Climate Variability and Change, Smallholder Farmer Decision Making, and Food Security in North-west Ghana

Thesis submitted for the degree of Doctor of Philosophy

School of Agriculture, Policy, and Development

University of Reading

George Dakurah

October 2018

Declaration of Original authorship

I duly confirm that this is my own work and the use of all material from other sources has been properly and fully acknowledged.

…………………………………………….

George Dakurah

Dedication

I dedicate this thesis to my mother of blessed memory; Madam Priscilla Zigree Dakurah

Acknowledgements
Thank you

I will first of all thank God, the Father Almighty; the creator of the universe for all His unmerited grace and mercies throughout my studies at the PhD level. Without Him, the ‘journey’ would not have been possible.

I also want to acknowledge all the selfless efforts my supervisors: Dr Henny Osbahr and Dr Alex Arnall made towards the completion of this PhD. I am particularly thankful for the constructive feedback, the short courses and articles that they recommended to make this PhD come to a successful completion. I will also want to thank Professor Roger Stern and Dr David Stern (both formerly of the Reading Statistical Services Centre) for all their support in guiding me to analyse meteorological data for my thesis.

This PhD would not have been possible without the Commonwealth Scholarships Commission (CSC-UK) awarding the researcher a scholarship to study. Thank you CSC for financing my studies. I wish to also thank the University of Reading Financial Hardship Team and the Leche Trust Charity for supporting me with some maintenance grants after my scholarship run out in the 3rd year- God bless you all.

I wish to also thank the Former District Chief Executive of the then Jirapa District; Hon Cletus Dapilah, the Presiding Member, Hon Helen Zaato, and the Assembly members of Baazu, Tizza Boi, the Doggoh and Tie electoral areas and the then Director of the Ministry of Food and Agriculture for all the support during my fieldwork in the then Jirapa District.

I am highly indebted to the chiefs, elders and people of the Doggoh and Tie villages for the warm reception throughout my fieldwork period in your villages. Thank you for all the food and the time to respond to my fieldwork questions. I particularly want to thank Francis Belingtaa of Doggoh, and David Tuozie of Tie for your work as village lead persons. Thank you for taking me around your villages.

I cannot forget about the young and energetic research assistants that helped in the data collection. Thank you Conrad Soyen, Fred Ayambire, Priscilla Toboyee, Michael Lang-uu, Stanley To-ang, George Nayas, Justice Dinaah, Sylvester Languang, Francis, Isaac Bafuuroh and Robert Kuuzuing. I am particularly grateful to Fred who had to pick me around on a motorbike after I had an accident and fractured my arm.

For my Landlord, DSP Johnbosco, I am grateful for your kind gestures towards me via offering me a house to live in Babile and undertake my fieldwork. I wish to also acknowledge all the wonderful people of Babile and Wuling particularly the chief of Wuling for the warm reception and accepting me as one of you.

At the end of it all, my family members have been my strongest backbone throughout the PhD study period. I particularly want to thank my elder brother; Peter Dakurah, Alfred Mwine and Bismarck Guba for all the support.

Abstract

This thesis investigates smallholder farmers' cropping decisions under climate variability and change using the villages of Doggoh and Tie of North Ghana as a case study. With rainfall projected to decrease and temperatures expected to rise, it is essential to understand the impacts of farmers' cropping decisions under climate variability and change on the availability and utilisation of culturally preferred foods. To that end, this study had three objectives: (i) to examine farmers' perception of climate variability and change and see how farmer perceptions match and mismatch analysis of meteorological data; understand how farmer' perception of CVC are socially differentiated; and understand how cultural values shape farmers' perception of CVC, (ii) to characterise farmers' responses to CVC and understand why farmers are adapting or not adapting to CVC via crop selection, and (iii) to understand the social uses of food and the impact of farmers' adaptation to CVC on the availability and utilisation of culturally preferred foods. The study draws on the Theory of Drought Perception, the Theory of Planned Behaviour, and the Social Identity Theory as theoretical lenses to guide the presentation of results. Situating the fieldwork in North-west Ghana, the data collection for this study lasted for ten months (spanning from January to October 2016). To that end, mixed methods involving key informant interviews, semi-structured questionnaire, focus group discussions, and household case studies were used for the data collection. This involved 150 households for the semi-structured questionnaire (75 for each research village) and 34 household case studies (19 in the village of Doggoh and 15 in the village of Tie).

The results revealed that farmers' perceptions are not supported by the climatic data. Farmers observed a shift in the onset and cessation of rainfall from March to June and from November to October respectively. Farmers' identified cultural factors as essential in explaining changes in their local climate. Having perceived changes in their local climate farmers have adapted by cultivating crops and crop varieties that are better suited to the prevailing changing climate. The only exception is that a few male-headed households continue to cultivate traditional varieties of groundnuts for cultural reasons even though such varieties produce less yield. Farmers reported changing diet patterns of culturally preferred foods as a result of the non-availability and less availability of culturally preferred food crops due to responses to climate variability and change. This study highlights the critical need for policymakers to be sensitive to the cultural foods of local people in the design of adaptation measures.

Table of Contents

List of Figures

List of Tables

List of Pictures

List of Boxes

List of Appendices

List of Abbreviations

AM- Assembly Member

CCAFS- Climate Change, Agriculture and Food Security

CFC- Canadian Feed the Children

CMIP- Coupled Model Intercomparison Project

CVC – Climate Variability and Change

CVAM_ Comprehensive Vulnerability Analysis and Mapping

EPA – Environmental Protection Agency

FAO- Food and Agriculture Organisation

GIS- Geographic Information Systems

GSS- Ghana Statistical Service

GCMs- Global Circulation Models

IPCC- The Inter-Governmental Panel on Climate Change

ITCZ- Inter-Tropical Convergence Zone

MCE- Municipal Chief Executive

MoFA- Ministry of Food and Agriculture

MPO- Municipal Planning Officer

NGOs- Non-governmental Organisations

PBC- Perceived Behavioural Control

PM- Presiding member

RESULT- Resilience and Sustainable Livelihoods Transformation Programme

RCP- Representative Concentration Pathway

SIT- Social Identity Theory

SCT- Social Cognitive Theory

SSA- Sub-Saharan Africa

SSQ- Semi -Structured Questionnaire

TDP- Theory of Drought Perception

TPB- Theory of Planned Behaviour

TRA-n Theory of Reasoned Action

USAID- The United States Agency for International Development

USDA- United States Department of Agriculture

WFP- World Food Programme

CHAPTER ONE

GENERAL INTRODUCTION TO THE THESIS

1 GENERAL INTRODUCTION TO THE THESIS

1.1 General Background to the Study

Climate variability and change (CVC) are among the major threats to the world in the 21st century (IPCC, 2014). No sector of the global economy is devoid of the impacts of CVC. Agronomic related studies suggest that, agriculture is the sector most affected, and will be highly affected as compared with other sectors (Ericksen et al., 2011, Lobell et al., 2008, Thornton et al., 2011). Literature suggests 90% of the world's staple food comes from rain-fed areas, which constitute 1.233 billion ha (82%) of the global cropland of 1.5 billion ha (FAO, 2005). This suggests that areas where agricultural activities rely entirely on rainfall will be the most affected by CVC.

Literature on vulnerability to CVC impacts suggest that different parts of the globe experience CVC impacts differently. Sub-Saharan Africa (SSA) has been documented as the most vulnerable to climatic perturbations (IPCC, 2014). First, a greater proportion of the region's population is dependent on natural resource-based livelihoods, which are highly sensitive to climate variability (Osbahr et al., 2008, Wlokas, 2008). For example, it is reported that 93% of the cultivated land in SSA is rain-fed (FAO, 2002). Rainfall variability is a particular problem for areas that experience uni-modal rainfall regimes with limited or no irrigation schemes to support farming activities during periods when there is no rainfall. Second, literature reveals that countries in SSA have limited capacity or technology to cope with the impacts (Gregory et al., 2005). Third, high vulnerability of SSA is exacerbated by poverty, social and economic processes, including conflicts (Gregory et al., 2005).

