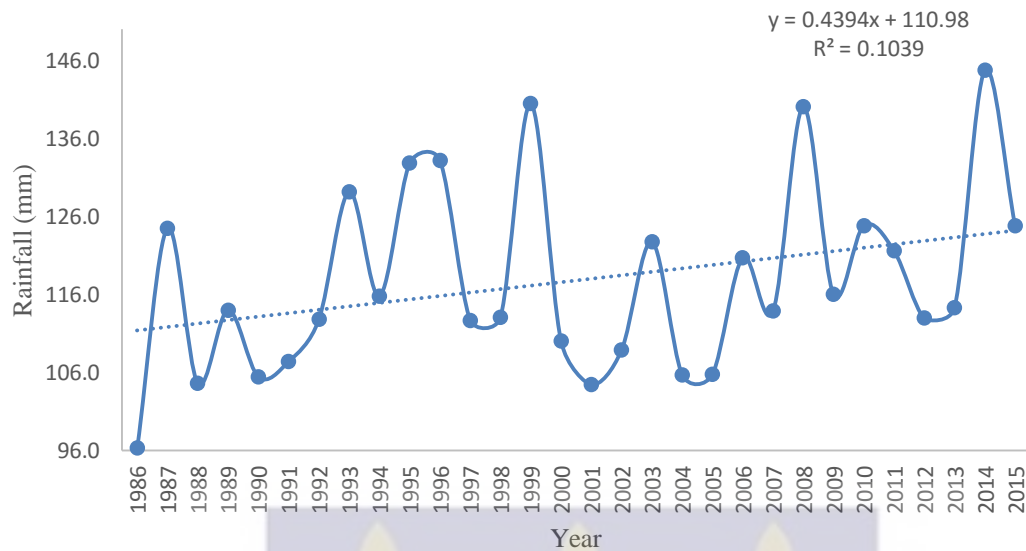


Figure 4.3 Changes in rainfall patterns in the Bibiani-Anhwiaso Bekwai District from 1986 to 2015

#### 4.1.3. Awareness of Climate Change

From responses obtained in this study, about 61% of the participants were classified as being highly aware of changes in climatic conditions in the district and approximately 30% were classified as having average awareness of climate change (**Figure 4.4**). These participants had some knowledge about climate change and could tell its causes, observed changes in temperature and rainfall patterns and some possible effects of climate change. Ninety-two per cent (92%) of participants had perceived changes in both temperature and rainfall patterns and 55% reported that they had perceived either an increase in rainfall or delayed rainfall while 81% had perceived an increase in temperature over the past five years (**Appendix 3**).

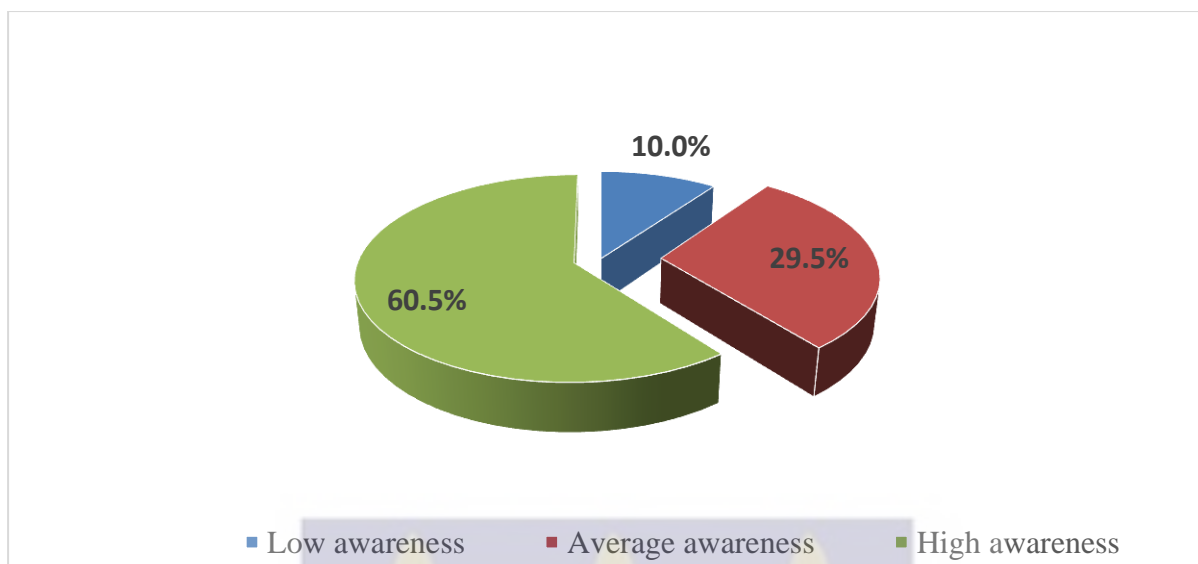


Figure 4.4 Awareness of Climate Change among Study Participants

#### 4.1.4. Household Dietary Consumption Patterns

**Table 4.3** shows the household dietary diversity scores of study participants. From this table, about 53% of study participants consumed food from up to 6 food groups while 47% consumed food from 7 or more food groups.

**Table 4.3 Household dietary diversity scores**

Variable	n (%)
<b>Dietary diversity scores</b>	
Average dietary diversity score (mean $\pm$ S.D)	6.31 $\pm$ 1.3
<b>Dietary diversity groups</b>	
% with lowest dietary diversity ( $\leq$ 3 food groups)	3 (1.4)
% with medium dietary diversity (4 to 6 food groups)	108 (51.4)
% with high dietary diversity ( $\geq$ 7 food groups)	99 (47.1)

**Table 4.4** shows the food groups from which more than 50% of study participants consumed foods. From this table, study participants who consumed food from up to 3 food groups consumed food from the other vegetables, white roots and tubers and fish and sea foods food groups. Those who consumed food from 4 to 6 food groups consumed food from spices, condiments and beverages, cereals and red palm products food groups, in addition to the three (3) food groups mentioned above. The dietary consumption patterns of participants who

consumed food from seven (7) or more food groups consisted of foods from the other vegetables, white roots, tubers and plantain, fish and sea foods, spices, condiments and beverages, cereals, red palm products and sweets food groups. As indicated in **Appendix 6**, few participants consumed foods from the fruits, meat, eggs, legumes, nuts and seeds and milk and milk products food groups.

**Table 4.4 Dietary Consumption Patterns: Food Groups Consumed by  $\geq 50\%$  of Households**

Lowest dietary diversity ( $\leq 3$ food groups)	Medium dietary diversity (4 to 6 food groups)	High dietary diversity ( $\geq 7$ food groups)
Other vegetables	Other vegetables	Other vegetables
White roots and tubers	White roots and tubers	White roots and tubers
Fish and seafood	Fish and seafood	Fish and seafood
	Spices, condiments and beverages	Spices, condiments and beverages
	Cereals	Cereals
	Red palm products	Red palm products
		Sweets

#### 4.1.5. Perceived Climate Change and Household Dietary Consumption Patterns

From **Tables 4.5**, there was no statistically significant association between perceived climate change and dietary diversity scores of households that participated in this study.

**Table 4.5 Relationship between Perceived Climate Change and Dietary Diversity**

Variable	Climate change Perceived		<i>p</i> -value
	Yes (n = 151)	No (n = 59)	
Mean dietary diversity score*	6.4 $\pm$ 1.2	6.1 $\pm$ 1.5	0.130
	n (%)	n (%)	n (%)
High dietary diversity	121 (74.7)	41 (25.3)	
Low dietary diversity	30 (62.5)	18 (37.5)	0.099

\*Mean  $\pm$  S.D

#### 4.1.6. Predictors of Household Dietary Diversity

**Table 4.6** shows that, none of the independent variables in the model were significant predictors of low dietary diversity.

**Table 4.6 Predictors of Low Dietary Diversity**

Variable	OR	95% CI	<i>p</i> -value
<b>Mother's age</b>			
< 20 years	0.85	0.30-2.37	0.754
≥ 20 years	1		
<b>Marital status</b>			
without partner	1.73	0.73-4.10	0.213
with partners	1		
<b>Household size</b>			
≥6	0.87	0.49-1.52	0.620
<6	1		
<b>Household head</b>			
Mother	1.12	0.46-2.77	0.799
Spouse or other household member	1		
<b>Household head's level of education</b>			
Below secondary education	1.31	0.64-2.68	0.464
Secondary education and above	1		
<b>Household head's income</b>			
< Ghc200	1.03	0.59-1.79	0.920
≥ Ghc200	1		
<b>Perception of climate change</b>			
Climate change perceived	1.13	0.60-2.12	0.699
Climate change not perceived	1		

#### 4.1.7. Coping Strategies Used to Offset the Negative Impacts of Climate Change

**Table 4.7** below shows that, the most frequently used coping strategy by households in this study in times when less food was available is reduction of meals of adults in favour of young children. This strategy was adapted by approximately 84% of study participants. This was followed by consumption of less quality and variety of foods, limiting the portion of meals for all household members, reducing the number of meals consumed per day and harvesting immature crops for consumption which were practiced by 79%, 73%, 64% and 55% of study participants respectively.

Most households (85%) watered their food crops using water from other sources to help ensure adequate food production in spite of changes in rainfall patterns and temperature. In about 66% of the households, harvested food crops were dried in order to preserve them. Other households also either buried some of their tubers such as cassava in the ground after harvesting or did not harvest them at all until they were needed as ways of preserving them. **Table 4.7** shows the coping strategies adapted by households in this district to offset the negative impacts of climate change.

**Table 4.7 Coping Strategies Adapted to Offset the Negative Impacts of Climate Change**

<b>Variable</b>	<b>n (%)</b>
<b>Food insecurity coping strategies adapted by <math>\geq 50\%</math> of study participants</b>	
Reduce the meal of adults in favour of children	177 (84.3)
Consume less quality & variety of food	165 (78.6)
Limit the portion of meal for all household members	154 (73.3)
Reduce number of meals per day	134 (63.8)
Harvest immature crops	116 (55.2)
<b>Measures taken to reduce the effect of the changing climate on your food crop production<sup>a</sup></b>	
Watering crops with water from other sources	106 (85.5)
Others <sup>1</sup>	18 (18.5)
<b>Food preservation methods adapted by study participants<sup>b</sup></b>	
drying	119 (66.5)
Others <sup>2</sup>	60 (33.5)

<sup>1</sup>Including: Putting more soil on roots/ adding weeds to soil/ providing shade for young plant to prevent moisture loss (3.2%); Changing planting and harvesting period (7.3%); apply more fertilizer/ chemicals (4.0%). <sup>2</sup> Including: Not harvesting crops until they are needed (5.6%); Burying tubers in the ground until they are needed (8.4%); Smoking cereals (0.6%); drying & not harvesting crops until they are needed (5.6%); drying & burying tubers in the ground until they are needed (6.1%); drying & smoking (7.3%)<sup>a</sup>(n=124);<sup>b</sup>(n=179)

#### 4.1.8. Perceived Climate Change and Food Security

The study participants had average household food insecurity access scale score of  $11 \pm 5$ .

Most study participants (94%) had some form of food insecurity based on responses from the household food insecurity access scale questionnaire (**Table 4.8**).

From **Table 4.9**, there was a statistically significant association between perceived climate change and food insecurity. Participants who had perceived climate change had higher mean food insecurity scores than those who had not ( $p < 0.001$ ). Also, most (64%) of those who had not perceived climate change had lower food insecurity scores (that is, they were more food secure) than those who had perceived climate change ( $p$ -value = 0.009). Details of household food security status and relationship between perceived climate change and household food security are indicated in **Tables 4.8** and **4.9** below respectively.

**Table 4.8 Household Food Insecurity Prevalence**

Variable	n (%)
<b>HFIAS Score (mean <math>\pm</math> S.D)</b>	10.77 $\pm$ 5.2
<b>Food Insecurity Prevalence</b>	
Food Secure	13 (6.2)
Mildly Food Insecure	21 (10.0)
Moderately Food Insecure	78 (37.1)
Severely Food Insecure	98 (46.7)

**Table 4.9 Relationship between perceived climate change and food security**

Variable	Climate change Perceived n (%)		<i>p</i> -value
	Yes (n = 151)	No (n = 59)	
Food insecurity score*	11.9 $\pm$ 4.8	7.8 $\pm$ 5.1	<b>&lt;0.001</b>
<b>High/Low food insecurity score</b>			
Low food insecurity score	67 (63.8)	38 (36.2)	
High food insecurity score	84 (80.0)	21 (20.0)	<b>0.009</b>

\*Mean  $\pm$  S.D; NB: The higher the food insecurity score, the less food secure the household

#### 4.1.9. Predictors of Household Food Insecurity

**Table 4.10** shows that, the food insecurity status of the participating households did not differ statistically in relation to mother's age, marital status of respondents, household size, who the household head was, level of education of household head, income of household head and number of income generators in the household. However, there was a statistically significant association between perceived climate change and household food insecurity status. Households that had perceived climate change were eleven (11) times more likely to be food insecure than those who had not perceived climate change.

**Table 4.10 Predictors of Food Insecurity**

<b>Variable</b>	<b>OR</b>	<b>95% CI</b>	<b>p-value</b>
<b>Mother's age</b>			
< 20 years	0.21	0.03-1.45	0.113
≥ 20 years	1		
<b>Marital status</b>			
without partner	4.9	0.53-44.28	0.16
with partners	1		
<b>Household size</b>			
≥6	0.47	0.12-1.88	0.287
<6	1		
<b>Household head</b>			
Mother	0.235	0.04-2.18	0.235
Spouse or other household member	1		
<b>Household head's level of education</b>			
Below secondary education	1.81	0.41-7.96	0.431
Secondary education and above	1		
<b>Household head's income</b>			
< Ghc200	0.98	0.29-3.29	0.975
≥ Ghc200	1		
<b>No. of income generators</b>			
≤2	1.04	0.23-4.64	0.963
>2	1		
<b>Perception of climate change</b>			
Climate change perceived	10.91	2.72-43.76	0.001
Climate change not perceived	1		

#### 4.1.10. Nutritional Status of Mothers and Children in the Study

From **Table 4.11**, 61% of the mothers had normal BMI (between 18.5 and 24.9 kg/m<sup>2</sup>) while 5% were underweight and 33.4% were overweight or obese. Anaemia prevalence among mothers in this study was also quite low (13.2%).

From **Table 4.12**, 27% of the children under 5years old were underweight, 37% were stunted and approximately 10% were wasted. Also, about 85% of the children under 5years had mid-upper arm circumference (MUAC)  $\geq$ 13.5 cm while 15% had MUAC below 13.5 cm, indicating risk of malnourished.

**Figure 4.5** shows that about 44% of the children under 5years old had at least some form of malnutrition based on their anthropometric measurements while 56% were well nourished. A child was considered to be well-nourished if he or she was not stunted, wasted or underweight and children under five years old who were stunted, wasted or underweight or had two or all of the three conditions mentioned were considered to be malnourished.