In terms of the impacts of CVC on crops, the 2014 IPCC report suggests that cereal based crops are the most vulnerable particularly in SSA due to increasing temperatures, and a reduction in rainfall is projected (IPCC, 2007). This implies that countries, communities, and individuals that rely on cereal-based crops for their food needs will be the ones that would be the most affected.

1.2 Research Gap, and Justification for the Study

1.2.1 Research gap

This study argues that although the nexus between climate variability and change is not a new phenomenon, little is being understood about certain aspects of the discourse. To that end, this research identified three gaps in an attempt to contribute to knowledge on farmers' cropping decisions under climate variability and change, and the implications on households' culturally preferred foods.

To begin with, even though the discourse on farmers' perceptions of CVC has gained wide attention (Codjoe and Owusu, 2011, Osbahr et al., 2011, Thomas et al., 2007, Yaro, 2013) the focus has mainly been to only look at farmers' perceptions without comparing with climatic data (Asante et al., 2017, Derkyi et al., 2018, Elum et al., 2017, Kolleh and Jones, 2015).

Looking at only farmers' perceptions makes it difficult for policy makers to reflect on the different factors that drive perceptions. Recognising the value of identifying matches and mismatches, the methodology has shifted though limited in Ghana to comparing farmer perceptions with climatic data (Amadou et al., 2015, Osbahr et al., 2011, Thomas et al., 2007, Yaro, 2013), and recently to understanding how farmers' perception of CVC are socially differentiated (Horsefield, 2016, Singh et al., 2018). Despite the above attempts, there is still a gap in understanding how farmers' interpretations of changes in their local climate are constructed by cultural beliefs and values as the focus is mainly centred on identifying what changes are perceived by farmers. The literature suggests a strong connection between farmers' perceptions of, and adaptation to CVC (Arbuckle et al., 2013, Menapace et al., 2015). Therefore, it is vital to understand how farmers perceive changes in their local climate as that will serve as a springboard to understanding adaptation decisions in chapter 5[1].

Similarly, on the dimension of the connection between climate variability and change, and crop selection or switching, the literature documents that few empirical studies have been conducted globally (Issahaku and Maharjan, 2014, Kurukulasuriya and Mendelsohn, 2007, Seo and Mendelsohn, 2008, Wineman and Crawford, 2014). Generally, findings from the above studies suggest that farmers will switch their crops, by cultivating crops that are more appropriately suited to the new climate. For example, in exploring the crop substitution behaviour among food crop farmers under climate change in Ghana using quantitative techniques, Issahaku and Maharjan (2014) report that farmers will allocate more land for the cultivation of sorghum, cassava, maize and rice, and less land for the cultivation of yam because findings from their study project that the yields of sorghum, cassava, maize and rice will increase and that of yam will decrease. This study however challenges this line of thinking with the argument being that farmers have multiple motives for selecting crops and adaptation to CVC could potentially lead to trade-offs between other uses of crops. Therefore, farmers may not adapt to CVC for some cultural reasons (Adger et al., 2009).

Additionally, studies on the food utilisation dimension of food security have largely concentrated on the nutritional and biological dimensions, with little attention paid to the cultural aspects of the uses of food (Treffrey et al., 2014). Interestingly, the literature suggests that attempts to understand the development of food preferences have assumed that food is always available and people can choose one food over another.

[1] Section 1.3 details the research objectives and corresponding research questions

This study however contends that the availability and utilisation of culturally preferred foods especially for people who live in rain-fed areas and in particular the poor are mainly shaped by climatic factors. There has been some recent documentation in the literature about the role of food preference in shaping food accessibility and crop production. For example, Noack and Pouw (2014) report *ugali* as a “real food” and the absence of it means no food in Kenya. This translates into people forgoing access to, or cultivation of other crops in favour of cultivation of maize and cassava to process *ugali*. Contrary to farmers not adapting in the context of Noack and Pouw, to preserve their culturally preferred foods, it is also important to acknowledge that the opposite could take place. Specifically, farmer adaptation via crop selection could potentially translate into the compromise of their culturally preferred foods if they grow other crops that are better suited to the prevailing changes which are not their cultural food crops. To address food security holistically, it is important to understand the cultural uses of food as food may be consumed for reasons beyond physiological, and nutritional benefits. Similarly, this study seeks to contribute to our understanding of how adaptation to CVC impacts on the availability and utilisation of culturally preferred foods.

1.2.2 Why is Ghana considered an appropriate setting for this study?

Ghana is an appropriate setting to examine the nexus between climate variability and change (CVC) and food security because the economy is predominantly agrarian. It is documented that agriculture contributes significantly in terms of raw materials for industry, foreign exchange earnings for the country (MoFA, 2011) contributing to over 60% of Ghana’s livelihoods (Al-Hassan and Diaox, 2007). Despite all the tremendous contribution to national growth and development, this sector of the country is largely rain fed making it susceptible to CVC (Adjei-Nsiah, 2012). Out of a total agricultural land area of 13,628,179 hectares, 57.6% is under cultivation with only 0.2% of that being under irrigation (MoFA, 2011).

Climate associated extremes such as droughts and floods pose many challenges to agricultural activities in Ghana particularly in the northern belt which has one farming season due to the uni-modal nature of rainfall that characterises the area. Ghana has ten (10) administrative regions with Northern region, Upper West, and Upper East regions constituting northern Ghana. The rest of the regions constitute southern Ghana, which experience a bi-modal rainfall regime providing the opportunity for two cropping seasons (MoFA, 2011)[2].

1.2.3 Why North-west Ghana is an appropriate setting for the study?

The North-west Ghana has been chosen as an appropriate site for research into smallholder farmer decisions under climate variability and change, and the impacts on culturally appropriate foods because of the following. First, climatic factors (as in the area being semi-arid and a unimodal rainfall zone; variable and unpredictable in nature with the situation exacerbated by climate extremes such as drought and floods). Second, a large proportion of the population is engaged in agriculture, as there are limited income generating opportunities for inhabitants to diversify their livelihoods (GSS, 2014). Third, poverty is very high in the area, which translates into low economic power to secure appropriate technologies for farm activities and access to food via market sources (GSS, 2014)[3].

---

[2] See Figure 1.1 for the map of Ghana showing the ten administrative regions and the division into northern and southern Ghana

[3] See chapter 3 (section 3.3.2) for a detailed discussion of the justification of North-west Ghana for this research

Figure 1. 1 Map of Ghana showing the administrative regions

Source: Author's Construct (Geographic Information Systems, 2018)

1.3 Research Aim, Objectives, and Questions

The main aim of the research is to understand the impacts of adaptation to climate variability and change on the availability and utilisation of culturally preferred foods. There are three objectives and the corresponding research questions as tabulated below.

Table 1. 1 An illustration of the Research Objectives and Questions.

Research Objectives	Research Questions
Objective 1: To understand farmer perceptions of climate variability and change, and how perception is socially differentiated	1. What are farmers' general perception of climate variability and change? 2. Are there any perception differentials among farmer groups? 3. What shape farmers' perceptions of CVC? 4. What matches and mismatches exist between farmer perceptions, and analyses from meteorological data?
Objective 2: To understand farmers' adaptation behaviour under climate variability and change via crop selection.	1. What crops are selected, where, and when in the agricultural cycle? 2. How have the cropping systems changed now, as compared to that of the past? 3. Who are adapting, and who are not adapting? 4. Why do farmers adjust, or not adjust their crops under climate variability and change?
Objective 3: To understand the social aspects of the uses of food, and the impacts of adaptation to CVC on culturally preferred foods	1. What is the value of *tuo-zaafi*[4] beyond biological and nutritional uses? 2. Who eats first, why, and with whom? 3. How has the pattern of consumption of *tuo-zaafi* changed now, as compared to that of the past? 4. Are the forms of *tuo-zaafi* available now what households prefer to eat? Why, or why not? 5. How the preference for tuo-zaafi is socially differentiated?

[4] The focus of chapter 6 is largely on *tuo-zaafi* (the main staple food of north-west Ghana – GSS, 2014). The details of *tuo-zaafi* are discussed in section 6.2.2 (Chapter 6).

1.4 Statement of Personal Motivation for the Study

The researcher's motivation for the Doctor of Philosophy Degree (PhD) with a focus on the nexus between climate variability and change, and food security was driven by the following factors: First, having lived the greater part of his life in rural-north west Ghana, the researcher has been a witness to the impacts of climate variability and change. The impacts manifested include farmers getting less yield and the energetic youth undertaking seasonal migration to the southern part of Ghana during the long dry season. However, the researcher did not have much understanding of the changes associated with the climate, the impacts, and the decisions that farmers are making in responses to the changing climate.

Therefore, at the Master's level at King's College London, the researcher's dissertation was focused on rainfall variability in North-west Ghana. Even though his fieldwork was briefly for a month in rural North-west Ghana, the findings suggested climate variability was a challenge to farmers' activities. To that end, the researcher was motivated to further understand the cropping decisions that farmers in North-west Ghana will make under climate variability and change. The researcher was particularly interested in whether farmers would persist in cultivating low yielding cultural crops in a quest to procure cultural foods, or farmers will displace cultural food crops if they are not suitable to the prevailing changing climate hence trade-off the availability and utilisation of culturally preferred foods.

1.5 Definition of key terms and concepts

This section clarifies the meaning of key terms and concepts as used in this thesis. These include: climate change, climate variability, adaptation, and food security. The details of each are defined below:

Climate change

"Climate change refers to 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" (IPCC, 2014:120).

Climate variability

Climate variability "refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all spatial and temporal scales beyond that of individual weather events" (IPCC, 2014:121).

Adaptation is defined "as the process of adjustment to actual or expected and it effects in order to lessen or avoid harm or exploit beneficial opportunities" (IPCC, 2014: 76).

Maladaptation **"**refers to actions, or inaction that may lead to increased risk of adverse climate-related outcomes, increased vulnerability to climate change, or diminished welfare, now or in the future" (IPCC, 2014: 857).

Food security: there are diverse definitions of food security over the years. In the context of this study, the researcher adopts the FAO (2002) definition as a "situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life."

1.6 Outline of the Thesis

Chapter 1 has introduced the study, highlighted the research gap, and explained why North-west Ghana was the focus of the case study. The research aim, objectives, and associated questions have also been outlined in chapter 1.

Chapter 2 reviews the conceptual debates around perceptions of climate variability and change; adaptation, and limits to adaptation, the cultural dimensions of food, and food preferences. These concepts are used to guide the focus of the study. The chapter also reviews empirical studies, which are related to the major themes of this study. The review was very useful in identifying the gaps of this study.

The research methodology is presented chapter 3 of the thesis. The scope is to detail the research approach, the research design, and the justification of the need to blend qualitative and quantitative research methods in understanding farmer decisions under climate variability and change, and the impacts on culturally preferred foods.

The chapter also justifies the choice of the research villages, the sampling procedure, the research methods and tools used in the data elicitation. The chapter concludes on a discussion on the data analysis process, and the identification of research challenges.

The results of the thesis are presented in chapters 4, 5, and 6 according to the objectives detailed in table 1.1. The associated implications of the findings are discussed as well in each of the three chapters. Specifically, chapter 4 deals with farmer perceptions of climate variability and change (CVC). As justified earlier, it is important to understand this to see how that translates into farmers adapting, or not adapting to CVC in chapter 5. Here, four things are the focus: (i) the general idea of farmer perceptions of CVC, (ii) how perception of CVC is socially differentiated, (ii) the factors that shape farmer perceptions particularly cultural worldviews and values, and (iii) identify the matches and mismatches between farmer perceptions and analyses from climatic data.

For chapter 5, the key issues are to understand: (i) how the cropping system has changed now, as compared to that of the past, (ii) who adapts to CVC, and who does not, and (iii) what factors influence farmers to adapt or not to adapt to CVC.

Then, in chapter 6, the focus is to present results on the cultural aspects of food, and how farmer adaptation to climate variability and change has influenced households' access to and consumption of culturally preferred foods. It also looks at how other factors contribute to differential preference for food among the social groups.

Chapter 7 is the conclusion chapter, which summarises all the three results chapters bringing together how farmer perceptions of CVC leads to adaptation via crop selection and how that has translated into affecting the culturally preferred food needs of the households of the villages of Doggoh and Tie. The chapter also discusses the theoretical, and policy implications of the findings of the research. Furthermore, the chapter discusses the implications for future research and policy.

CHAPTER TWO

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2 Literature Review and Conceptual Framework

2.1 Introduction

The objective of this literature review chapter is to discuss what is known theoretically and empirically about climate variability and change (CVC), smallholder farmer decision making, and food security, with particular reflection on the cultural dimensions of food and food preferences. The review seeks to highlight the research gaps that frame this topic, helping to refine the research objectives and organise the concepts that will shape the research design.

The review covers four debates around this central topic. Section 2.2 summarises the evidence for climate variability and change in Sub-Saharan Africa (SSA), recognising both the climate science and local perception. Next, the literature on adaptation to climate variability and change is explored, with typologies of adaptation and typologies of the limits to climate change outlined in section 2.3. Section 2.4 then seeks to examine the relationship between climate variability and change and food security in Sub-Saharan Africa. Here the focus is to discuss how understandings of food security have evolved. Section 2.5 then considers the key debates on smallholder farmer decision making. Based on the ideas that emerge through the literature review, in section 2.6, a conceptual framework for the thesis is developed to organise the ideas and linkages.

2.2 Evidence of Climate Variability and Change in Sub-Saharan Africa

2.2.1 The climate science Dimension

Changes in temperature

Temperature across the African continent is projected to rise far faster than the global increase during the 21st century (Christensen et al., 2007, IPCC, 2007, James and Washington, 2013, Joshi et al., 2011, Sanderson et al., 2011). Temperature projections over West Africa for the end of the 21st century, from both the CMIP3 GCMs (SRES A2 and A1B Scenarios) and CMIP5 GCMs (RCP4.5 and RCP8.5), range between 3^{o}C and 6^{o}C above the late 20th century baseline (Diallo et al., 2012, Fountaine et al.,2011, IPCC 2014, Meehl et al., 2007, Monerie et., 2012).

For Sub-Saharan Africa (SSA), several observations about temperature have been reported. The Inter-Governmental Panel on Climate Change (IPCC) reported that near-surface temperature over West Africa and the Sahel has increased over the last 50 years (IPCC, 20014). Similarly, New et al., (2006) showed that the numbers of cold days and nights have decreased, and the numbers of warm days and nights have increased between 1961 and 2000. Collins (2011) produced statistically significant evidence of warming of between 0.5^{o}c and 0.8^{o}c between 1970 and 2010 over Africa using remotely-sensed data. In the case of Ghana, it has been reported that the country has experienced a 1^{o}c rise in temperature over the last three decades (EPA, 2000). Minia (2004) used climate scenarios to report that mean daily temperatures will increase from between 2.5 and 3.2^{o} C in Ghana.

Rainfall

There is uncertainty about rainfall projections for Africa (Rowell, 2012, IPCC, 2014) and projected change over SSA for the mid and late 21st century remains unclear. In regions of high or complex topography, such as the Ethiopian Highlands, downscaled projections indicate likely increases in rainfall and extreme rainfall by the end of the 21st century (IPCC, 2014).

By contrast, annual precipitation in SSA, and especially across West Africa and the Sahel, is reported to be declining (Hulme et al., 2001, Nicholsen, 2001). For example, Nicholsen (2001) reports that in the semi-arid and sub-humid zones of West Africa, rainfall during the last 30 years (1968-1997) has been on average 15-40% lower than during the period 1931-1960. The main reason for this uncertainty in rainfall projections is that most areas of the African continent lack sufficient observational data to draw reliable conclusions about the trends in annual precipitation over the past century (IPCC, 2014).