Majority (58%) of the children under 5 years old were also anaemic. Details of the nutritional status of mothers and children who participated in this study are shown in **Tables 4.11** and **4.12** respectively.

**Table 4.11 Mothers' Nutritional Status Profile**

Variable	n (%)
<b>Height (cm)*</b>	159.9 $\pm$ 6.2
<b>Weight (kg)*</b>	60.9 $\pm$ 11.4
<b>Mean BMI (kg/m<sup>2</sup>)*</b>	23.8 $\pm$ 4.0
<b>BMI categories</b>	
Underweight	11 (5.2)
Normal	129 (61.4)
Overweight	56 (26.7)
Obese	14 (6.7)
<b>Any anaemia</b>	
Yes	7 (13.2)
No	46 (86.8)

\*Mean  $\pm$  S.D

**Table 4.12 Nutritional status of children under 5years**

Variable	n (%)
Height (cm)*	83.8 ± 12.9
Weight (kg)*	11.13 ± 3.2
Underweight (WAZ<-2SD)	60 (28.6)
Stunting (HAZ <-2SD)	76 (36.2)
Wasting (WHZ <-2SD)	20 (9.7)
MUAC (cm)	
% < 12.5 <sup>1</sup>	3 (1.5)
% ≥ 12.5 < 13.5	29 (13.8)
% ≥ 13.5	178 (84.8)
Any anaemia	
Yes	31 (58.5)
No	22 (41.5)

\*Mean ± S.D <sup>1</sup>% < 11.5 (.05%); % ≥11.5 < 12.5 2(1.0)

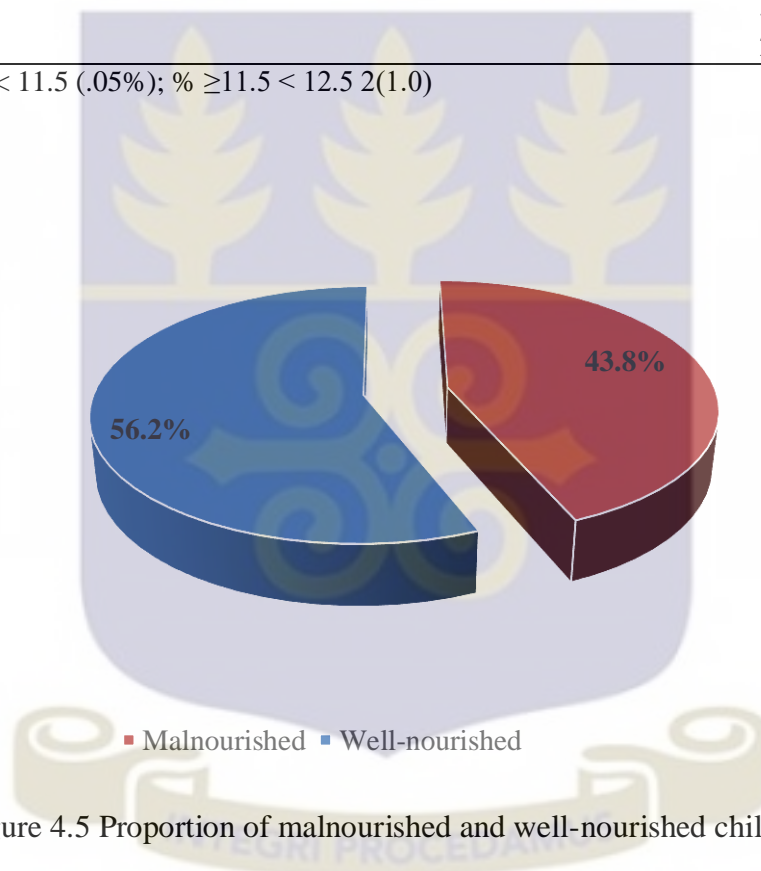


Figure 4.5 Proportion of malnourished and well-nourished children

#### 4.1.11. Perceived Climate Change and Nutritional Status of Study Participants

The nutritional status of children in this study did not differ significantly in relation to perceived climate change however, that of the women interviewed were approaching significance ( $p$ -value  $< 0.1$  for mothers' BMI and Hb). **Table 4.14**, shows that mothers who had not perceived climate change had higher mean haemoglobin concentration than those who had perceived climate change and this was statistically significant ( $p$ -value = 0.004) (**Table 4.13**).

**Table 4.13 Relationship between perceived climate change and nutritional status of participants**

Variable	Climate change Perceived n (%)		<i>p</i> -value
	Yes (n = 151)	No (n = 59)	
<b>Mothers' Nutritional Status</b>			
<b>Mothers' BMI</b>			
Underweight	8 (72.7)	3 (27.3)	0.057
Normal	92 (71.3)	37 (28.7)	
Overweight/ obese	51 (72.9)	19 (27.1)	
<b>Mothers' Hb</b>			
Anaemic	7 (100.0)	0 (0.0)	0.074
Not anaemic	31 (67.4)	15 (32.6)	
<b>Children's Nutritional Status</b>			
<b>WHZ (wasting)</b>			
Wasted	14 (70.0)	6 (30.0)	0.847
Normal	134 (72.0)	52 (28.0)	
<b>HAZ (Stunting)</b>			
Stunted	54 (71.0)	22 (29.0)	0.836
Normal	97 (72.4)	37 (27.6)	
<b>WAZ (Underweight)</b>			
Underweight	41 (68.3)	19 (31.7)	0.466
Normal	110 (73.3)	40 (26.7)	
<b>MUAC</b>			
Undernourished	23 (71.9)	9 (28.1)	0.997
Normal	128 (71.9)	50 (28.1)	
<b>Children's Hb</b>			
Anaemic	23 (74.2)	8 (25.8)	0.632
Not anaemic	15 (68.2)	7 (31.8)	

**Table 4.14 Mean anthropometric and biochemical profile of participants based on perception of climate change**

Variable	Climate change Perceived*		<i>p</i> -value
	Yes (n = 151)	No (n = 59)	
<b>Mothers' Nutritional status</b>			
Mothers' BMI	23.6 ± 3.9	24.3 ± 4.2	0.205
Mothers' Hb	13.0 ± 1.6	14.4 ± 1.3	<b>0.004</b>
<b>Children's Nutritional Status</b>			
WHZ	-0.4 ± 1.6	-0.5 ± 1.2	0.871
HAZ	-1.5 ± 2.8	-1.6 ± 3.2	0.753
WAZ	-1.2 ± 1.7	-1.2 ± 1.9	0.948
MUAC	15.1 ± 1.6	15.3 ± 1.6	0.540
Children's Hb	10.7 ± 1.5	10.8 ± 2.0	0.888

\*Mean ± S.D

**4.1.12. Predictors of Nutritional Status**

**Table 4.15** shows the predictors of Mothers' Nutritional Status as indicated by their BMI.

With the exception of mother's age, none of the variables in this model were significant predictors of maternal malnutrition (underweight among mothers). Mothers who were below 20 years old were 5 times more likely to be malnourished than those who were 20 years old and above.

Household head's income was found to be a significant predictor of child malnutrition. Children from households where the head of household earned less than GHC 200 per month were two (2) times more likely to be malnourished compared to children from households where the head of household earned GHC 200 or more (**Table 4.16**).

**Table 4.15 Predictors of Mother's Nutritional Status as Indicated by their BMI**

<b>Variable</b>	<b>OR</b>	<b>95% CI</b>	<b>p-value</b>
<b>Mother's age</b>			
< 20 years	4.75	1.05-21.51	<b>0.043</b>
≥ 20 years	1		
<b>Marital status</b>			
without partner	1.46	0.27-7.90	0.662
with partners	1		
<b>Household size</b>			
≥6	0.63	0.17-2.35	0.493
<6	1		
<b>Household head</b>			
Mother	0.89	0.14-5.66	0.898
Spouse or other household member	1		
<b>Household head's income</b>			
< GHC200	2.49	0.69-9.07	0.165
≥ GHC200	1		
<b>Perception of climate change</b>			
Climate change perceived	1.21	0.27-5.34	0.802
Climate change not perceived	1		



**Table 4.16 Predictors of Child Malnutrition**

<b>Variable</b>	<b>OR</b>	<b>95% CI</b>	<b>p-value</b>
<b>Mother's age</b>			
< 20 years	1.20	0.41-3.53	0.743
≥ 20 years	1		
<b>Marital status</b>			
without partner	1.45	0.60-3.48	0.406
with partners	1		
<b>Mother's level of education</b>			
Below secondary education	3.32	0.68-7.89	0.179
Secondary education and above	1		
<b>Household size</b>			
≥6	0.7	0.39-1.26	0.231
<6	1		
<b>Household head</b>			
Mother	0.86	0.35-2.12	0.741
Spouse or other household member	1		
<b>Household head's income</b>			
< GHC200	1.87	1.05-3.31	<b>0.032</b>
≥ GHC200	1		
<b>Household food security</b>			
Food insecure	1.16	0.35-3.84	0.810
Food secure	1		
<b>Perception of climate change</b>			
Climate change perceived	1.27	0.65-2.47	0.488
Climate change not perceived	1		



**4.1.13. Food Security and Nutritional status**

From **Table 4.17**, there was no statistically significant association between household food security status and nutritional status of both mothers and children below five (5) years. Even though there were no significant associations between food insecurity and children's nutritional status as shown in Table 4.18, there were tendencies of association between household food security and mothers' BMI ( $p$ -value  $< 0.1$ )

**Table 4.17 Mean anthropometric and biochemical profile of participants by household food security status\***

<b>Variable</b>	<b>Food secure n (%)</b>	<b>Food insecure n (%)</b>	<b><i>p</i>-value</b>
<b>Mothers' Nutritional Status</b>			
BMI	24.2 ± 4.2	23.3 ± 3.7	0.100
Hb	13.7 ± 1.3	13.1 ± 2.0	0.279
<b>Children's Nutritional Status</b>			
WHZ (Wasting)	-0.3 ± 1.5	-0.5 ± 1.4	0.340
HAZ (Stunting)	-1.7 ± 2.9	-1.3 ± 2.9	0.359
WAZ (Underweight)	-1.2 ± 1.7	-1.2 ± 1.8	0.869
MUAC	15.1 ± 1.6	15.2 ± 1.6	0.662
Hb	10.7 ± 1.8	10.9 ± 1.5	0.713

\*Mean ± S.D



**Table 4.18 Relationship between food security and nutritional status**

<b>Variable</b>	<b>High food security n (%)</b>	<b>Low food insecurity n (%)</b>	<b>p-value</b>
<b>Mothers' Nutritional Status</b>			
<b>BMI</b>			
<18.5	4 (3.8)	7 (6.7)	
≥18.5 <25	66 (62.9)	63 (60.0)	
≥25	35 (33.3)	35 (33.3)	0.086
<b>Anaemia Prevalence</b>			
Anaemic	2 (6.7)	5 (21.7)	
Not anaemic	28 (93.3)	18 (78.3)	0.108
<b>Children's Nutritional Status</b>			
<b>WHZ (Wasting)</b>			
< -2 S.D	11 (10.8)	9 (8.6)	
≥ -2 S.D	91 (89.2)	95 (91.3)	0.606
<b>HAZ (Stunting)</b>			
< -2 S.D	37 (35.2)	39 (37.1)	
≥ -2 S.D	68 (64.8)	66 (62.9)	0.774
<b>WAZ (Underweight)</b>			
< -2 S.D	30 (28.6)	30 (28.6)	
≥ -2 S.D	75 (71.4)	75 (71.4)	1.000
<b>MUAC</b>			
≤ 13.5	14 (13.3)	18 (17.1)	
> 13.5	91 (86.7)	87 (82.9)	0.442
<b>Anaemia Prevalence</b>			
Anaemic	19 (63.3)	12 (52.2)	
Not anaemic	11 (36.7)	11 (47.8)	0.414



## **4.2. Qualitative Results**

### **4.2.1. Key Informant Interviews**

Key informant interviews (KII) were used to find out about awareness of climate change in the district, impact of climate change on household dietary consumption patterns and the coping strategies adapted by farmers to offset the negative impacts of climate change. The key informants involved in this study were three (3) Agricultural Extension Officers, made up of two males and a female, and eight (8) farmers who had lived in the Bibiani-Anhwiaso Bekwai District for at least 10 years. The farmers were all 45 years old and above and these included 3 males and 5 females. All the key informants were Akans.

#### ***4.2.1.1. Major Themes***

In all 11 key informant interviews, similar themes and subthemes emerged. As reported below, the main areas of discussion were awareness of climate change in the study district (knowledge about climate change, causes of climate change, perceived climate change in the district), impacts of climate change on dietary consumption patterns and coping strategies adapted to offset the negative impacts of climate change.

#### **i. Awareness of Climate Change in the Study District**

##### ***a. Knowledge about climate change***

In all but one key informant interviews, participants defined climate change per their knowledge as changes in the normal rainfall patterns and temperature. Below are some of the responses received from two key informants, both farmers when they were asked what they knew about climate change:

*“Climate change is the change in the way the sun shines and how the rainfall starts and stops which we do not see it like that now. That is what I will say climate change is to us farmers”*

*“When we say climate change, what I know about it is that, as we move forward, in the past how it used to rain, now we do not get it like that. At first,*

*the weather looked cold but now the weather is hotter than it used to be in the past. This means the weather has changed.”*

An Agricultural Extension Officer put it this way when asked what he knew about climate change:

*“... so I will say it is the change of rainfall patterns and all the climatic factors with time.”*

***b. Causes of climate change***

All key informants attributed changes in rainfall patterns mainly to deforestation. From interviews with both farmers and Agricultural Extension Officers, it came up that people usually cleared the forest in order to farm or build houses. Two farmers also mentioned bush burning as another way by which the forests were sometimes destroyed.

During interviews with Agricultural Extension Officers it was mentioned that release of carbon dioxide into the atmosphere as well as changes in the movement of the earth and sun are also possible causes of climate change. Some responses in relation to the causes of climate change received from farmers are indicated below:

*“The little I know about it is that, in the past, when our forefathers were alive and they were into farming, there was much rainfall than we have today. There were trees around us. They were not cutting down the forest trees so we had much rain which made farming attractive. Since they cut down the trees, it does not rain much as compared to past years.”*

*“In my opinion, the causes of climate change are in part due to human activities. All the forests we used to have here have been destroyed. They have used all for farming.....they have used it all for farming. In this community, our forest was at Aboduabo (nearby community), so when it is cloudy here,*

*you could tell it will rain. But now that the forests have been destroyed, the rain can scatter and there is little rainfall. So the causes are mainly from human activities, the indiscriminate cutting down of trees and the use of our forest for farming has resulted in the little rainfall. So most of these things are from our own activities.”*

*“Another cause may also be from bush burning. Fire can burn most of our trees too. Now our forest is turning to desert. In the past, you cannot see the nearby community because there were big trees around us. But now we can see the next community and the one behind. So you can see that, as time goes on, our forest is turning to be a desert.”*

Responses from KIIs with Agricultural Extension Officers also showed that the causes of climate change could be as a result of natural factors or anthropogenic factors. This is reflected in responses similar to this:

*“There are so many causes, some we may not understand. People are ascribing it to the cosmic movement. The earth movement, the sun movement, some have ten year occurrences, all these things, are contributing to climate change. And now some people are ascribing it to carbon release and other things but one significant issue which is man-made is deforestation.”*

***c. Perceived climate change in the Bibiani-Anhwiaso Bekwai District***

In all key informant interviews with both farmers and Agricultural Extension Officers, participants reported that the weather had become unpredictable. They experienced sunshine in times when they expected rainfall and it rained when rainfall was not expected, destroying most of their crops. Participants also reported that they experienced less rainfall which was

usually delayed. The following are some responses from farmers concerning perceived climate change in the district:

*“What I know is, in the past, when we were sure in the fourth month (April) it will rain, today it has changed. When you wait for the rain in the fourth month today, it will not rain, when you think there will be sunshine in the third month (March) that is when it will rain. The way God used to give us rain and sunshine has really changed. We do not have it like that now.”*

*“In the past, we knew which month it will rain and if we expected sunshine, the sun shines but now we do not see it like that.”*

*“In this community, what I have observed is that, around 1970’s where I started farming, in the past; there was timely rainfall around June –July. So around this time we relied on the rainfall. We started our farming activities in somewhere May and expected the rainfall in June-July. But right now, it is not like that. Today, as you wait for the rain, it might come somewhere October or November instead of the June-July you were expecting. So a lot of things have changed in this community.”*

Responses such as these indicate what Agricultural Extension Officers had perceived concerning climate change within the district:

*“First we knew that it used to rain at the right time but now it has changed. Even now, the season we are in is almost becoming like one season because even looking at last year, from June it didn’t rain for a long time so it affected us very much. It affected the crops we grow very much. Even though some of*

*the crops yielded some fruits, most of them didn't do well because the farming is mainly rain-fed."*

*"The volume and pattern have changed. The quantity that used to fall at first does not fall like that again. The temperature is increasing. We can say that the savannah is catching up with those of us in the forest areas. You will notice that towards the Harmattan period in September- October, you will see that the temperature is high."*

**ii. Impact of Climate Change on Dietary Consumption Patterns**

The changing climate in this district makes farmers food insecure. In response to questions concerning how the changing climate had been affecting their dietary consumption patterns, participants in all key informant interviews mentioned that the changing temperature and rainfall patterns were reducing crop yield and making food less available. Farmers who would otherwise depend on the crops they produced for consumption now had to buy food from the market. In two key informant interviews, participants also mentioned that the decrease in crop yield as a result of changes in rainfall patterns had caused an increase in some food prices. Eight key informants, who were farmers said the changes in temperature and rainfall had brought them hunger. They also mentioned that they were unable to eat the types of food they wanted to eat because of the impact the changes in rainfall patterns had on their crop yield.

The changes in temperature and rainfall patterns reduced availability of food to the extent that the quantity of food consumed by household members had to be reduced. Some also reduced the number of meals consumed per day since there was less food available for consumption. During interviews with all three Agricultural Extension Officers, they added that the changes in temperature and rainfall patterns had affected the availability of fruits and vegetables. Some farmers described the situation of farming households in statements such as these:

*“As I mentioned to you, our crops have failed us. Now even with maize we have to buy it from Bibiani (nearby town) and there is no money. It has affected the food we eat. Our women even buy these vegetables from the market which may cost up to GHC10. If you do not have that money it will be difficult to feed yourself.”*

*“When we do not get enough food from the farm, it brings hunger to households. We may not get maize to prepare ‘banku’ even if we got maize to prepare ‘banku’ there might not be okro to prepare soup because of the strong sun. It has destroyed all the okro crops. You could have even got 50 pesewas okro to prepare soup but because we did not get enough from the farm the okro will sell for GHC1.0 instead of the 50 pesewas which might not be enough. It affects the way we eat. You do not get enough food to eat.”*

Two key informants (both farmers) described the impact of climate change on quantity and number of meals consumed per day with the following responses:

*“In years back when we were not feeling the impact of climate change, we were not buying food from outside; we got a lot of food from our farms; cocoyam, plantain, cassava, yams and the rest..... Today there is hunger in our households and everybody buys food from outside. We buy food from outside. People eat in the morning when going to their farms and do not take in food again till evening. Even with the evening food, they have to go and buy it from outside. So the climate change is affecting us.”*

*“We do not get much food to eat as we used to eat in the past. You got little food from the farm, and maybe you have 4 or 5 children, how will it be sufficient for all of you. You will have less food to eat.”*

Interviews with Agricultural Extension Officers also revealed that the changing temperature and rainfall patterns made fruits and vegetables less available.

*Now, the vegetables, kontomire, aleefu... that we have to use to support our food, we don't eat them because they are not there. And even when they will come, they are small small and insects have torn some so even if you eat them, you cannot get any nutrients from it. And even when you are going to buy it, it is not nice for you so you will leave it.*

*"Because the yield has reduced and as for the population, it just keeps growing. So people will go for the small yield and they have to go and buy foreign people's food (imported food) to go and eat. For instance if you look at Lineso, because their rice didn't grow well, most of them have to come and buy imported rice. And if you look at cassava, now cassava has become expensive because of the rainfall pattern or let me say climate change. Even maize, this year like this, maize is going high. It is going high and if it doesn't grow well in the North too, then it will go very high because if this one gets finished, they go to Tekyiman to get some. So if it doesn't rain in Takyiman and the North too, then definitely, it will affect the Lineso people and the people in this district."*

### **iii. Coping Strategies Adapted to offset the Negative Impacts of Climate Change**

In order to cope with the negative impacts that come along with the changes in temperature and rainfall patterns, five key informants (two farmers and three Agricultural extension officers), mentioned that farmers store some of the harvested food when they have little harvest and fall back on the stored food in lean seasons. Two key informants mentioned diversification of livelihoods as an alternative way of offsetting the negative impacts of the changing climate on food security. Three other key informants who were all farmers

mentioned that they usually had to go for loans to be able to meet the needs of their households. All key informants also mentioned that farmers adapted some measures to improve crop yield in order to offset the impacts of the changing weather pattern on their crop production. Some responses from key informants concerning coping strategies used by farmers are as follows:

### ***Using stored food crops***

*“If I do not get enough from the farm, let us say I get only two baskets of tomatoes, I will put one in the house to use and sell the other one for people to also get some to buy”*

*“As farmers our food.....plantain is a seasonal crop. Something we can keep is maize. For maize if we get little from the farm, we keep them in silos. But it might not be enough and it comes in hardship times, around June-July. If the farmers hired labourers for the farm, then he has to sell it. When the maize is enough we keep some in silos so we can rely on them as time goes on.”*

This was an Agricultural extension officer’s response when asked about how farming households cope when harvest is poor:

*“In terms of food consumption, they store. If they notice that this year, food will not be available, they store all the small ones that they will get, they will not use it roughly. Maybe dashing people. They will keep it. But where they do not have any power on the ..... they don’t do anything.”*

### ***Diversification of livelihoods***

In statements such as these, some farmers explained how they were coping with the negative impacts of climate change by looking out for alternative sources of income:

*“I sell the eggs and hens. This Christmas, I announced the availability of poultry in my house for people to come and buy. Some people also used to work on getting charcoal to sell but now the trees are all finished. There are no charcoal businesses; so some of the boys are working in saw mills while others have ventured into rice farming in addition to their work.”*

An Agricultural extension officer expressed his view on the use of alternative sources of income as a way of coping with the negative impacts of climate change this way:

*“Now most people have learnt how to eat rice! Imported rice, so they go and buy rice and eat it like that. But if you don't get enough money from your farm to buy food, then you will go into hardship. So now, we encourage them to do livestock farming so that the eggs can help them small. But even the climate change affects the animals that they rear because if you rear cow or goat and it doesn't rain and you don't get food for your animals it means you have to open them and they will go and eat someone's food so they have been banned from rearing those animals.”*

### ***Acquisition of loans***

Statements such as these reflect some actions that farmers take to meet the needs of their households while experiencing some negative impacts of climate change:

*“It brings problems to us. We go for loan to survive. We go about to ask people; gentleman give me something small.....gentleman give me something small. We go about for loan.”*

*“When harvest is poor, the little we get from our farms, we make sure it will be sufficient for our family. Maybe you might not have money to buy. This is what brings hunger because you have to eat less food. Again, you might have*

*children who may go to school; if your sole work is farming and the weather changes and you do not meet your target, then you have to go for loan, you have to ask for loan to cater for your children.”*

#### **iv. Measures Adapted to Improve Crop Yield**

In all key informant interviews, participants mentioned that farmers, in order to protect their crops from the negative impacts of climate change watered their crops with water from other sources, applied more fertilizer or other chemicals while others adjusted their planting times and only prepared their farms and planted crops after seeing signs that they would have some rainfall. The following are some responses from key informants based on the various measures adapted:

##### ***Watering crops with water from other sources***

*“Hmm!! Sometimes we fetch water to water our crops. But at times the rivers get dried.”*

*“Those of us closer to water, we get wells near our farms to water our crops. If you think you will grow pepper, you get your well to water them. That is all we can do. We have nothing to do again; we all improvise.”*

*“When the rainfall does not come after growing my crops, I fetch water to water the crops. I will water them in the morning and the evening. I do not water them in the afternoon because the sun will dry them. So I water the crops early in morning and late evening around 6:00pm. This is what I do to protect my crops from destroying. When other people see how my crops are growing well they will learn from me.”*

***Applying more chemicals/ fertilizer***

*“Now farming activities is different from how we used to farm in the past. Everything has changed. In the past years we grew our crops without applying anything (chemical), we only rely on the rain and we got more yield. Now if you grow crops and you do not apply anything (chemical) to them it does not bear much fruit. Even with the application of chemicals, there are fewer yields. We did not experience these in the past.”*

*“At first, when it could rain much, we were not applying fertilizer to our cocoa crops but we got much yield but because the climate has changed unless you apply fertilizer before you can get much. Our forefathers used to apply only one DDT to their crops but now we have to apply like 2, 3 to 4 times before we get many pods from our cocoa. The climate here has changed.”*

***Changing planting time to meet suitable weather***

*“I prepared a land to grow okro and I was expecting the rainfall but it never came, so I could not grow them. If I did, they would not have germinated. The land is still there. I am still waiting for the rain to start before I grow them. If I grow them and the rain still does not come then I will run at a lost. Have you seen that?”*

#### **4.2.2. Focus Group Discussion**

Four focus group discussions were held to find out about awareness of climate change in the district, impact of climate change on household dietary consumption patterns and the coping strategies adapted to offset the negative impacts of climate change. Participants in all focus group discussions were farmers who were 30 years old or more. Three focus groups were made up of both males and females (27 males, 15 females) while one was made up of only males (n=14). The participants were all Akans who either spoke Sefwi or Twi.

##### ***4.2.2.1. Major Themes***

Similar themes and subthemes emerged in all four focus group discussions. As reported below, the main areas of discussion were, awareness of climate change within the district (knowledge about climate change, causes of climate change and perceived changes in weather patterns within the district over the years), impacts of climate change on dietary consumption patterns of farming households within the district and coping strategies adapted to offset the negative impacts of climate change.

#### **i. Awareness of Climate Change within the District**

##### ***a. Knowledge about Climate Change***

In all focus groups, participants defined climate change as changes in the normal rainfall patterns which cannot be predicted. Participants explained that experiencing sunshine when it is expected to rain and experiencing rainfall in times when it is unexpected which is different from what used to be experienced in years past can be associated with climate change. The responses below illustrate what some participants knew about climate change:

*“What I can say about it is that, for instance, is how the rainfall and dry season is changing. Let us say, the time it has to rain, it does not and the sun shines to destroy crops. That is climate change to my knowledge.”*

*“When we look at some years back, our normal system of the weather we were seeing, now it has changed. Like we know that from June-July it rains but now*

*during June it does not rain. The time you need rainfall, there will be no rainfall and when you need the sun, there will also be no sunshine. That is what I think is climate change.”*

***b. Causes of climate change***

Deforestation was the main cause that participants attributed changes in weather patterns to. Participants mentioned that destruction of forest trees for timber and farming as well as bush burning in search of bush meat were the causes of changes in weather patterns, specifically, changes in rainfall patterns. Other causes mentioned in two focus groups include the use of big machines and cars which produce fumes from combustion of fossil fuel. These responses reflect what participants in the focus group discussions had to say about the causes of climate change:

***Deforestation***

*“In this area, Lineso here, at first we did not use our forest for farming. We were not using our forest, so many times you will see that there is forest around us; so the rain could take the moist from the earth and send them upwards for us to get rain. Now we have used all our forest for farming. Everybody is doing rice farm, which is also one factor that is causing climate change.*

*Again in this community, because of the mining activities, the whites were growing trees around, tick and the rest which were protective that no one could cut them. People feared that if you cut them you would be arrested. So you could see that there were forests around us; even if we would make farm, we used small land so it helped us have timely rainfall. Today since the mining collapsed, you cannot see any tree, the land is just bare. It has brought changes to this community.”*

*“Please, another cause is that, now there is no forest around. You cannot find forest anywhere. All our forest has turned to ‘acheampong’ (bare land). It cannot cause rainfall. That is also part of the causes.”*

*“For me, what I know is that, where there is much forest, there is rampant rainfall. We have destroyed all our forest and the land is now bare that is why the rainfall pattern has changed like that.”*

*“Again, bush burning.....people burn our lands in search of bush meat. Every year, we burn our farms. All these are the causes.”*

#### ***Use of fossil fuel***

*“I think the use of big machines in cities which sends smoke to the weather is causing it”*

*“Me too, mine is that, when we look at first, the machines we are using in Ghana now. The cars, the fumes from cars rise up to affect the system.”*

#### ***c. Perceived climate change in study district***

In all focus groups, participants reported that the weather had become unpredictable. They experienced sunshine in times when they expected rain and it rained when they did not expect rainfall. In some cases, the rain delayed and it rained when rainfall was not needed. Some participants described the situation by giving the following responses:

*“There have been changes. There have been changes. As I was saying, there have been changes in rainfall pattern. It does not rain as it used to be like 10 years back. When it is time to rain for the small pods from our cocoa to mature, we will be experiencing sunshine and this destroys the cocoa. You see!! When it is time for sunshine too, then it rains and the mature pods also get rotten.”*

*“But I say something, when we talk of climate change, it is a change we see now in this world particularly in this area, the rainfall pattern has changed. At first we had rainy season and dry season. In the rainy season, we knew the months it fell into so is the dry season. Now these changes have been combined. Now we cannot tell which particular season this particular crop will fit for. It’s lucky, we stake the lotto and if you are lucky you win.”*

*“When we look at some years back, our normal system of the weather we were seeing, now it has changed. Like we know that from June-July it rains but now during June it does not rain. The time you need rainfall, there will be no rainfall and when you need the sun, there will also be no sunshine.”*

*“The raining season we saw from the time of our forefathers is not like that now. They started growing their crops when it is time for the raining season and they grew nice. But this season we are in now, you cannot tell which particular season, whether June, July or August all have been combined. There can be dry season even in July that we know it is raining season and extends to August.”*

**ii. Impacts of Climate Change on Food Security and Dietary Consumption Patterns**

In all four focus groups, participants mentioned that changes in weather particularly the unpredictable nature of rainfall had brought about some form of food insecurity in their households. The changing weather destroys most of their crops, leading to reduced yield and income. This makes their households go hungry since food becomes less available. In two focus group discussions, it came up that some farmers incur debts when their crops get destroyed as a result of changes in rainfall patterns. This is because, they borrow money to

purchase seeds and suckers to plant with the intention of paying back after harvesting and selling crops. This affects their ability to access food to feed their households.