In the instance of Ghana, the United States Agency for International Development (USAID) reported that although Global Circulation Models (GCMs) agree generally that mean temperature will rise, there is limited agreement on future precipitation amounts and implications for seasonality, and some GCMs project increased precipitation in the northern three regions of Ghana while others project decreases (USDA, 2011).

Minia (2008) reports that for most eco-climatic zones in Ghana, the five-year moving averages shows a downward trend for total annual precipitation between 1961 and 2000. Over this period, mean decreases occurred in the Guinea Savanna zone (-120 mm decrease), Deciduous Forest Zone (-240mm decrease), and the Rain Forest zone (-750mm). Similarly, the Environmental Protection Agency of Ghana has reported a 20% reduction in rainfall since the 1960s (EPA, 2000).

Besides scenarios on rainfall and temperature change, climate models for the region project changes in intra-seasonal climate characteristics, including the duration of rainfall and onset of rainfall. For example, Thornton et al. (2011) reports that countries in Africa are likely to experience a reduction in the length of seasons. According to Christensen et al. (2007), extremely wet seasons, high-intensity rainfall events and associated flooding in West Africa are expected to increase by 20% over the next few decades.

Burke et al., (2006) predict that meteorological droughts, culminating from insufficient rainfall, are expected to increase in duration, frequency, and intensity. In the context of Ghana, Jung and Kunstmann (2007) suggest that between 2030 and 2039 the rainy season might only start in June and even later in northern Ghana.

The above projections of climate variability and change impacts could have negative implications on agriculture and rural livelihoods in northern Ghana through, for example, a reduction in rainfall in a region already experience variable uni-modal rainfall and with limited irrigation infrastructure (MoFA, 2011). Out of a total agricultural land area of 13,628,179 hectares, 57.6% is under cultivation, with only 0.2% of that under irrigation (MoFA, 2011). Similarly, climate extreme events have been observed in Ghana. Codjoe and Owusu (2011) reported that Ghana experienced the most severe drought condition in recent memory during the 1983-84 farming season. In a study on the Comprehensive Vulnerability Analysis and Mapping (CVAM) in northern Ghana, the World Food Programme reported that the 2011 growing season was characterised by mixed agro-meteorological conditions from May to July, with long dry spells hampering crop germination and development, resulting in the wilting of staple crops. Consequently, grain filling of late maturing crops was affected and lead to a deficit in grain production (WFP, 2013).

Reduction in water flow also leads to a reduction in soil moisture for crops, increased evaporation, and evapotranspiration that shortens the length of the growing season. This has serious implication for agricultural productivity across northern Ghana.

Coupled with extreme climate conditions, such as drought and floods, this trend could exacerbate the risk of crop failure and lead to national food insecurity. This has dire consequences on those family farms that rely largely on rain-fed agriculture for their food and livelihood. This is real concern because globally, areas where maize, rice, sorghum, soya bean and wheat are grown have seen an increase in the percentage of area affected by drought since the 1960s - from approximately 5-10% to 12-25% (Li and Yan, 2009). Drought and water scarcity are not the only components of extreme weather conditions that pose threats to livelihoods. According to Christensen et al. (2007), extreme wet seasons and high-intensity rainfall events are expected to increase by 20% over the next few decades. Such conditions will be detrimental to farming activities particularly through loss of crops and potential increases in pests and diseases (Christensen et al., 2007).

Climate variability, change, and climate extreme events are known to be influenced by multiple factors. For example, during El-Nino years sea-surface temperatures lead to feedbacks between the land and the atmosphere causing increased rainfall variability (Nicholsen, 2001). Similarly, van der Geest (2004) reports that in SSA, the length of the rainy season decreases from the south to the north, caused by the annual north-south shift of the Inter-Tropical Convergence Zone (ITCZ). This is a transition zone where continental air mass and moist tropical air converge. According to Kemp et al. (1994), drought in West Africa is associated with the failure of the ITCZ to penetrate northward as far as usual. Although cannot be generalised to the whole sub-region because drought itself varies spatially and temporally within Africa.

2.2.2 Farmer perceptions of climate variability and change

Having highlighted the evidence of a changing climate in northern Ghana and the impacts on crops and food security, this section goes on to explore farmers' perceptions of these changes. In particular, the section reviews the theoretical ideas that explain farmers' perceptions of climate variability and change, and insights from empirical studies.

This is important because a clear understanding of local perceptions enables the study to identify useful theoretical lenses for the presentation of the results for the first research objective (to understand farmer perceptions of climate variability and change), and identify gaps in the discourse about farmer perceptions of CVC to contribute to existing knowledge about local perceptions of CVC.

Defining perceptions

The study adopts a definition by Taylor et al. (1988) of perception, which has been widely used within Geography and social sciences. In this definition, perception is explained as "a range of judgements, beliefs, and attitudes" (Taylor et al., 1988: 152).

Key ideas explaining farmer perceptions of climate variability and change

There are a range of ideas that help to organise our understanding of farmers' perception. In their study of the Ogallala aquifer region in the United States of America, Taylor et al. (1988) conceptualised farmers' perception of drought as a construct of four factors: experience, memory, definition, and expectation. They considered 'experience' as the meteorological events that occurred during the farmers' careers. To Taylor et al. (1988), drought experience could be experienced indirectly, such as those via oral, written, or pictorial accounts- interestingly, this was outside the scope of their study. On the element of memory, Taylor et al.

(1988) considered that as consisting of those drought events that were part of farmers' direct experiences and that could be recalled by farmers.

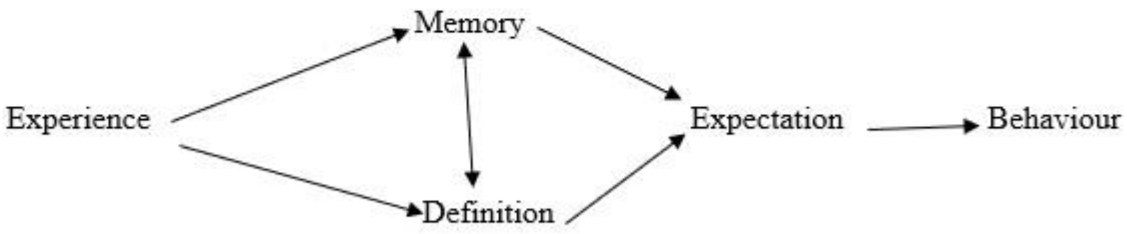
They considered definition as a set of criteria, usually moisture shortage, for classifying a period as “drought”. To Taylor et al. (1988), drought could be defined in relation to social or economic impacts of the associated drought. On the last but not the least of the criteria, Taylor et al. (1988) opine that expectation of future drought included how often farmers expected droughts to occur and how severe they expected them to be.

Consolidating these ideas, Taylor et al. (1988) developed a framework that could be used to explain connections between the four elements (figure 2.1). Farmers’ drought experience shapes farmers’ memory, and definition of drought events. Memory and definition of drought are intertwined because what one recalls as drought is shaped by how one defines drought, and definition of droughts is a construct of remembering drought.

Taylor et al. (1988) added ‘future expectations’ to explain that farmers’ expectations about future drought is a function of how drought is defined, and the way in which past experiences are remembered.[5]

[5] See Figure 2.1 for the conceptualisation of the perceptions of drought

Figure 2. 1 Conceptualisation of the perceptions of drought



Source: Taylor et al., (1988)

The ideas from Taylor et al. (1988) have been applied in many studies to explain perceptions of climate variability and change. For example, Slegers (2008) use the ideas to examine famers' perceptions of drought in Tanzania and Ethiopia. Osbahr et al. (2011) drew on some elements of the theory of drought perception to understand farmer perceptions in a study in Uganda. However, despite the wide application of these ideas, some dimensions of the framework have come under critique.