It also came up in three focus groups that households were unable to eat the kind of food they would normally like to eat because of the changes in crop production occurring as a result of changes in rainfall patterns. In some cases, farmers who would otherwise depend on the crops they produce for consumption are forced to purchase food from the market. The impacts of the changing weather patterns on food availability and access were reflected in statements such as these:

*“The food they are talking about, we do not even get some to eat. The whole community, we do not have cassava, who is going to sell for others to buy? Since the weather has affected our yams too, we do not have much to eat. We have difficulty in getting food to eat. The weather has destroyed all our crops. From March onwards, come here and observe the way we eat; you will see that we are dying out of hunger.”*

*“It has brought extreme poverty to us. Let me tell you something, I planted over 1000 plantain suckers this year and was expecting timely rainfall and the rain failed me and all was almost destroyed. I was expecting one trip of bunches of plantain of the “motor KIA” every two weeks, the weather destroyed almost all the plantain I planted. When I go to the farm I could only harvest two or three bunches of plantain. Do we push car with this? Why won't it bring poverty to you? You might have invested much on the farm and was expecting the money back but you will not get it. It has brought debt to us. There is also hunger. Right now I do not have cassava because my cassava did not grow well; I harvested all of them like that. I also crave for “fufuo”, if you*

*go to the market and you do not get some, you sleep with hunger. So, all these have brought to us hunger and poverty.”*

*“We do not get yams from our farms as we used to get in years back. This has brought hunger in our eating. We do not get food to eat. The little you will get to share with your children and family is very difficult.”*

*“What I know is, because of the changes in weather conditions, our ways of eating too have changed. At first, ‘banku’ (a local food) was not our (sefwi’s) food, and akpele (local food) and other foods was not our staple food. Ours was ‘ampesi’ and “fufuo”. If we were changing these foods, then it is at the end of the year (Christmas) where we eat rice. Because the weather has changed, we do not get what we want to eat”*

### ***Decreased quantity of food and number of meals consumed per day***

In three focus groups, participants reported that the changes in weather reduces availability of food to the extent that the quantity of food consumed by household members has to be reduced and some households have to reduce the number of meals consumed per day. These issues were raised in responses such as these:

*“Now we do not have as much as we used to do. We cannot eat three times a day. Some years back, we had plenty cassava, plantain, cocoyam to cook but now we do not have them. Now we eat rice like those of you in the cities. Rice was not our staple food for those of us in the village.”*

*“Because of how thing have changed and the debt it has brought to us, if it is two cups of rice you will share with your wife and children, you have to reduce it because you will not get normal as you want it. If you eat twice a day, you have to eat once a day now. We are dying out of hunger here.”*

### ***Decreased dietary diversity***

In two focus groups, participants reported that they no longer had varieties of food to eat. Fruits and vegetables were now scarce and they had to consume the same kind of food daily.

*“I will say something. You were asking how it has affected our way of eating in our various households. Now our way of eating is one way. What is one way? If you wake up in the morning and you do not eat “fufuo” .....if you eat “fufuo” in the morning, you will eat it again in the evening, if you eat ‘banku’ in the morning, you will eat it again in the evening. Our food has been one way; maize, cassava; maize, cassava. You do not actually get fruits to eat to help your health. So our eating has been really one way.”*

*“As they are saying. At first, where it could rain, you could get cocoyam, plantain and cassava. The more you are eating varieties of food, it gives you good health. Now it is dry season, my plantain did not grow well, I am only left with cassava, if I eat that one alone, it will give me “effect”. If it had rained, I could have had plantain. As human, you cannot eat one type of food; ‘kontomire’ is in abundance, ‘kwansusa’ (local vegetable) is available, all boost our blood level and gives us good health. Now it cannot rain so we cannot get these vegetables. Now our food has been one way. At first there were even banana which all helped our health. Now because of rainfall failure, all our food has been one way, if it is cassava, it is only cassava. Do you get what I mean? It has brought sickness to us.”*

*“Please, now, all we are saying go to rainfall failure. As we speak I have plantain of fire, because I do not have money to buy garden eggs, I just added salt. At first, where we had much rainfall, I could have added okro, garden*

*eggs to my plantain. Now the climate change is affecting the way we eat in our households.”*

*“It has also resulted in feeding on only one type of food. Rice, rice, rice.....if the climate had not changed we could have gotten varieties like we today, you will eat rice, tomorrow, plantain, “fufuo”, but now, each day if you are not careful, you will eat rice in the morning, afternoon and even in the evening. You see!!”*

### **iii. Coping Strategies Adapted to Offset the Negative Impacts of Climate Change**

Four main coping strategies were identified in the four focus groups. In order to be able to meet the dietary needs of their households, farmers resorted to storing harvested food without selling them when harvest was low, acquisition of loans, depending on other farmers for food and diversification of livelihoods. In all four focus groups, some participants mentioned that farmers also adapted measures such as watering their crops to improve crop production when it doesn't rain as they expect.

#### ***Storing food without selling any when harvest is low***

*“When we get plenty from our farms; that is when we sell some. But when harvest is poor, we feed ourselves and our families. We do not sell.”*

*“For farmers, we sell only when we have plenty to eat. But now harvest is poor.”*

#### ***Acquisition of loans***

*“If you put all your hope on the farm and the crops do not produce much yield, it brings to you hardship. Here in this community, we rely on our farms to cater for our children in school; that is what we use to do everything. If the crops fail you, then you have to go for government loan or loan from the bank.*

*There are difficulties in paying such loans too; it brings hardship to us. When the crops fail us like this, we go for loan.”*

*“The issue is when we do not get much from our farms; we go for loan from cocoa buyers and promise to pay at the end of the year, cocoa season.”*

#### ***Diversification of livelihoods***

*“What we do is that, when your crops do not grow well for you, you have to find another business to do. You have to find another business to venture into to survive.”*

#### ***Depending on other farmers (family and friends) for food***

*“This community we are, one thing I like about this community is that.....since we were all born here, we are all one family. When the weather fails us like that, it is not likely that it will affect every farmer, at least one or two farmers .....because we all do not start farming at the same time, so the rainfall may not fail all farmers. When this happens and you are in need your brother or sister can get you some food like maize and cassava. That is what we do to support ourselves in this community. Had it not been that then death is what we would be left with.”*

#### **iv. Measures Adapted to Improve Crop Production**

In order to improve crop production in the face of the changing climate, some farmers water their crops using water from other sources without depending entirely on rainfall. Others apply fertilizer and other chemicals including DDT to their crops and some also wait until it starts raining before planting their crops. The following are some responses from participants on measures that farmers adapt to improve crop production:

*“As I speak, I have made maize farm, in no time, I am going to fetch water to water them. When we do this, we get little from our farms but there is no river around like that to water your crops.”*

*“Again, as our mother was saying; at first, where it could rain, when you grow your crops, you get bigger and higher yield but now they are small. The cocoyam and cassava become smallish. This has brought difficulties in our way of eating because we have to apply chemical... Because it does not rain, we have to apply chemicals to the crops and patiently water the crops so that it may help.”*

*“Me too, as farmers, we study the rainfall pattern carefully and adjust our farming activities. At first, if the rain was falling in March and it is no more raining in March but August, we farmers have to change our farming activities to suit the changing climate.”*

*“What we are doing to prevent the changing climate from affecting us is that, right now, we are studying the weather changes to grow our crops. We are also looking forward to receiving information as to the best season to start farming and grow our crops. Now we are studying the weather with our own home knowledge, we do not have that technical knowledge so if we receive it from you later, we will be very happy.”*

**v. Setbacks to Adaptive Strategies used to Improve Crop Yield**

It came up in three focus groups that though farmers try to improve crop yield by watering their crops with water from other sources aside rainwater, these water sources also sometimes dry up. This was evident in statements such as the following:

*“Me too, I know that, at first as we are saying, when we were young, we had rivers here. Me I was at “Bayerebon”. We left rivers in our forest. Now we have used our rivers for farming. We grow crops like maize and rice in the rivers. Now dry season do not even start before these rivers get dry. If you grow tomatoes like this, at first you could get water to water them even in the dry season, but now all the rivers are dried because of the sun”.*



### Summary of Findings from Focus Group Discussions

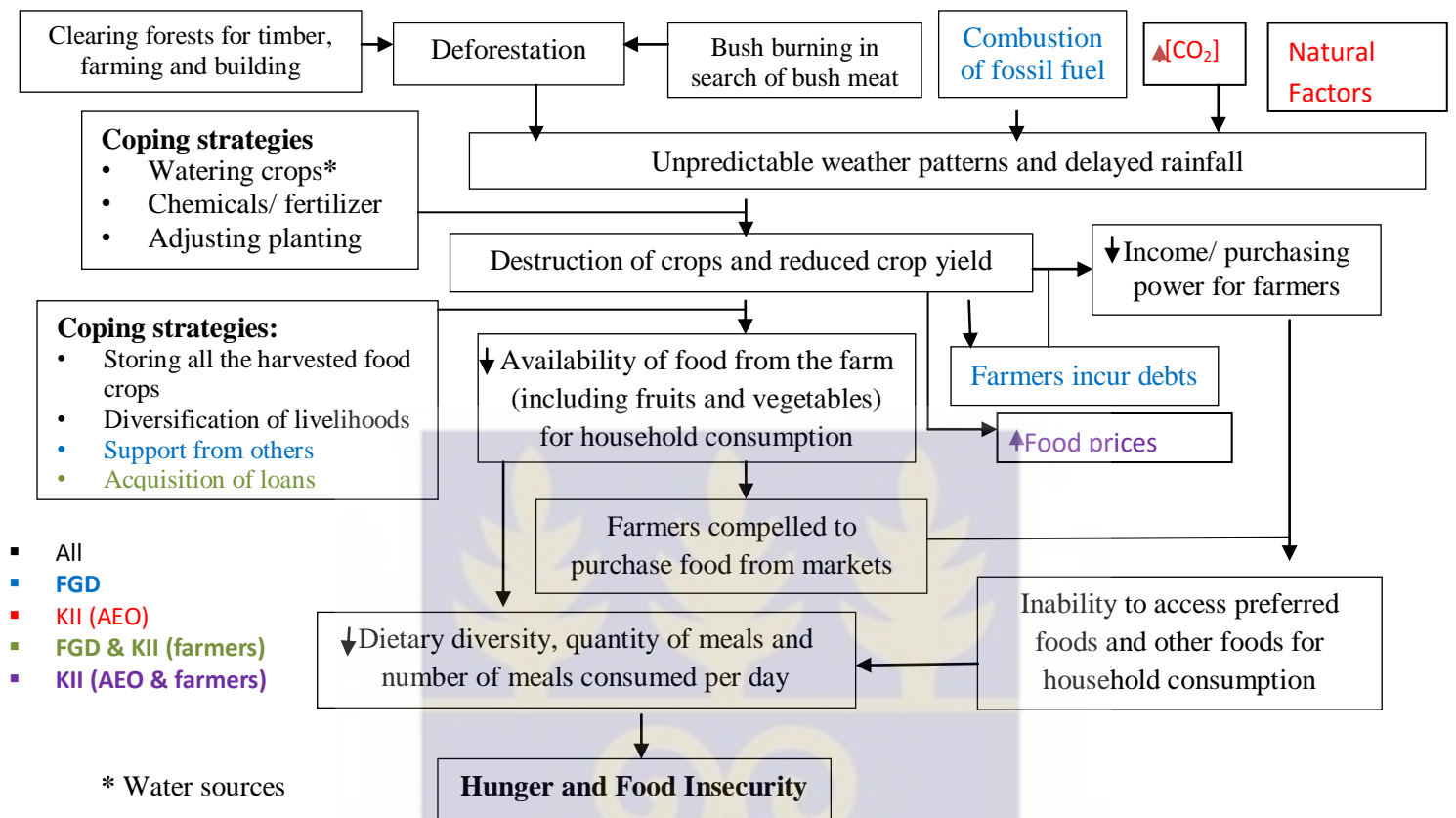


Figure 4.6 Schematic representation of farmers’ perception of how climate change affects food and nutrition security in the Bibiani-Anhwiaso Bekwai District from qualitative studies

## CHAPTER FIVE

### 5.0. DISCUSSION

This chapter discusses the results obtained in this work and the explanations are supported with literature.

#### 5.1. Background Information

The study had a total of 210 participants with children less than five years from four different communities within the Bibiani-Anhwiaso Bekwai District. The socio-economic characteristics showed that most (77%) of the study participants were farming as their primary occupation and had an average age of  $30 \pm 9$  years, indicating they were still in their active years. According to Sofoluwe *et al.* (2011), younger farmers have been found to possess knowledge about more desirable and effective farming practices and because of their longer planning horizons, may be more willing to take risks and employ new and improved farming techniques. Similar findings were reported by Acquah *et al.* (2011) in Dunkwa in the Shama Ahanta East Municipality in the Western Region of Ghana.

Education is important as it helps people to acquire and utilize knowledge needed for good quality of life. Among farmers, education is crucial because farmers who are educated are more likely to access, analyse, interpret and utilize information about new and improved farming systems than their less educated counterparts (Sofoluwe *et al.*, 2011). Previous studies have also indicated that children whose mothers had no education or lower than secondary education had a 29% odds of being malnourished (stunted) compared to children whose mothers had at least secondary education ( $p < 0.01$ ).

Findings from this study however, showed that most of the mothers (93%) had not attained at least a secondary education (SHS). This was in line with results reported by Gyasi (2008) within the same district. This finding may be as a result of poverty in these small scale farming households. According to Ferguson *et al.* (2007), poverty, together with community

characteristics and social networks, have impacts on educational attainments. Seventy-one percent (71%) of the study participants reported they received average monthly income below GHC200. According to Apata *et al.* (2010), a lot of small scale farmers live in absolute poverty with high prevalence of malnutrition.

This study also brought to light that within the same district, some people had perceived climate change while others had not. Similar to findings by Acquah *et al.* (2011), 72% of the study participants which represents the majority had perceived climate change (**Appendix 4**). With regards to perceived climate change, respondents were different in relation to their marital status, occupation and communities in which they lived, that is, their location. There was also a statistically significant difference between respondents who had perceived climate change and those who had not in relation to household head's income.

According to Climate Change Knowledge Network (2001), a common theme in the climate change impact and vulnerability literature is that even within the same social group such as a community, the degree of vulnerability to and the impacts of climate change differs partly due to the fact that resources and wealth are unevenly distributed. Broody *et al.* (2008) also noted that natural risk perception had been explained by factors such as prior experience, knowledge, socioeconomic and demographic characteristics as well as household composition.

Thus, it is likely that households that had perceived climate change had less resources available or probably depended more on climate-related resources for their livelihood hence, were more vulnerable to and quick to perceive the impacts of climate change than those who had not perceived climate change.

## 5.2. Awareness of Climate Change

Results of the study showed that participants had quite appreciable knowledge about climate change. Sixty-one percent (61%) had high awareness of climate change since they had some knowledge on what climate change was, and could mention some of its causes and possible effects.

A greater percentage (71%) of the study participants reported they had heard about climate change and 66% mentioned that climate change was about changes in temperature and rainfall over a period of time. Similar to findings by Rademacher-Schulz *et al.* (2014) in rural Savannah communities in Northern Ghana and Sofoluwe *et al.* (2011) in Nigeria, that majority of their study participants had observed changes in rainfall patterns or temperature over the years, about 92% of the participants in this study also reported they had observed some changes in rainfall patterns and temperature over the past 5 years (**Appendix 1**).

Most of the participants (81%) who reported they had observed changes in temperature said there had been an increase in temperature over the past five years. More than half (54%) of the participants who had observed changes in rainfall patterns reported they usually experienced delayed rainfall. This was in line with qualitative findings from this study in which participants reported that they had perceived increase in temperature and less predictable rainfall patterns such that they usually planted their crops just before the rainy season and expected rain but it never rained until the rain was no longer needed.

Available data from other studies indicate that farmers in other parts of Ghana had also perceived changes in temperature and rainfall patterns. In their study to examine the perception of farmers in Sekyedumase, a district in the Ashanti region of Ghana on climate change, Fosu-Mensah *et al.* (2012) reported that 92% of their study participants had observed an increase in temperature, while 87% had observed a decrease in rainfall output over the

years. In Nigeria, Sofoluwe *et al.* (2011) in their study reported that majority of the farmers had perceived at least one change in the climatic attributes.

The changes in temperature and rainfall patterns reported by participants in this study were supported by data from the Ghana Meteorological Agency which showed an increase in mean annual minimum temperature of 0.7°C and 1.2°C for mean annual maximum temperature from 1986 to 2015. The mean annual rainfall output also varied greatly and changes in rainfall patterns were irregular from 1986 to 2015. According to Akudugu *et al.* (2012), an increase in temperature by 1°C to 3°C could have negative impacts on crop yield particularly in dry regions such as Africa. Rowhani *et al.* (2011), indicated in their study that a 2°C temperature increase by 2050 will reduce average maize, sorghum, and rice yields by 13%, 8.8%, and 7.6% respectively. Decline in crop yield as a result of the changing climatic conditions according to Akudugu *et al.*, (2012) will affect food prices and make it less affordable, affecting the ability of poor households to access quality food to meet their nutritional needs. Thus, the observed increase in temperature and variability in rainfall patterns within this district are likely to have negative implications for food crop production as well as food security and dietary intake if no adaptive strategies are put in place ahead of time.

### **5.3. Perceived Climate Change and Dietary Diversity**

According to Ruel (2003), dietary diversity is a key element of high quality diet, and household level dietary diversity is a good indicator of household food security and has been strongly associated with energy availability. About half of the households in this study (51%) had medium dietary diversity and consumed foods from 4 to 6 food groups including starchy staples such as roots, tubers and plantain (88%) and fish and sea foods (87%). Very small proportions of households, however, consumed foods from food groups such as vitamin A rich fruits and vegetables, dark green leafy vegetables, as well as organ meat and flesh meat, all of which are rich in essential micronutrients such as iron and vitamin A (**Appendix 6**).

According to Taruvinga *et al.* (2013), in developing countries, many households in rural communities have a challenge with dietary diversity and their diets are mainly composed of starchy staples with inadequate amounts of animal products and fresh fruits and vegetables. This may be as a result of high food prices, poverty and less diversity in the types of crops and livestock produced among these small scale farmers. In their study, Jones *et al.* (2014) found a positive association between farm diversity and household dietary diversity with a stronger association in wealthier homes. It is however, recommended that households consume a variety of foods within and across different food groups. Consuming a wide variety and diversity of diets have been associated with improved outcomes such as nutrient adequacy, anthropometric indices and improved haemoglobin concentrations (Taruvinga, *et al.*, 2013).

Though there was no statistically significant between the dietary consumption patterns of participants who had perceived climate change and those who had not, majority of the participants in this study (74%) mentioned that the changes in climate had affected the quantity of foods available for consumption. Forty-one per cent (41%) also mentioned that they no longer consumed certain foods because of the changes in temperature and rainfall patterns (**Appendix 5**).

Springmann *et al.* (2016), made it known that the changing climate will decrease energy availability, consumption of meat as well as fruits and vegetables globally over the years. Edame *et al.* (2011) also stated that, through its negative impacts on food crop production, the changing climate will reduce the availability of some foods for consumption and as a result, reduce the ability of vulnerable households to obtain a diversity of foods.

Participants in the qualitative aspect of this study mentioned that the availability of fruits and vegetables in particular had been affected by the changes in temperature and rainfall patterns

and had also become more expensive. These could account for the low consumption of fruits and dark green leafy vegetables observed in the quantitative study. This situation confirmed projections by Springmann *et al.* (2016) that, climate change could lead to a 4.0% per-person reduction in fruit and vegetable consumption by 2050.

There was a statistically significant decrease in the average annual frequency of consumption of foods from all food groups ( $p < 0.05$ ) except cereals 5 years ago and currently as reported by study participants (**Appendix 7**).

Data from the qualitative aspect of this study showed that households in this district usually depend on food from the grains and cereals food group as their main energy source particularly, maize and rice, mostly when food from other food groups such as white roots, tubers and plantain was less available. Previous studies have however shown that cereal production would decrease with time as temperature increases and rainfall patterns change (Rowhani *et al.*, 2011; Joshi *et al.*, 2011). This means that availability of cereals for consumption is likely to decrease over the years, increasing the risk of food insecurity and malnutrition within this district.

#### **5.4. Coping Strategies used to offset the Negative Impacts of Climate Change**

In order to offset the negative impacts posed on household food security by the changes in temperature and rainfall patterns, majority of the participating households in this study reduced the meals of adults in favour of children. Other food insecurity coping strategies adapted include consuming less quality and variety of food (79%), limiting the portion of meals for all household members (73%), reducing the number of meals consumed per day and harvesting immature crops for consumption. Consistent with these quantitative findings, participants from the qualitative study also mentioned that they had to reduce the quantity, diversity and number of meals consumed per day as coping strategies to offset the negative impacts of climate change. These findings were in line with results reported by Quaye (2008)

and Rademacher-Schulz *et al.* (2014). According to Coates *et al.* (2006), consumption of food in insufficient quantities and inadequate quality among others are significant parts of food insecurity experience.

In order to ensure adequate food production even in the face of climate change, most participants in the quantitative study (86%) reported that they watered their food crops with water from other sources. Similar coping strategies together with adjusting planting times to meet more suitable weather conditions, application of more fertilizer and other chemicals were mentioned in the qualitative studies. Participants however, mentioned that they had problems with access to water since the water sources usually used in watering their crops were all drying out. These were consistent with findings by Sofoluwe *et al.* (2011) who reported that majority of his study participants adapted to changes in weather conditions over time by employing late planting, irrigation, planting of trees as well as planting different varieties of crops.

Participants in this study however, did not mention planting of crop varieties (such as more climate resistant varieties) as an adaptive strategy to offset the negative impacts of climate change even though it is a very important strategy which can help ensure adequate crop yield and make more food available for consumption. This may be due to lack of information on availability of such technology, inaccessibility or high expense associated with the acquisition of such crops or seeds for planting (Sofoluwe *et al.*, 2011).

Drying was the main preservation method adapted, especially for cereals to ensure that food was available during the lean season. Roots and tubers were usually not harvested until they were needed as a way of preserving them, however, participants in the qualitative studies mentioned that long periods of drought and increasing temperature usually affected these crops. Participants also mentioned that fruits and vegetables were mostly available in

abundance only when there was enough rainfall and cannot be stored due to lack of electricity.

Similar to findings by Lyimo *et al.* (2013) and Rademacher-Schulz *et al.* (2014), results from the qualitative study also indicated that some participants adapted to finding alternative livelihoods apart from farming to ensure the needs of their households were met.

### **5.5. Perceived Climate Change and Household Food Security**

Based on responses from the household food insecurity access scale questionnaire, majority (94%) of the small scale farming households in this study were found to be food insecure. The causes could be poverty and reduced crop yield from their farms.

There was a statistically significant difference in the food security status of households that had perceived climate change and those that had not. Households that had perceived climate change had significantly higher mean household food insecurity scores ( $11.9 \pm 4.8$ ) and were about eleven (11) times more likely to have low food security (to be food insecure) than those that had not perceived climate change who had mean household food insecurity score of  $7.8 \pm 5.1$ .

Similar to these findings from the quantitative aspect of the study, results from the qualitative study (both focus group discussions and key informant interviews) showed that the changes in temperature and rainfall patterns had negative impacts on the food security situation of farming households in this district. This occurred as a result of decrease in crop yield caused by unpredictable weather patterns. Study participants also mentioned that these changes affected both availability of food for household consumption as well as household income, making it difficult to meet the dietary needs of their households.

This is similar to findings by Rademacher-Schulz *et al.* (2014) in a study in Northern Ghana to assess associations between rainfall variability, livelihood/food security and migration.

From his study, farmers reported that the changes in rainfall patterns had negative impacts on their food security situation.

According to Edame *et al* (2011), by directly impacting on agriculture, climate change makes households that depend on it for their livelihoods food insecure. Climate Change Knowledge Network (2001) also stated that within communities in the tropics and sub-tropics, some crops are near their maximum tolerance temperature and at the same time, some of these dry lands are not irrigated. These factors alone are likely to decrease crop yield and overall agricultural productivity, increasing the risk of food insecurity and hunger.

#### **5.6. Perceived Climate Change and Nutritional Status**

Majority (61%) of the mothers in this study had normal BMI between 18.5 and 24.9 kg/m<sup>2</sup> while 33% were overweight or obese. Mother's age was a significant predictor of nutritional status of mothers in this study. Though prevalence of underweight and anaemia were low among mothers, child malnutrition in this district was observed to be high. Stunting (36%), wasting (10%) and underweight prevalence (29%) were of high public health significance according to WHO classifications, and majority of the children (about 58%) had some form of anaemia. These findings were slightly higher than findings by Gyasi (2008) who reported malnutrition prevalence of 17%, 6% and 18% for stunting, wasting and underweight respectively among children within this district. The slightly higher malnutrition prevalence observed in this study may be due to the fact that this study focused on children under 5 years old from farming households only. Infants and children from small-scale farming households may be more vulnerable to malnutrition because of the threats posed by the changing climatic conditions on the livelihoods and food security situation of agricultural workers who depend on climate-sensitive resources for their livelihood. A study by Babatunde *et al.* (2011) also reported high prevalence of malnutrition (24% stunting, 14% wasting and 22% underweight) among children under 5 years old from farming households in Kwara State, Nigeria. Their

study reported that mother's level of education, mother's BMI, household energy intake, access to clean water and presence of toilet in the households were among the main predictors of child nutritional status in these farming households.

Gyasi (2008), also reported in his study that most mothers in the district were not practicing appropriate infant and young child feeding practices as recommended by WHO. This could contribute to the high prevalence of child malnutrition within this district. According to ACF (2012), the changing climate will exacerbate child malnutrition by increasing the already heavy workload of women, and thus negatively affect their ability to appropriately care for their infants and young children.

There was no significant difference in the anthropometric indicators of nutritional status measured in this study for both mothers and children in relation to perceived climate change even though perceived climate change was significantly associated with food insecurity. There was also no statistically significant association between food security and nutritional status. This could be because several other factors apart from inadequate dietary intake affect nutritional status. Factors such as inadequate maternal and child caring and feeding practices as well as poor household access to health services and unhealthy environment among others also have impacts on nutritional status.

Mothers from households that had perceived climate change had statistically significant lower mean haemoglobin concentration than those from households that had not perceived it. Household head's income was also significantly associated with child malnutrition. According to Wheeler and Braun (2013), climate change is likely to exacerbate food insecurity in areas that are already vulnerable to food insecurity and also negatively affect both household and individual income. UNICEF (2011) also stated that through its impact on household income generation, climate change will result in likely reductions in the ability of

households to produce and procure a diversified diet and to seek health care for illness. These can eventually affect the nutritional status of both mothers and their children in small-scale farming households.

### **5.7. Policy Implications of Findings**

To build resilience and reduce vulnerability to the impacts of climate change within this district, there is the need to integrate adaptation to climate change into an overall development agenda. Based on findings from this study, the following suggestions are recommended:

- Formulation of policies which will encourage increased investment in improved agricultural technologies to enhance food production and improve food security and nutritional status of women and children within this district.
- Formulation of policies which will help put measures in place to ensure farmers are adequately informed about and have access to the best adaptive strategies for the negative impacts of climate change. These include information about crop varieties (such as climate-resistant varieties) among others that will help ensure food security in the households of small-scale farmers

### **5.8. Challenges and Limitations of this study**

- The initial objective of this study was to assess the impact of climate change on food and nutrition security in the Bibiani-Anhwiaso Bekwai District, however, due to lack of previous data on indicators of food and nutrition security within the district, the study found associations between perceived climate change and food and nutrition security within the specified district.
- Study participants were asked to recall how often they used to consume foods from the various food groups, 5 years ago and currently because there was no such data already available and this was subject to recall bias. To address this problem, the

researcher mentioned the individual foods commonly consumed in the various food groups and also provided options on the frequency of consumption to facilitate recall.

- There was also a challenge with language barrier since the researcher could not speak all the languages commonly spoken in the study district (Sefwi, Twi, Fanti and Ewe). The researcher therefore got people who could speak both English and the local languages commonly spoken the district fluently to assist with data collection.



## CHAPTER SIX

### 6.0 CONCLUSION AND RECOMMENDATION

#### 6.1 Conclusion

This study showed that in the Bibiani-Anhwiaso Bekwai District, most people from farming households had high awareness of climate change and had perceived climate change.