For example, different people may experience the same climatic phenomenon of drought but may recall it differently. In their study in Uganda, Osbahr et al. (2011) argued that within a given context there will be farmers that have good memories regarding their farming activities and climate-related events whilst others may not, hence this would potentially translate into considerable variation in the accuracy of understanding climatic events. It has also been documented that memory is subjective in the sense that events that are recalled differ from person to person (Ferrier and Haque, 2003, Singh et al., 2018), there is the tendency of people to exaggerate, or even forget drought events based on how they were affected (Slegers, 2008). Similarly, Hansen et al. (2004) in a study in the Argentine Pampas and in South Florida critiqued the memory component within the framework highlighting that likelihood of the distortion of farmers' memory of past climate events could be shaped by their wishful thinking, personality characteristics and pre-existing beliefs.

Contrary to the idea in Taylor et al. (1988) that personal experience shapes perceptions of climate variability and change, Weber (2010) argues that climate change is not a phenomenon that the lay public can easily and accurately identify. He claims that it is a statistical phenomenon that describes the average weather conditions of a region, and that observations are spaced in time, so memory of past events will be faulty (Weber, 2010). Weber (2010) suggests that because climate change cannot be detected and judged accurately on the grounds of personal experience, the detection of climate change should be left to experts (i.e. climate scientists) and their social amplifiers, such as the media and educators.

Weber does recognise that people will not just accept climate information from any external source but rather from trusted sources (Weber, 2010) although this might ignore the potential of information to also be distorted by political or cultural communication within the media for example.

Thus, moving beyond the idea of people learning about climate change only from experts, Weber (2010) introduces an understanding that the existence of climate change, the causes, and likely consequences are socially constructed. These constructions are functions of the cultural worldviews of societies. What is missing in this conceptualisation is reflection on what criteria are used to identify trusted sources and implications for knowledge as a result.

Empirical evidence of farmer perceptions of climate variability and change in Sub-Saharan Africa

This section narrows the review to empirical studies on farmer perceptions of climate variability and change (CVC) in Sub-Saharan Africa (SSA) to identify similarities and difference in approaches.

Farmers observe the world around them and use change in their environment as indicators of CVC. For example, in the Sahel, Roncoli et al. (2011) documented that farmers identify the shrinking of water bodies, the disappearance of plants and crops, and use changes in settlement patterns as evidence of reduced rainfall over the last three decades of the twentieth century (Roncoli et al., 2011). Similarly, a study in south western Tanzania showed that farmers use plant phenology for seasonal forecasting (Ladislaus et al., 2010). Ladislaus et al. (2010) highlighted how farmers recognised early and significant flowering of Mihemi (*Erythrina abyssinica*) and Mikwe (*Brachystegia Speciformis*) trees from July to November as the signals of good rainfall season (Ladislaus et al., 2010). While Laube et al. (2012) reported the observation of traditional environmental signs (e.g. behaviours of birds and ants, changing wind patterns, new leaves) to indicate the onset of the rainy season have recently become unreliable indicators.

In terms of the role of memory in shaping famers' perceptions of CVC, there are empirical studies. For example, Codjoe and Owusu (2011) reported that in Ghana the annual rainfall totals have decreased. Respondents in their study felt that rains were better during the 1960s compared to the 2000s.

Regarding the onset of the rains, Codjoe and Owusu (2011) study indicated that the rainfall was perceived to start in February but now starts in March, while it was perceived to be hotter than the past. Codjoe and Owusu (2011) also document a trend in the bi-modal precipitation pattern in which two separate rainy seasons are being replaced by a single rainy period, beginning later and ending more quickly.

Osbahr et al. (2011) have similar reports in their study from Southwest Uganda, in which farmers reported that the first season had shifted from a start during February to March and now ended in April rather than May. Meanwhile, they found the second season had shifted from a start in August to September and now ended in November rather than December.

This is the case for Ghana where there are several studies only on farmers' perceptions of climate variability and change (Asante et al., 2017, Codjoe and Owusu, 2011, Derkyi et al., 2018, Kolleh and Jones, 2015). For example, Kolleh and Jones (2015) focused on only farmer perceptions to report that farmers perceived decreasing precipitation and increasing temperature in the Ketu north district of the Volta region in Ghana. Similar results are reported by others in South Africa (Elum et al., 2017), and Ghana (Asante et al., 2017, Derkyi et al., 2018).

There is a limitation from this approach, in that it is then difficult to reflect on the implications of local perception for effective adaptation or potential mal-adaptations because it is not compared with patterns of actual climatic data, nor does it let the researcher reflect on what might be driving perception for some farmers when there are differences.

Thus, it is important to review empirical studies that have explored perceptions of climate variability and change with local meteorological data. Empirically, several studies have used this approach in South Africa (Gandure et al., 2013, Thomas et al., 2007), Uganda (Osbahr et al., 2011), Nigeria (Ayanlade et al., 2017), Zimbabwe (Moyo et al., 2012), and Ghana (Limantol et al., 2016, Yaro, 2013).

For example, in their study focusing on the Vea catchment in Ghana, Limantol et al. (2016) reported that famers observed an increased in temperature for the past 30 years, and that the amount of rainfall, duration, intensity and the number of rainy days has decreased. The analysis with their climate data revealed a rising trend in temperature but no long-term trend changes in annual or monthly rainfall within the Vea catchment area.

Similarly, in a study in four communities in the Upper East region of Ghana, Amadou et al. (2015) reported that farmers reported increased temperatures which matched the analysis of temperature data, but there was also no clear evidence of a statistically significant reduction in the amount of rainfall, but rather high inter-annual variability. Amadou et al. (2015) found an agreement between climatological data and farmers' observation of a shift in the onset of the rainy season from April to June accompanied by an increased in dry spell. This approach is useful as it gives room for the identification of matches and mismatches, and an opportunity to then understand the reasons behind this and where appropriately support farmers with better information and a forum for discussing these differences with farmers (Arbuckle et al., 2013, Dohmen et al., 2009, Menapace et al., 2015).

Despite the value of this approach, it is essential to also recognise the importance of recognising different farmer understandings and how these shape adaptation responses.

Recently, there is growing empirical interest in trying to understand how farmers' perceptions of climate variability and change are socially differentiated. For example among farmers in Rajasthan, India (Singh et al., 2018), in Swaziland (Mamba, 2016), and in Zimbabwe (Horsefield, 2016). The study in Swaziland sought to understand how perception is differentiated by different farmer groups using the parameters of age, gender, and level of educational attainment. In the context of age, Mamba (2016) found that older farmers accurately perceived change as compared to younger farmers based on their greater experience. Mamba (2016) also found a strong association between farmers' level of educational attainment and how they accurately perceive climate variability and change.

This is explained by educated people's competence in the interpretation of information. However, the researcher contends this largely depends on a farmers' level of educational attainment as lower level of education may not expose farmers to climate systems and climate change related academic discourse.

Similarly, Mamba (2016) found that more women as compared to men correctly perceived climate variability and change and argued that women play critical roles in agricultural activities in patriarchal societies allowing them to be closely connected to the environment around them. Singh et al. (2018) found in India that older farmers had clearer perceptions than younger farmers. However, Singh et al. (2018) found no difference between male and female farmers' perceptions of water scarcity. Singh et al. (2018) did find that more female farmers than male farmers indicated that they ‘don’t know’ and suggests this could be due to differential access to and use of information between men and women.

2.3 Adaptation to Climate Variability and Change

The concept *adaptation* has become enshrined in global policies. For example, it has appeared in Article 2 of the United Nations Framework on Climate Change (UNFCCC). This suggests that the concept is neither a new empirical or theoretical construct. Ultimately, the objective of the UNFCCC concedes that adaptation to climate change (CC) in relation to food production, ecosystem health, and economic development can, and will occur (Hulme et al., 2007). Despite the global recognition of the importance of adaptation to CC, until the 1990s and early 2000s, the focus of the international climate policy debate was centred on mitigation. The shift to adaptation from the early 2000s has been documented (Pielke et al., 2007, Parry et al., 1998, Hulme et al., 2007).