There was a high prevalence of food insecurity and households that had perceived climate change were eleven (11) times more likely to be food insecure than households that had not perceived climate change.

Coping strategies adapted to offset the negative impacts of climate change include reducing the quantity, quality and number of meals consumed per day, watering crops with water from other sources and drying foods as a way of preserving them.

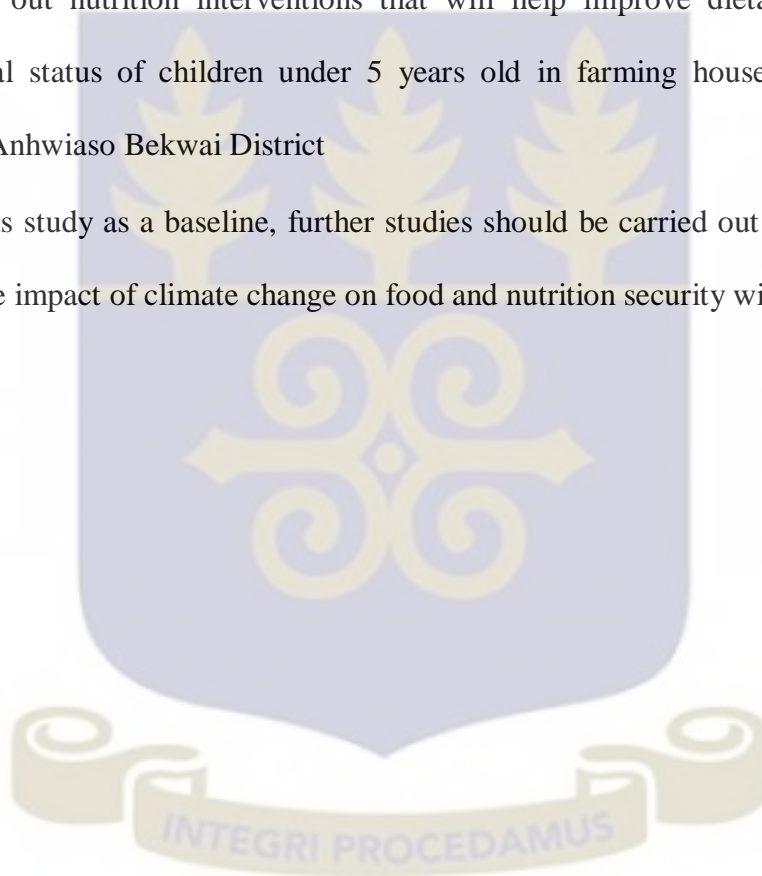
Although there was no significant difference in the dietary consumption patterns of participants who had perceived climate change and those who had not, the changing temperature and unpredictable rainfall patterns had negative impacts on the types and quantities of food available for consumption.

Undernutrition among children under 5 years old was of high public health significance and most of the children were anaemic. Generally, the mothers were well nourished. There was no significant difference in the nutritional status of women and children as indicated by their anthropometric characteristics in relation to perceived climate change. Mothers from households that had perceived climate change however had significant lower haemoglobin concentrations than those from households that had not perceived climate change.

## 6.2 Recommendations

Based on findings from this study, the following suggestions are recommended:

- Introduction of irrigation projects to help improve crop yield, and food security within this district
- Education of farmers within the Bibiani-Anhwiaso Bekwai District on modern and improved adaptive strategies to offset the negative impacts of climate change
- Carrying out nutrition interventions that will help improve dietary diversity and nutritional status of children under 5 years old in farming households within the Bibiani-Anhwiaso Bekwai District
- Using this study as a baseline, further studies should be carried out over the years to assess the impact of climate change on food and nutrition security within the district



## REFERENCES

- Abuya, B. A., Ciera, J., & Kimani-Murage, E. (2012). Effect of mother's education on child's nutritional status in the slums of Nairobi. *Bmc Pediatrics*, 12(1), 1.
- ACF. (2012). Who Cares About the Impact of Climate Change on Hunger and Malnutrition? Retrieved on 20/09/2015 from <http://www.cmamforum.org/Pool/Resources/Who-cares-about-impact-on-climate-change-on-hunger-and-malnutrition-ACF-2014.pdf>
- Acquah, H. D. G., & Onumah, E. E. (2011). Farmers perception and adaptation to climate change: An estimation of willingness to pay. *Agris on-line Papers in Economics and Informatics*, 3(4), 31.
- 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.
- Apata, T. G., Apata, O. M., Igbalajobi, O. A., & Awoniyi, S. M. O. (2010). Determinants of rural poverty in Nigeria: Evidence from small holder farmers in South-western, Nigeria. *International Journal of Science and Technology Education Research*, 1(4), 85-91.
- Babatunde, R. O., Olagunju, F. I., Fakayode, S. B., & Sola-Ojo, F. E. (2011). Prevalence and determinants of malnutrition among under-five children of farming households in Kwara State, Nigeria. *Journal of Agricultural Science*, 3(3), 173.
- Barrett, C. B. (2010). Measuring Food Insecurity. *Science* 327(5967), 825-828.
- Benson, T. and Shekar, M. (2006) 'Trends and Issues in Child Undernutrition', in D.T. Jamison, R.G. Feachem, W. Malegapuru et al. (eds), *Disease and Mortality in Sub-Saharan Africa*, Washington DC: World Bank
- Black, R. E., Victoria, C. G., Walker, S. P., Bhutta, Z. A., Christian, P., De Onis, M., ... & Uauy, R. (2013). Maternal and child undernutrition and overweight in low-income and middle-income countries. *The lancet*, 382(9890), 427-451.
- Brody, S. D., Zahran, S., Vedlitz, A., & Grover, H. (2008). Examining the relationship between physical vulnerability and public perceptions of global climate change in the United States. *Environment and Behavior*, 40(1), 72-95.
- Buhi, L. K. (n.d.). Food Insecurity - nutrition, deficiency, body, health, protein, vitamin, weight. Retrieved on 12/04/2016 from <http://www.faqs.org/nutrition/Erg-Foo/Food-Insecurity.html>
- Carty, T., & Magrath, J. (2013). Growing disruption: Climate change, food and the fight against hunger. Issue briefing. Retrieved on 2/08/2016 from <http://policy-practice.oxfam.org.uk/publications/growing-disruption-climate-change-food-and-the-fight-against-hunger-301878>
- Centre for Disease Control and Prevention (CDC). (2007) *Anthropometric Procedure Manual*. National Health and Nutrition Examination Survey.
- CFSVA. (2009). *Comprehensive Food Security & Vulnerability Analysis (CFSVA) Ghana*. WFP (Vol. 53). <http://doi.org/10.1017/CBO9781107415324.004>

- Climate Change Knowledge Network (2001). *Vulnerability and Adaptation to Climate Change : Concepts , Issues , Assessment Methods*, (July). Retrieved on 9/07/2016 from [http://seachangeop.org/sites/default/files/documents/2001\\_CCKN\\_Vulnerability and Adaptation to Climate change.pdf](http://seachangeop.org/sites/default/files/documents/2001_CCKN_Vulnerability_and_Adaptation_to_Climate_change.pdf)
- Coates, J., Frongillo, E. A., Rogers, B. L., Webb, P., Wilde, P. E., & Houser, R. (2006). Commonalities in the experience of household food insecurity across cultures: what are measures missing?. *The Journal of nutrition*, 136(5), 1438S-1448S.
- Coates, Jennifer, A. S. and, & Bilinsky., P. (2007). *Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide (v. 3)*. Food and Nutrition Technical Assistance Project, Academy for Educational Development, 1689–1699. <http://doi.org/10.1017/CBO9781107415324.004>
- Daniels, W.W. (1999). Determination of sample size for estimating proportions. In: *Biostatistics: Foundation for Analysis in the Health Sciences*. John Wiley & Sons, Inc. New York, pp 183.
- Dore, M. H. (2005). Climate change and changes in global precipitation patterns: what do we know?. *Environment international*, 31(8), 1167-1181.
- Dyg, P. M., Joldasov, A., Atadjanova, Z., & Breda, J. (2011). Climate change and its impact on food and nutrition security: Report on an assessment conducted in four regions of the Autonomous Republic of Karakalpakstan, Uzbekistan, (June).
- Edame, G. E., Ekpenyong, A. B., Fonta, W. M., & Ejc, D. (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. Retrieved on 15/03/2016 from [http://www.ijhssnet.com/journals/Vol\\_1\\_No\\_21\\_Special\\_Issue\\_December\\_2011/21.pdf](http://www.ijhssnet.com/journals/Vol_1_No_21_Special_Issue_December_2011/21.pdf)
- FAO IFAD WFP. (2015). *The State of Food Insecurity in the World: Meeting the 2015 international hunger targets: taking stock of uneven progress*. FAO, IFAD and WFP. <http://doi.org/I4646E/1/05.15>
- FAO. (2006). *FAO / FIVIMS Framework : linkages between the overall development context, the food economy, households and individual measures of wellbeing*, 14–50. Retrieved from <ftp://ftp.fao.org/docrep/fao/010/ai799e/ai799e02.pdf>
- FAO. (2015). *Climate change impacts on food security and nutrition*. Retrieved on 12/02/2016 from [http://www.fao.org/fsnforum/sites/default/files/resources/Webinar\\_Conclusions.pdf](http://www.fao.org/fsnforum/sites/default/files/resources/Webinar_Conclusions.pdf)
- Ferguson, H. B., Bovaird, S., & Mueller, M. P. (2007). The impact of poverty on educational outcomes for children. *Paediatrics & child health*, 12(8), 701.
- Firth, P., & Fisher, S. G. (Eds.). (2012). *Global climate change and freshwater ecosystems*. Springer Science & Business Media.
- Fosu-Mensah, B. Y., Vlek, P. L., & MacCarthy, D. S. (2012). Farmers' perception and adaptation to climate change: a case study of Sekyedumase district in Ghana. *Environment, Development and Sustainability*, 14(4), 495-505.

- Ghana Health Service (GHS) (2013). Agriculture and Nutrition in Ghana. Ghana Fact Sheet Agriculture and Nutrition.
- Ghana Statistical Service. (2014) Ghana Demographic and Health Survey 2013. Accra: Ghana Statistical Service.
- Gruber, P. C., & Kepler, J. (2012). Sustainable Food and Nutrition Security under Changing Climatic Conditions. Retrieved on 26/10/2015 from <http://www.welthungerhilfe.de/en/about-us/media-centre/artikel/mediathek/sustainable-food-and-nutrition-security-under-changing-climatic-conditions.html>
- Gyasi, V. N. (2008). The influence of feeding practices on nutritional status of children (0-23 months) in the Bibiani-Anhwiaso Bekwai District of Ghana. Kwame Nkrumah University of Science and Technology.
- Hansen J., Sato, M., Ruedy, R., Lo, K., Lea, D. W., & Medina-Elizade, M. (2006). Global temperature change. *Proceedings of the National Academy of Sciences*, 103(39), 14288-14293.
- Hedzro-Garti, E. (2010). Report of the 32nd RECA Seminar on Food Security – Global Trends and Perspective. Afro-Asian Rural Development Organization.
- IPCC. (2007). AR4 SYR Synthesis Report Summary for Policymakers - 2 Causes of change. Retrieved on 02/04/2016 from [http://www.ipcc.ch/publications\\_and\\_data/ar4/syr/en/spms2.html](http://www.ipcc.ch/publications_and_data/ar4/syr/en/spms2.html)
- IPCC. (2014). Climate change 2014: Mitigation of Climate Change, 4–5.
- IPCCWGII. (2007). Executive summary - AR4 WGII Chapter 10: Asia. Retrieved on 02/04/2016 from [https://www.ipcc.ch/publications\\_and\\_data/ar4/wg2/en/ch10s10-es.html](https://www.ipcc.ch/publications_and_data/ar4/wg2/en/ch10s10-es.html)
- Jones, A. D., Shrinivas, A., & Bezner-Kerr, R. (2014). Farm production diversity is associated with greater household dietary diversity in Malawi: findings from nationally representative data. *Food Policy*, 46, 1-12.
- Joshi, N. P., Maharjan, K. L. and, & Luni, P. (2011). Effect of climate variables on yield of major food-crops in Nepal -A time-series analysis *J. Contemp. India Stud.: Space Soc.*, 1 (2011), pp. 19–26
- Lartey, A. (2008). Maternal and child nutrition in Sub-Saharan Africa: challenges and interventions. *Proceedings of the Nutrition Society*, 67(01), 105-108.
- Levinson, F. J., & Bassett, L. (2007). Malnutrition is still a major contributor to child deaths. Population Reference Bureau.
- Lloyd, S. J., Kovats, R. S., & Chalabi, Z. (2011). Children’s health climate change, crop yields, and undernutrition: development of a model to quantify the impact of climate scenarios on child undernutrition. <http://doi.org/10.1289/ehp.1003311>
- Lyimo, James, G., Ngana, J. O., Liwenga, E., & Maganga, F. (2013). Climate change, impacts and adaptations in the coastal communities in Bagamoyo District, Tanzania. *Environmental Economics*, 4(1).