Defining adaptation to climate variability and change

Adaptation has been defined by the Intergovernmental Panel on Climate Change as “the process of adjustment to actual or expected climate and its effects in order to lessen or avoid harm or exploit beneficial opportunities” (IPCC, 2014:76). The contemporary focus of adaptation has been documented to be on two areas: (i) to understand how adaptation can be facilitated to reduce the negative impacts associated with climate variability and change (CVC), and to maximise the opportunities that come with CVC, and (ii) to understand, and deal with the factors that impede the success of adaptation actions (Adger et al., 2009, Hulme et al., 2007). To this end, section 2.3.1, and section 2.3.2 are devoted to reviewing literature on the typologies of adaptation to climate variability and change, and the limits and barriers to adapting to CVC respectively. Section 2.3.3 specifically then focuses on empirical studies carried out on farmer adaptation to CVC via crop selection.

2.3.1 Typologies of adaptation to climate variability and change

Adaptation can be characterised in terms of i) intent and purposefulness; ii) Timing and duration; iii) scale and responsibility; and iv) form.

In terms of intent and purposefulness, adaptation is differentiated in terms of adaptations that are undertaken spontaneously or autonomously as against ones that are consciously and specifically planned in the light of climate variability and change (Bryant et al., 2000, Carter et al., 1994, Smith et al., 2000).

Regarding timing and duration, adaptation is either anticipatory (proactive), concurrent or reactive (responsive). Duration of adaptation distinguishes responses according to the period over which they apply, such as tactical (shorter-term) versus strategic (longer-term) (Smithers and Smit, 1996, Stakhiv, 1993). In agriculture, tactical adaptations might include adjustments made within a season that involves dealing with a climatic condition, such as drought, in the short term. This, for instance, may include selling of livestock.

In terms of scale and responsibility, adaptations can be distinguished according to the scale at which they occur and the agent responsible for their development and employment. In agriculture, adaptations occur at a variety of spatial scales, including plant, plot, field, farm, region, and nation (Smithers and Smit, 1996). At the same time, responsibility can be differentiated among the various actors that undertake or facilitate adaptations in agriculture including individual producers (farmers), agri-business (private industries), and governments (public agencies) (Smith et al., 2000). Adaptation in agriculture occurs via a variety of processes and can take many different forms at any given scale or with respect to any given stakeholder. Distinctions among adaptations based on the form have been suggested by among others, Carter et al. (1994), and Smithers and Smit (1996). These studies consider adaptations according to their administrative, financial, institutional, legal, managerial, organizational, political, practical, structural, and technological characteristics.

For example, Bryant et al. (2000) identify forms of adaptation at the farm-level, including modification of resource management, purchasing crop insurance, and diversification. They also identify different forms of policy level adaptations including aid for research and development, incentive strategies and infrastructure measures. Differentiating responses to climate change according to form provides a useful framework for understanding adaptation in agriculture.

It is worth noting that the above typologies are not mutually exclusive, because the dimensions are inextricably intertwined. This research recognises that adaptation does not simply occur independently at the field or farm level, but it is a process influenced by broader economic, political and social forces. Therefore, besides focusing on farmer adaptation, to understand the limits and barriers to adaptation, the study acknowledges that other actors, including government (with a focus on the Ministry of Food and Agriculture) and non-governmental organisations (NGOs) that run agriculturally related intervention programmes play a role in terms of adaptation.

2.3.2 Typologies of the barriers, and limits to climate change adaptation

The concept of 'limits' or 'barriers' to climate change adaptation have emerged and been used interchangeably by some scholars and differently by others (Islam et al. 2014). What stands out clearly in the literature is that the two concepts have been considered as the factors that restrict people's ability to identify, assess, and manage risks in a way to enhance their wellbeing (IPCC, 2007, Moser and Ekstrom, 2010). In terms of differentiating the two concepts, a number of parameters have been used as summarised in table 2.1.

Table 2. 1 Summary of the different definitions of limits and barriers to climate change adaptation

Element	Definitions
Limits	• Adaptation limit is considered "as more restrictive in that it means there are no adaptation options that can be implemented over a given time horizon to achieve one or more management objectives, maintain values, or sustain natural systems" (IPCC, 2014: 906). Similarly, the IPCC sub-divides adaptation limits into hard and soft adaptation limits with the former being "no adaptive actions are possible to avoid intolerable risks" and the latter "options are currently not available to avoid intolerable risks through adaptive action" (IPCC, 2014: 907). • Limits are obstacles that are in some sense absolute (Adger et al., 2009)
	• "the conditions or factors that render adaptation ineffective as a response to climate change and are largely insurmountable" (Adger et al., 2009: 733)
	• Limits exist when thresholds or tipping points associated with social and /or natural systems are exceeded (IPCC, 2007).
Barriers	• "A factor or process that makes adaptation planning more difficult" (IPCC, 2014: 906). • Barriers are obstacles that are mutable (Adger et al., 2009)
	• Barriers are the conditions or factors that render adaptation difficult as a response to climate change (Nielsen and Reenberg, 2010)
	• "Barriers can be overcome with concerted effort, creative management, change of thinking, prioritisation, and related shifts in resources, land use, institutions, etc. (Moser and Ekstrom, 2010).

The definitions of limits and barriers in the context of this study highlight how efforts to support the success of adaptation can be constrained (IPCC, 2014).

Having reviewed the literature around limits and barriers to adaptation, it is necessary to understand the various debates on the typologies of limits and barriers to climate change adaptation. The focus on the limits and barriers to climate change adaptation has centred on technological, economic, physical, and ecological factors.

However, there is a growing interest on other aspects of limits and barriers to climate change adaptation, known as the 'social limits' to adaptation to climate variability and change (Adger et al., 2009).

Natural barriers to climate change adaptation

Natural barriers include a range of ecosystems thresholds to geographical and geological limitations (Jones and Boyd, 2011). It is suggested that a dramatic change may alter physical environment and potentially translate into limits to adaptation possibilities (Nicholls and Tol, 2006). It has documented that the sensitivity of some ecosystems, habitats, and species could also influence the limits of adaptation to CVC (Schefer et al., 2001).

Economic limits to climate change adaptation

The success of climate change adaptation could be constrained by economic factors. It is documented that this is particularly the case for low income households and communities (Adger et al., 2009). Empirically, several studies have explored the economic limits to adaptation. For example, Mahon (2002) identified the cost of vessel insurance, gear replacement, repairs, operation, safety measures and increased investment as the barriers to adaptation among fishing communities in the CARICOM region (Mahon, 2002).

Technological limits to climate change adaptation

On the aspect of technological factors impeding the success of adaptation to climate variability and change, it has been documented that the lack of engineering structures, for example the lack of equipment, tools and techniques may also constrain adaptation (Mahon, 2002). It is also suggested that technological barriers may emanate from inaccurate information, due to for example limitation in the modelling of the climate system or lack of accurate weather forecasts.

Social limits to climate change adaptation

To Adger et al. (2009), previous analyses have considered adaptation from a narrower standpoint that focuses on predominantly ecological, physical, economic or technological aspects. To them, instead of looking at limits to adaptation from predominantly exogenous or analytical terms, they believe that the limits to adaptation should be considered differently focusing on how societies are organised, the values that they hold, the knowledge they construct, and the relationships that exist between individuals, institutions, and the state.

Adger et al. (2009) further argue that, the limits to climate change adaptation are endogenous and emerge from 'inside' society. To Adger et al. (2009), limits to climate change adaptation are contingent on goals, values, risk and social choice. Adger et al. (2009) contend that the social limits to adaptation to climate change are shaped by four elements: ethics (how and what we value), knowledge (how and what we know), risk (how and what we perceive) and culture (how and why we live).

In sum, different typologies can be connected. For example, economically, farmers may have the ability and can get improved varieties of seeds and farm inputs but because of cultural reasons may still decide to grow traditional varieties of certain crops, which are not suitable to the prevailing climate in a quest to preserve cultural values.

2.3.3 Farmer adaptation to climate variability and change via crop selection

Adaptation in agricultural systems can be with respect to adverse effects or vulnerabilities, as well as in response to opportunities (Smith et al., 2000). Adaptation can be in response to past, actual or anticipated conditions, changes or opportunities. The study recognises that adaptation by farmers can be on-farm or off-farm adjustments (including livelihood diversification).

However, it is noteworthy that, in the context of the research area, the livelihoods of the population are focused largely on agricultural activities, as there are limited income-generating activities for livelihood diversification (GSS, 2014). Therefore, the research is mainly anchored on adaptation via crop selection.

Empirically, several case studies, though limited in nature particularly in the context of low latitude countries, have documented crop selection or switching under climate variability and change. These studies, largely quantitative in nature are underpinned by the assumption that, farmers will select crops that will give maximum yield under climate variability and change. For instance, using a multinomial logit model to estimate the choice of crops by farmers in seven countries in South America, Seo and Mendelsohn (2008) reported that farmers choose fruits and vegetables in warmer locations and wheat and potato in cooler locations. They further report that farmers in wetter locations are more likely to grow rice, fruits, potatoes and squash and in dryer locations maize and wheat. They argue that global warming will cause South American farmers to switch away from maize, wheat, and potatoes towards squash, fruits and vegetables. Also, in a study conducted in selected African countries, Kurukulasuriya and Mendelsohn (2007) found that farmers adapt their crops to suit local conditions. For example, farmers in cooler regions choose maize-beans and sorghum, whereas farmers in hot regions choose cowpea and millet. Farmers in dry regions choose millet and sorghum whereas farmers in wet regions choose maize-beans, cowpea-sorghum, and maize-groundnut. The study also reports that farmers choose only a single crop to grow such as sorghum, cowpea or maize. However, farmers often select a combination of those that will survive harsh conditions, such as maize-beans, cowpea sorghum, and millet-groundnut. These combinations provide the farmer with more flexibility across climates than growing a single crop on its own.

Similarly, using a Multivariate Tobit Model to analyse the impact of climate change on yield, planting decisions and output of five major food crops in Ghana, Issahaku and Maharjan (2014) reported that climate change will stimulate farmers to allocate more land for cassava, maize, sorghum, and rice cultivation.

Their study indicates that farmers respond to the positive impact of climate on yields of cassava, maize, sorghum, and rice by relocating more land for the cultivation of these crops, which is in line with the neoclassical understanding of producer behaviour. Results from their study indicate for instance that by 2025, land allocated for cassava, maize, sorghum, and rice cultivation will increase by 5.56%, 2.10%, 31.20%, and 11.25% respectively while decreasing farm size for yam by 5.38%. Their findings, however, contradict that of some studies (Knox et al., 2012) that predict that yields of cassava, sorghum, millet, and maize will decrease in West Africa through adverse effects of climate.

Findings from these studies suggest that farmers under climate variability and change will select crops that will give them maximum yield. It is, however, noteworthy that, production decisions by farmers may not only be motivated by yield or profit maximisation or optimisation behaviour. For example, smallholder farmers are likely to cultivate more of staple crops that will do better under climate variability and change, than staples that would not do better. Also, smallholder farmers are more likely to continue to cultivate staple crops and get low yields than cultivate non-staple crops that would give better yields under climate variability and change. Similarly, smallholder farmers with relevant knowledge of climate services and extension services are more likely to choose crop type or varieties that are more appropriately suited to the climate than those without access to such information. It is worth noting that rich smallholder farm households are more likely to adopt improved crop varieties than poor smallholder farmers.

It is noteworthy that, farmers as consumers may have certain preferences for some crops over others hence likely to choose these crops, although they may not be the ideal crop in terms of yields or welfare maximisation (Chipanshi et al., 2003). Ziervogel and Ericksen (2014) reported how farmers prefer to cultivate maize in South Africa even though sorghum fares well under the new climate.

2.4 Climate Variability and Change, and Food Security

The Inter-Governmental Panel on Climate Change (IPCC) states with high confidence that globally extreme climate and weather events will reduce food production and the most affected among crops in Africa will be cereals due to increasing temperatures and changes in precipitation (IPCC, 2007). Thornton et al. (2011) suggests that there will be strong regional variation in the degree of yield reduction in Africa (except for eastern Africa where maize production could benefit from warming at high elevation locations). With many communities and households relying on local natural resources, this trend will have significant effects on food security (Wlokas, 2008). Those engaged in cereal-based crop cultivation would be at most risk to climate variability and change.

Variability in the amount and distribution of rainfall in the sub-region, affects many aspects of agricultural production, including farm sizes, crop enterprises, cropping calendars, incidence, and growth of weeds, crop pests and diseases (Yengoh et al., 2010). It is worth noting that variability in intra-seasonal climate characteristics may pose challenges that are more critical to farmers than inter-annual climate characteristics. Osbahr et al. (2011) reported that in-season dry spells or an intense rainfall event in Uganda during a crop flowering period reduce yield.

Similar insights by Laube et al. (2012) in Ghana highlighted how a dry spell in May of 2007/2008 rainy season badly affected the yield of early millet and bean crops, while heavy rains and floods in August and September destroyed late season crops of guinea corn, rice, and groundnuts. Both the events in Ghana led to almost complete crop failure that warranted distribution of food aid across large parts of northern Ghana, particular where there are limited economic activities for people to generate income to procure food through market sources.

Falloon and Betts (2010) argue that intense rainfall can translate into farms becoming flooded, which destroys the entire seasons crops over a wide areas, and also devastates food stores or assets, such as farming equipment and agricultural land (due to sedimentation).

This can be even more devastating for farmers to recover from than drought. High temperatures during flowering can be particularly problematic for maize and soybean (Porter and Semenov, 2005) because physiological processes, such as germination, flowering and photosynthesis, have an optimum temperature range within which they function effectively (Gliessman, 2007). Extreme weather events due to the impacts of climate change may also reduce the efficiency of application of farm inputs, such as fertilizers (Porter and Semenov, 2005). Climate change impacts such as intense rainfall may also increase the risk of soil erosion and salinization (Nearing et al., 2004).

Thus, the impacts of climate variability and change affect physical but also economic access to food. Food that is successfully produced has to be transported to the consumer and local transport networks are required to ensure physical access to food. This is problematic in many developing countries where rural transport networks are inefficient or poorly established. The impacts of climate change exacerbate these challenges by undermining food security indirectly through disruptions to the local systems and the infrastructure that people use to access food (Tyler et al., 2013). Perry and Symons (1994) found that temperature increases have the potential of reducing the lifespan of the roads themselves. Increased severity and frequency of windstorms impact negatively on transit at seaport terminals as well as damaging infrastructure. Keating (2010) reported that extreme weather events complicate the logistics of food storage and distribution, creating delays in food transportation and thereby food accessibility problems. Ultimately economic access to food could be threatened by the adverse impacts of climate change by reduced productivity in some areas of important cereals (IPCC, 2007), which creates delays in transporting food to market. Food shortages at market also will raise the prices of food products.

A study by the International Food Policy Research Institute (IFPRI) suggests that by 2050, real prices might increase by 87-106% for maize, 55-78% for rice and 54-58% for wheat, relative to the 2010 baseline, because of adverse climate change impacts (Nielsen and Reenberg, 2010). In terms of vulnerability and impacts, the most affected would be the poor who have inadequate or no purchasing power to procure food from market sources (Morton, 2007). Under these circumstances, the poorest people, who already use most of their income on food products, would have to sacrifice additional income to meet their food and nutritional requirements (WFP, 2013).

Climate variability and change impacts on availability and accessibility pose challenges to utilisation as well. For instance, reduced calorie intake due to lower food availability, particularly those that rely on their own production for their food needs and the poor who cannot afford to get sufficiently nutritious food due to the higher prices triggered by climate variability and change will suffer nutrition challenges. Climate change impacts can exacerbate patterns of under-nutrition (WFP, 2013). Due to low productivity, resulting from climate change impacts, households that rely largely on their own production must manage the little they have - for example by reducing the number of meals taken and, in some circumstances, change their diets (Corbett, 1988, Fleuret, 1986). Climate change and variability are active drivers of food stress in areas that are largely dependent on rain-fed agriculture. Climate change also has an important impact on food security by affecting calorie consumption.