- Marquis, G. S. (2014). Food insecurity among households with young children in rural Ghana. Retrieved on 03/04/2016 from [https://www.mcgill.ca/globalfoodsecurity/files/globalfoodsecurity/food\\_insecurity\\_among\\_households\\_with\\_young\\_children\\_in\\_rural\\_ghana.pdf](https://www.mcgill.ca/globalfoodsecurity/files/globalfoodsecurity/food_insecurity_among_households_with_young_children_in_rural_ghana.pdf)
- Matheson, D. M., Varady, J., Varady, A., & Killen, J. D. (2002). Household food security and nutritional status of Hispanic children in the fifth grade. *The American journal of clinical nutrition*, 76(1), 210-217.
- McMichael, A., Campbell-Lendrum, D., Kovats, S., Edwards, S., Wilkinson, P., Wilson, T., ... Andronova, N. (2004). Global climate change. *Comparative Quantification of Health Risks: Global and Regional Burden of Diseases Attributable to Selected Major Risk Factors*, (Volume 2), 1543–1649. Retrieved on 04/04/2016 from [http://www.who.int/healthinfo/global\\_burden\\_disease/cra/en/](http://www.who.int/healthinfo/global_burden_disease/cra/en/)
- McMichael, A. J., Powels, J. W., Butler, C. D., & Uauy, R. (2007). Food, livestock production, energy, climate change, and health. *The lancet*, 370(9594), 1253- 1263
- Misselhorn, A. A. (2005). What drives food insecurity? A meta-analysis of household economy studies. *Global Environmental Change*, 15(1), 33–43. Retrieved on 04/04/2016 from [http://ac.els-cdn.com/S0959378004000822/1-s2.0-S0959378004000822-main.pdf?\\_tid=0220ddf2-1088-11e6-bbe1-00000aacb35f&acdnat=1462208881\\_0ef82c8df380d6554c79973451572f51](http://ac.els-cdn.com/S0959378004000822/1-s2.0-S0959378004000822-main.pdf?_tid=0220ddf2-1088-11e6-bbe1-00000aacb35f&acdnat=1462208881_0ef82c8df380d6554c79973451572f51)
- MoFA. (n.d.). Food security situation in Ghana. Retrieved from <https://mofafoodsecurity.wordpress.com/food-security-situation-in-ghana/>
- National Research Council (NRC). (2010). (2010). *Advancing the science of climate change*. The National Academies Press, 1–4.
- Nelson, G. C., Rosegrant, M. W., Koo, J., Robertson, R., Sulser, T., Zhu, T., and Magalhaes, M. (2009). *Climate Change: Impacts on agriculture and costs of adaptation* (Vol. 21). Intl Food Policy Res Inst.
- Owusu, V., Abdulai, A., & Abdul-Rahman, S. (2011). Non-farm work and food security among farm households in Northern Ghana. *Food Policy*, 36(2), 108–118. <http://doi.org/10.1016/j.foodpol.2010.09.002>
- Pangaribowo, E. H., Gerber, N., & Torero, M. (2013). Working Paper 108 Food and Nutrition Security Indicators, (February). <http://doi.org/ISSN 1864-6638>
- Quaye, W. (2008). Food security situation in northern Ghana, coping strategies and related constraints. *Journal of Agricultural Research*, 3(5), 334–342.
- Rademacher-Schulz, C., and Mahama, S. (2012). Rainfall, food security and human mobility "Where the Rain Falls" Project Case study: Ghana Report No. 3.
- Rademacher-Schulz, C., Schraven, B., & Mahama, E. S. (2014). Time matters: shifting seasonal migration in Northern Ghana in response to rainfall variability and food insecurity. *Climate and Development*, 6(1), 46–52. <http://doi.org/10.1080/17565529.2013.830955>
- Rosen, S., Shapouri, S., Quanbeck, K., and Meade, B. (2008). *Food Security Assessment, 2007*. US Department of Agriculture, Economics Research Service. Rowhani, P., Lobell,

- D. B., Linderman, M., & Ramankutty, N. (2011). Climate variability and crop production in Tanzania. *Agricultural and Forest Meteorology*, 151(4), 449-460.
- Ruel, M. T. (2003). Is dietary diversity an indicator of food security or dietary quality? A review of measurement issues and research needs. *Food and Nutrition Bulletin*, 24(2), 231–232.
- Saaka, M., & Osman, S. M. (2013). Does household food insecurity affect the nutritional status of preschool children aged 6–36 Months?. *International Journal of Population Research*, 2013.
- Santos, L. P. D., & Gigante, D. P. (2013). Relationship between food insecurity and nutritional status of Brazilian children under the age of five. *Revista Brasileira de Epidemiologia*, 16(4), 984-994.
- Smith, P., & Olesen, J. E. (2010). Synergies between the mitigation of, and adaptation to, climate change in agriculture. *The Journal of Agricultural Science*, 148(05), 543-552.
- Sofoluwe, N. A., Tijani, A. A., & Baruwa, O. I. (2011). Farmers perception and adaptation to climate change in Osun State, Nigeria. *African Journal of Agricultural Research*, 6(20), 4789-4794.
- 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*, 6736(15), 1–10. [http://doi.org/10.1016/S0140-6736\(15\)01156-3](http://doi.org/10.1016/S0140-6736(15)01156-3)
- Taruvunga, A., Muchenje, V., & Mushunje, A. (2013). Determinants of rural household dietary diversity: The case of Amatole and Nyadeni districts, South Africa. *International Journal of Development and Sustainability*, 2(4), 1-15.
- Thompson, H. E., Berrang-Ford, L., & Ford, J. D. (2010). Climate change and food security in Sub-Saharan Africa: A systematic literature review. *Sustainability*, 2(8), 2719–2733. <http://doi.org/10.3390/su2082719>
- Tirado, M.C., Crahay, P., Hunnes, D., Cohen, M. (2012). Climate change and nutrition in Africa with a focus on Sub-Saharan Africa. *Public Health*, (1), 1–24.
- Tlhompho, G. (2014). African indigenous food security strategies and climate change adaptation in South Africa. *J Hum Ecol*, 48(1), 83–96.
- UNICEF. (2008). Food prices increases/ nutrition security: Action for Children, 1-8.
- UNICEF. (2011). Children and climate change the impacts of climate change on nutrition and migration affecting children in Indonesia, 12. Retrieved on 20/05/2016 from [http://www.unicef.org/eapro/Indonesia\\_climate\\_change\\_report.pdf](http://www.unicef.org/eapro/Indonesia_climate_change_report.pdf)
- United Nations Environment Programme. (2007). Fact sheet: climate change in Africa - what is at stake?, 1–4. Retrieved on 02/04/2016 from [http://www.unep.org/roa/amcen/docs/AMCEN\\_Events/climate-change/2ndExtra\\_15Dec/FACT\\_SHEET\\_CC\\_Africa.pdf](http://www.unep.org/roa/amcen/docs/AMCEN_Events/climate-change/2ndExtra_15Dec/FACT_SHEET_CC_Africa.pdf)
- United States Environmental Protection Agency (US-EPA). (2015). Causes of Climate Change Climate Change US EPA. Retrieved from

<https://www3.epa.gov/climatechange/science/causes.html>

United States Environmental Protection Agency (US-EPA). (2016). Changing Rain and Show Patterns \_ A Student's Guide to Global Climate Change \_ US EPA. Retrieved on 09/10/2015 from <https://www3.epa.gov/climatechange/kids/impacts/signs/precip-patterns.html>

UNS-SCN. (2010). Climate Change and Nutrition Security. In United Nations System Standing Committee on Nutrition (pp. 1–12). [http://doi.org/10.1007/978-94-017-9744-3\\_3](http://doi.org/10.1007/978-94-017-9744-3_3)

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

World Bank. (2009). Making Development Climate Resilient. A World Bank Strategy for Sub-Saharan Africa. Report No. 46947-AFR, (46947), 144.

World Food Program. (2012). Ghana Comprehensive Food Security & Vulnerability Analysis 2010: Focus on Northern Ghana, Ministry of Food and Agriculture Ghana Statistical Service. Retrieved on 09/08/2015 from <http://documents.wfp.org/stellent/groups/public/documents/ena/wfp257009.pdf>

World Health Organization. (2010). Nutrition Landscape Information System Country Profile Indicators: Interpretation Guide.

World Health Organization. (2011). BMI Classification World Health Organization.

World Health Organization. (2011). Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. Vitamin and Mineral Nutrition Information System. Geneva. Retrieved on 31/01/2017 from <http://www.who.int/vmins/indicators/haemoglobin.pdf>



## APPENDICES

**Appendix 1: Scoring of Climate Change Awareness Based on Responses to Climate Change Awareness-Related Questions**

Questions	Responses	Score
1. Have you ever heard about climate change?	<ul style="list-style-type: none"> <li>• Yes</li> <li>• No</li> </ul>	1 0
2. What do you know about climate change?	<ul style="list-style-type: none"> <li>• [Change in average weather conditions over a long period of time or any related answers]</li> <li>• [Unrelated responses]</li> </ul>	1 0
3. What is causing climate change?	<ul style="list-style-type: none"> <li>• [human activities e.g. deforestation and combustion of fossil fuels etc. and natural causes]</li> <li>• [Unrelated responses such as our sins etc.]</li> </ul>	1 0
4. Do you think that climate change can affect you or your household?	<ul style="list-style-type: none"> <li>• Yes</li> <li>• No</li> </ul>	1 0
5. How does the problem of climate change affect you or your household?	<ul style="list-style-type: none"> <li>• [It reduces crop yield or destroys crops, reduces water availability, leads to food shortage, hunger and sickness]</li> <li>• [Unrelated responses]</li> </ul>	1 0
6. Have you observed any changes in the rainfall patterns over the past five years or more?	<ul style="list-style-type: none"> <li>• Yes</li> <li>• No</li> </ul>	1 0
7. What changes have you observed in rainfall patterns over time?	<ul style="list-style-type: none"> <li>• [Increasing rainfall, reducing rainfall, delayed rainfall, too early rainfall]</li> <li>• [No change, Don't know]</li> </ul>	1 0
8. Do the changes affect the food crops you grow in anyway?	<ul style="list-style-type: none"> <li>• Yes</li> <li>• No</li> </ul>	1 0
9. If yes to the above, how do the changes in rainfall affect the crops you grow?	<ul style="list-style-type: none"> <li>• [It reduces crop yield, it destroys crops, crops don't germinate, it reduces water availability etc.]</li> <li>• [Inappropriate responses]</li> </ul>	1 0
10. Have you observed any changes in temperature over the past five years or more?	<ul style="list-style-type: none"> <li>• Yes</li> <li>• No</li> </ul>	1 0
11. What changes have you observed in temperature over time?	<ul style="list-style-type: none"> <li>• [Increasing temperature]</li> <li>• [Reducing temperature, no change, don't know]</li> </ul>	1 0
12. Do the changes affect the food crops you grow in any way?	<ul style="list-style-type: none"> <li>• Yes</li> <li>• No</li> </ul>	1 0

**Appendix 2: Scoring of Perceived Climate Change Based on Responses to Perceived Climate Change -Related Questions**

Questions	Responses	Score
1. Have you observed any changes in the rainfall patterns over the past five years or more?	<ul style="list-style-type: none"> <li>• Yes</li> <li>• No</li> </ul>	1 0
2. What changes have you observed in rainfall patterns over time?	<ul style="list-style-type: none"> <li>• [Increasing rainfall, Delayed rainfall]</li> <li>• [No change, Reducing rainfall, Too early rainfall Don't know]</li> </ul>	1 0
3. Do the changes affect the food crops you grow in anyway?	<ul style="list-style-type: none"> <li>• Yes</li> <li>• No</li> </ul>	1 0
4. Have you observed any changes in temperature over the past five years or more?	<ul style="list-style-type: none"> <li>• Yes</li> <li>• No</li> </ul>	1 0
5. What changes have you observed in temperature over time?	<ul style="list-style-type: none"> <li>• [Increasing temperature]</li> <li>• [Reducing temperature, No change, Don't know]</li> </ul>	1 0
6. Do the changes affect the food crops you grow in any way?	<ul style="list-style-type: none"> <li>• Yes</li> <li>• No</li> </ul>	1 0
7. Are there some foods that you no longer eat because of the changes in weather conditions over time?	<ul style="list-style-type: none"> <li>• Yes</li> <li>• No</li> </ul>	1 0
8. 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?	<ul style="list-style-type: none"> <li>• Yes</li> <li>• No</li> </ul>	1 0



**Appendix 3: Responses to Climate Change Awareness Related Questions**

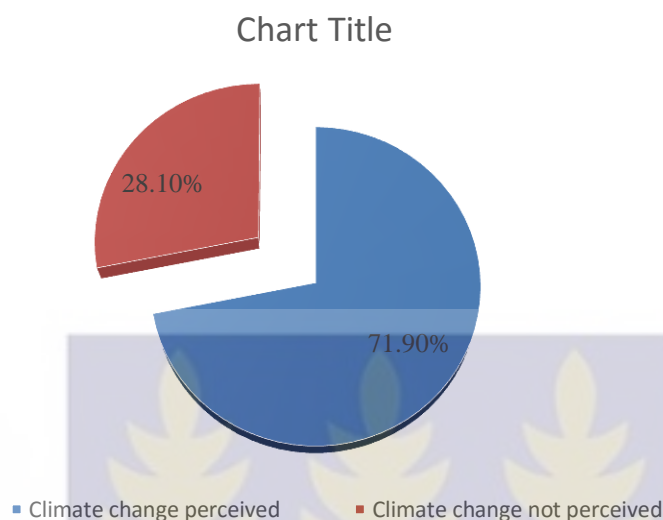
<b>Variable</b>	<b>n (%)</b>
<b>Have you ever heard of climate change (n=210)</b>	
Yes	150 (71.4)
No	60 (28.6)
<b>What do you know about climate change (n=149)</b>	
It has to do with changes in rainfall patterns over time	89 (59.7)
It is about changes in weather the weather changes	40 (26.8)
It is about increasing temperature and changes in rainfall patterns	9 (6.0)
Others <sup>1</sup>	11 (7.5)
<b>Causes of climate change (n=146)</b>	
Cutting down forest trees/ deforestation	52 (35.6)
Nature	22 (15.1)
Part of God's plan	14 (9.6)
Because the world is coming to an end	8 (5.5)
Others <sup>2</sup>	12 (7.1)
Don't know	38 (26.0)
<b>Do you think climate change can affect you or your household (n=152)</b>	
Yes	145 (95.4)
No	7 (4.6)
<b>How does the problem of climate change affect you or your household (n=144)</b>	
It causes food shortage and hunger	79 (54.9)
It reduces our income and brings poverty because of reduced crop yield	18 (12.5)
It causes diseases	41 (28.5)
Others <sup>3</sup>	6 (4.2)
<b>Have you observed any changes in rainfall over the past five years or more (n=210)</b>	
Yes	193 (91.9)
No	17 (8.1)



Variable	n (%)
<b>Changes observed in rainfall patterns (n=193)</b>	
Reducing rainfall	84 (43.5)
Delayed rainfall	105 (54.4)
Others <sup>4</sup>	4 (2.1)
<b>Do the changes in rainfall affect the food crops you grow (n=210)</b>	
Yes	191 (90.9)
No	19 (9.0)
<b>how do the changes in rainfall affect the food crops you grow (n=190)</b>	
The crops get dried up and they die on the farm because there is no rain	50 (26.3)
The crops don't germinate	24 (12.9)
The crops don't grow well	50 (26.3)
It reduces crop yield	59 (31.0)
Others <sup>5</sup>	7 (3.7)
<b>Have you observed any changes in temperature over the past five years or more (n=210)</b>	
Yes	193 (91.9)
No	17 (8.1)
<b>What changes have you observed in temperature over time (n=193)</b>	
Increasing Temperature	157 (81.3)
Reducing Temperature	32 (16.6)
Others <sup>6</sup>	4 (2.1)
<b>Do the changes in temperature affect the food crops you grow in any way (n=193)</b>	
Yes	181 (93.8)
No	12 (6.2)
<b>how do the changes in temperature affect the food crops you grow(n=174)</b>	
The crops get destroyed or they wither and die	87 (5)
The crops do not grow well as they are supposed to	40 (23.0)
It reduces crop yield	31 (17.8)
Others <sup>7</sup>	16 (9.2)

<sup>1</sup>Including: It is about increase in temperature over time 5(3.4); It destroys our food crops 2(1.3); It is about the months and changes that occur naturally 1(0.7); It is about the arrangement of the weather in different seasons 1(0.7); It shows us that the world has changed 1(0.7); It is about hot and cold weather over a period of time 1(0.7) <sup>2</sup>Including: Bush burning 3(2.05); Dumping refuse in the wrong places 2(1.37); Increasing population 1(0.68); Mining activities 1(0.68); Our sins 3(2.05); Not obeying taboos and the presence of churches 2(1.37) <sup>3</sup>Including: Our crops don't grow well 4(2.78); It affects availability of water for farming and domestic use 2(1.39) <sup>4</sup>Including: Increasing rainfall 1(0.52); Too early rainfall 2(1.04); No change 1(0.52) <sup>5</sup>Including: Crops don't become big in size/ fruits become smaller in size 5(2.63); it makes it difficult to uproot crops 2(1.05) <sup>6</sup>Including: No change 2(1.04); Don't know 2(1.04) <sup>7</sup>Including: The crops do not germinate at all 7(4.02); The cassava becomes spongy or they get cooked by the heat in the ground 4(2.30); The crops are unable to grow big in size as expected 4(2.30); The food crops rot quickly 1(0.57)

**Appendix 4: Proportion of Study Participants who had Perceived Climate Change**



**Appendix 5: Changes in Food Consumption Patterns as a Result of Climate Change**

Variable	n (%)
<b>Are there some foods you no longer consume because of the changes in weather conditions over time?</b>	
Yes	87 (41.4)
No	123 (58.6)
<b>Are there some foods you no longer consume in the quantities you used to because of the changes in weather conditions over time?</b>	
Yes	156 (74.3)
No	54 (25.7)

**Appendix 6: Proportions of Study Participants Consuming Foods from the Various Food Groups**

<b>Food group</b>	<b>n (%)</b>
Cereal	160 (76.2)
White roots, tubers and plantain	184 (87.6)
Vegetables <sup>1</sup>	201 (95.7)
Fruits <sup>2</sup>	7 (3.3)
Meat <sup>3</sup>	25 (11.9)
Egg	16 (7.6)
Legumes, nuts and seeds	92 (43.8)
Fish and sea food	182 (86.7)
Milk and milk products	18 (8.6)
Sweets	107 (51)
Spices, beverages and condiments	175 (83.3)
Fats and oils <sup>4</sup>	156 (74.3)

<sup>1</sup>Vitamin A rich vegetables (0.5%); Dark green leafy vegetables (33.8%); other vegetables (93.8%)

<sup>2</sup>Vitamin A rich fruits (1%); other fruits (2.4%) <sup>3</sup>Organ meat (0.5); Flesh meat (11.4%) <sup>4</sup>Oils (23.3%); red palm products (56.7%)

**Appendix 7: Average yearly frequency of food consumption from the various food groups five years ago and currently (in days)**

<b>Food Group</b>	<b>Average frequency of consumption per year 5years ago</b>	<b>Average frequency of consumption per year currently</b>	<b>p-value</b>
Cereals	299.9 ± 268.5	303.7 ± 224.2	0.412
White tubers, roots and plantain	1018.8 ± 402.9	614.5 ± 292.8	< <b>0.001</b>
Vitamin A rich vegetables	13.2 ± 52.1	10.0 ± 45.9	<b>0.009</b>
Dark green leafy vegetables	306.1 ± 140.1	256.6 ± 151.3	< <b>0.001</b>
Other vegetables	1466.4 ± 389.3	1296.3 ± 365.6	< <b>0.001</b>
Vitamin A rich fruits	102.8 ± 179.4	62.3 ± 116.6	< <b>0.001</b>
Other fruits	620.5 ± 565.0	384.4 ± 361.3	< <b>0.001</b>
Legumes, nuts & seeds	233.8 ± 240.9	135.5 ± 182.6	< <b>0.001</b>
Fats and oils	295.1 ± 183.3	214.8 ± 188.6	< <b>0.001</b>

**Appendix 8: Consent Form**

UNIVERSITY OF GHANA



Official Use only

OFFICE OF RESEARCH, INNOVATION AND  
DEVELOPMENT

Protocol number

**Ethics Committee for Basic and Applied Science (ECBAS)**

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
Certified Protocol Number	ECBAS013/15-16

Section B– CONSENT TO PARTICIPATE IN RESEARCH
---

**General Information about Research**

You are invited to participate in a research study conducted by Abigail .A. Armah and Patience Atitsogbey who are Masters Students from the Nutrition and Food Science Department, University of Ghana, Legon. They are conducting this study for their Masters dissertation. 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: <a href="mailto:cnti@ug.edu.gh">cnti@ug.edu.gh</a>	Prof. Matilda Steiner-Asiedu Co-Supervisor Department of Nutrition and Food Science University of Ghana, Legon Tel: 0541260704 Email: <a href="mailto:tillysteiner@gmail.com">tillysteiner@gmail.com</a>	Dr. Gloria Otoo Co-Supervisor Department of Nutrition and Food Science University of Ghana, Legon Tel: 0248689464 Email: <a href="mailto:geotoo@yahoo.com">geotoo@yahoo.com</a>
--	---	---

Abigail .A. Armah Student Investigator Department of Nutrition and Food Science University of Ghana, Legon Tel: 0205226434 Email: <a href="mailto:aarmah40@gmail.com">aarmah40@gmail.com</a>	Patience Atitsogbey Student Investigator Department of Nutrition and Food Science University of Ghana, Legon Tel: 0244019542 Email: <a href="mailto:patatitso@yahoo.com">patatitso@yahoo.com</a>
---	--

### 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.

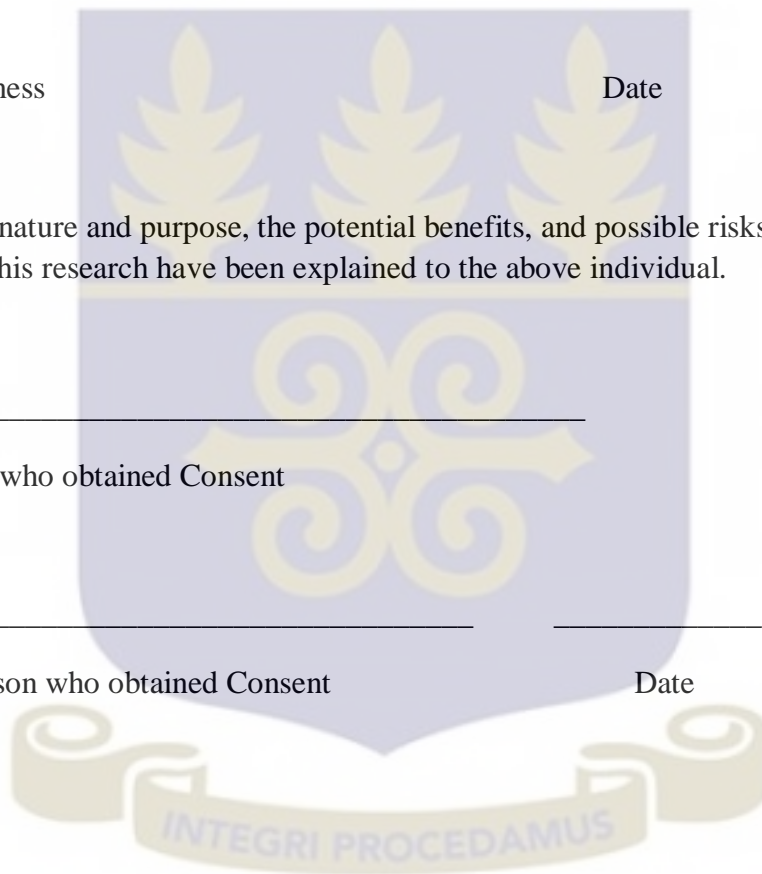
\_\_\_\_\_

Name of Person who obtained Consent

\_\_\_\_\_

Signature of Person who obtained Consent

Date



**Appendix 9: Research 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)Akan [ ] 2)Ewe [ ] 3)Sehwi [ ] 4)Ga Adangme [ ] 5)Frafra [ ] 6)Bossi [ ]  
 7) 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? **whhh9**  
 1)Myself [ ] 2)My husband [ ] 3)Someone else (*Please specify*).....  
 (*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 [ ] 6)Tertiary [ ] 7)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 Member	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 [ ] *(If “No” skip to Q13)* **caw12a**  
 b)What do you know about climate change? **caw12b**  
 .....  
 .....  
 c. What is causing climate change? **caw12c**  
 .....  
 .....
13. a. Do you think that climate change can affect you or your household?  
 1)Yes [ ] 2)No [ ] *(If “No” skip to Q14)* **caw13a**  
 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 as 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	0 = No (skip to Q6) 1 = Yes	

needed because there was not enough food?		
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**

<b>Coping Option</b>	<b>Every day</b>	<b>3–6 times/ week</b>	<b>Once or twice</b>	<b>Never</b>
1. Consume less quality & variety of food				
2. Reduce the meal of adults in favour 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 or anyone else in your household 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

**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) + <i>insert local foods e.g. ugali, nshima, porridge locally available grains</i>	
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 + <i>other locally available vitamin-A rich vegetables (e.g. red sweet pepper)</i>	
4	DARK GREEN LEAFY VEGETABLES	dark green/leafy vegetables, including wild ones + <i>locally available vitamin-A rich leaves such as amaranth, cassava leaves, kale, spinach etc.</i>	
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 + <i>other locally available vitamin A-rich fruits</i>	
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 <i>local examples</i>	

PAST AND CURRENT DIETARY HISTORY (*FOR WESTERN REGION*)

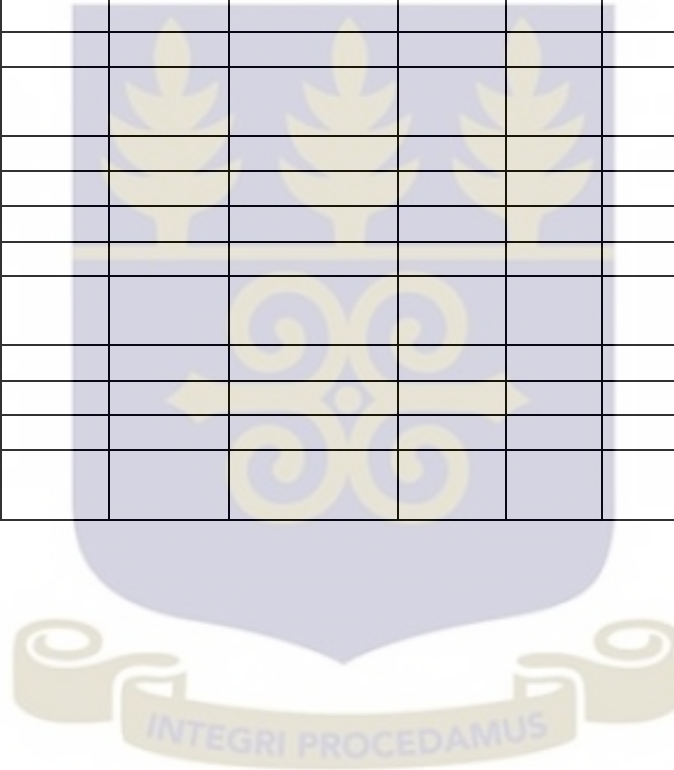
dhq23

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? ( <i>You can choose more than one answer</i> )  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----)	
<b>1. Cereal</b>												
Maize												
Rice												
Others ( <i>Please specify</i> ).....												
<b>2. White tubers &amp; Roots and Plantains</b>												
Cassava												
Yam												
Cocoyam												
Sweet potato												
Plantain												



Pear													
Tangerine													
Other ( <i>Please specify</i> )													
<b>8. Legumes, Nuts &amp; Seeds</b>													
Groundnut													
Beans													
Soybeans													
Tiger nuts													
Bambara beans													
Other ( <i>Please specify</i> )													
<b>9. Fats and Oils</b>													
Coconut oil													
Palm kernel oil													
Groundnut oil													
Other ( <i>Please specify</i> )													
<b>10. Red Palm Products</b>													
Palm oil													
Palm nut soup													
Other ( <i>Please specify</i> )													



**A. ANTHROPOMETRY**

*Infant*

**ianth**

<b>Anthropometric measures</b>	1 <sup>st</sup>	2 <sup>nd</sup>
Length/height (cm)		
Weight (kg)		
MUAC (cm)		

*Mother*  
**manth**

<b>Anthropometric measures</b>	1 <sup>st</sup>	2 <sup>nd</sup>
Height(cm)		
Weight (kg)		

**BIOCHEMICAL ASSESSMENT**

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



**Appendix 10: Focus Group Discussion Interview Guide  
University of Ghana**

**Department of Nutrition and Food Science**

**Perceived Climate Change and Food and Nutrition Security in the Bibiani-Anhwiaso**

**Bekwai District in the Western Region of Ghana**

**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 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?

**Appendix 11: Key Informant Interview Guide – Agricultural Extension Officers  
University of Ghana**

**Department of Nutrition and Food Science**

**Perceived Climate Change and Food and Nutrition Security in the Bibiani-Anhwiaso  
Bekwai District in the Western Region of Ghana**

**KEY INFORMANT INTERVIEW GUIDE: *AGRIC EXTENSION OFFICER***

**Awareness of Climate Change**

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 climate change?

**Impact of Climate Change on Food Crop Production & Food Consumption  
Patterns**

4. How is the changing climate affecting food crop production in this community?
  - How are changes in rainfall patterns affecting food crop production?
  - How are changes in temperature affecting food crop production?
  - How is the changing climate affecting availability of food crops for consumption in this community?
  - Which food crops are mostly affected?
5. How is the changing climate affecting food consumption pattern in this community?

**Coping Strategies Adapted to Offset the Negative Impacts of Climate Change**

6. 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?
7. How do people preserve their foods to prevent shortage of food?
8. What do you think can be done to overcome the problem of climate change and its impact on food production?

Are there any further recommendations that you would like to make or anything else you would like to tell me?

*Thank you for your time and your participation in this interview*



**Appendix 12: Key Informant Interview Guide – Farmers  
University of Ghana**

**Department of Nutrition and Food Science**

**Perceived Climate Change and Food and Nutrition Security in the Bibiani-Anhwiaso  
Bekwai District in the Western Region of Ghana**

**KEY INFORMANT INTERVIEW GUIDE: *FARMERS***

**Awareness of Climate Change**

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 climate change?

**Impact of Climate Change on Food Crop Production & Food Consumption  
Patterns**

4. How is the changing climate affecting food crop production in this community?
  - How are changes in rainfall patterns affecting food crop production?
  - How are changes in temperature affecting food crop production?
  - Which food crops are mostly affected?
5. How is climate change affecting food consumption patterns in this community?

**Coping Strategies Adapted to Offset the Negative Impacts of Climate Change**

6. 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?
7. In case there is poor harvest or less food for the household, what do people do?
8. How do people preserve their foods to prevent shortage of food?
9. What do you think can be done to overcome the problem of climate change and its impact on food production?

Are there any further recommendations that you would like to make or anything else you would like to tell me?

*Thank you for your time and your participation in this interview*