Climate-related shocks, such as drought, impact dietary diversity and reduce overall food consumption with long-term detrimental effects on stunting (Gitau et al., 2005). Inadequate care practices could result due to difficulty in accessing clean drinking water. Health would be impacted by changing disease patterns because of climate change (Akudugu et al., 2012). This will reduce the ability of the human body to absorb nutrients from food (IPCC, 2007).

Climate variability and change has therefore the potential of changing the food diet of people, particularly family farming households that rely on their own production to procure their food needs. If farmers switch away from crops that enable them to procure their culturally preferred food needs, there is then the likelihood of a change in diets and displacement of socio-culturally preferred food. This aspect of food security and climate change relationship is often overlooked in the literature.

Food stability refers to situations where people may either temporarily or permanently lose their access to resources that could enable them to consume food (Schmidhuber and Tubiello, 2007). Increased incidence of extreme events, including drought and flooding, have the potential to affect local food production and food supplies (IPCC, 2007). A reduction in productivity will have two specific consequences. First, reduction in food productivity will mean those that rely solely or largely on their own production will not have sufficient food stock for the whole year. Second, income levels of farmers who spend large proportions of their income on food based on procurement from market sources are likely to decrease. The infrastructure for staple distribution and supply of food for food stability cannot then be guaranteed for all year.

2.4.1 Understanding the different perspectives on food security

Food insecurity is a phenomenon that continues to capture attention at the global, regional, national, community, household and individual levels. Food insecurity is an issue of global concern to everyone as its impacts directly or indirectly. For instance, during moments of a food crisis, food secure nations usually allocate part of their budgets supplying food aid to insecure ones. Shortfalls in food supply coupled with high demand have the potential to trigger the rise of food prices.

The concept of food security has evolved over the last 40 years. The international community concerns about food insecurity in the 1970s lead to development of the terminology via the organisation of the World Food Conference in 1974, which was mainly necessitated by shortfalls in world food production coupled with price increment in foodstuffs. Hence, the focus of the international community at the conference was on improving world food production and stabilising food prices (Clay, 2002). Food Availability Decline (FAD) was the major cause of food insecurity.

The FAD approach has is useful to understand. Food must be available before it can be accessed economically (via purchase from market sources). Once food supply is low, several issues will potentially emerge including rising food prices and hence the poor will be most vulnerable to food insecurity. However, there are some issues to consider about world food supply. For instance, despite the marked evolution in world food supply, in the early 1980s famines continued in Africa (Staatz et al., 1990). Again, the technical successes of the Green revolution in Asia did not automatically translate into phenomenal reductions in poverty and levels of malnutrition (Clay, 2002).

With the antecedent matters associated with the Food Availability Decline (FAD) approach, the focus on food security in the 1980s shifted to accessibility. The work of Sen (1981) created a new focus, where decline in food availability could be seen as neither necessary nor sufficient to create hunger. Historical examples of famine conditions became evident from countries with sufficient national food supplies. His viewpoints are however not far from critique.

First, a decline in food production has the potential of reducing the incomes of farming households (Devereux, 2001) and that will translate into multiple effects including accessing food as well as catering for other household needs like education and hospital bills. Second, a decline in food availability will push food prices to go up and ultimately many would be vulnerable to food insecurity especially the poor. Sen's work did not factor in a temporal dimension as a given household may have many entitlements today and these may collapse in the future.

Concerns about food security continued to evolve with increased attention to intra-household dynamics to explain inequitable distribution of and access to food (Andrew et al., 2013). This led to the consideration of utilisation as a third domain of food security. Recognition of physical and economic access to food and food acquisition are necessary but insufficient to fully explain food insecurity, and especially at household level.

Utilisation at the household level may reflect cultural differences in the allocation of food within households, and the nutritional quality of the food and variation in the extent to which the nutrients in food can be absorbed and metabolised by individuals within households (Andrew et al., 2013). At the 1996 World Food Summit the definition went through further revision by recognising the importance of dietary quality as well as individual and household food needs (FAO, 1996).

This, therefore, shifted attention from mere caloric sufficiency to overall diet quality. The Food and Agriculture Organisation of the United Nations (FAO) declared food security as existing when "when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 1996).

The definition clearly indicates that socio-culturally acceptable foods are an integral component of the utilisation dimension of food security. Despite this recognition, studies looking at food utilisation have been focused largely on the biological and nutritional components with little attention paid to cultural aspects (Trefrey et al., 2014).

Interestingly, some studies recently have findings that suggest a pivotal role of cultural preferences for certain foods hence the advocacy for the incorporation of socio-cultural dynamics into the design of adaptation related programmes and projects to avoid maladaptation (Noack and Pouw, 2014). The following section therefore explores the cultural dimension of food security.

2.4.2 Key debates on the development of food preferences

A review of food preferences must draw on ideas from geography, anthropology, and psychology to understand the range of debates about the cultural uses of food and the development of food preferences.

The development of food preferences is largely a construct of two factors: (i) cultural idealism, and (ii) cultural materialism. Other factors include the availability of food, the sensory characteristics of the food, parental feeding practices, and 'mere' exposure theory.

Defining food preferences

Several definitions have emerged in attempts to conceptualise food preferences. Key themes that have emerged from the definitions include the availability of food, the comparison of several foods, and selecting one food over the other (s). The details of the various definitions are summarised in table 2.2.

Table 2. 2 Selected definitions of food preferences

Author(s)	**Definition**
Pilgrim (1961)	The degree of like or dislike for food
Rozin and Vollmecke (1986)	Preference assumes the <u>availability</u> of at least two different items, and refers to the choice of one rather than the other
Birch (1999)	The selection of one item over others
Smith (2006)	The way in which people choose from among <u>available</u> comestibles on the basis of biological or economic perceptions including taste, value, purity, ease or difficulty of preparation, and the availability of fuel and other preparation tools
Rozin (2006)	Preference has to do with a comparison of two or more foods, as part of a set from which a choice can be made (p.24)

Cultural Idealism

Both the theory of cultural idealism and the theory of cultural materialism agree that foods in a given society will be related to the society's culture but they differ in terms of how this relationship is conceptualised (Torpoco, 1997).

Cultural idealists argue that food preferences are arbitrary and that preferences for food are the results of irrational cultural prejudices. In other words, food preferences are contingent largely on cultural prejudices. The proponents of the cultural idealism theory including Sahlins (1978) and Fides (1991) have demonstrated why food habits reflect cultural reason rather than biological, ecological or economic advantage. This theory sees variation in preferences as a direct consequence of a society's distinctive culture, and that eating behaviour is part of a wider cultural code that reflects, symbolises, and expresses the unique worldview of a that society

(Torpoco, 1997). Three themes have emerged to explain the cultural idealists' conceptualisation of food preferences: (i) food customs are the consequence of arbitrary whim, chance, and taste (ii) foods are a symbolic expressions of a society's values and beliefs, and (iii) foods are the consequence of historical continuities that that regress to an unknown beginning (Fieldhouse, 1986).

Sahlins (1978) argued that human valuations of the edibility and inedibility of animal meats are qualitative, and not in any way justifiable by biological, ecological, and economic advantage (Torpoco, 1997). Sahlins cites the central position of beef in the diet of Americans as irrational and argues that the American taboo of meat from dogs or horses which renders the consumption of these animals unthinkable even though the consumption of these animals is technically feasible and from a nutritional standpoint logical. Sahlins strongly believes that it is a culture that shapes utility, and the not the other way around (Torpoco, 1997).

Similarly, Fides (1991) argues that the cultural worldview of a given society shapes the society's attitudes toward what it consumes (Torpoco, 1997). Here the consumption of food is largely symbolic and reflects a society's cultural orthodoxy, and that consumption of meat then has little to do with reason as many people in the world eat little or no meat, yet they are perfectly healthy (Torpoco, 1997).

Cultural Materialism

Cultural materialism sees explanations of food preferences begin with the assumption that a society's food habits are a construct of technological, biological, political-economic, and environmental influences (Torpoco, 1997). As a core proponent of cultural materialism, Harris (1987) claims that the theory of cultural materialism is based on the simple premise that all human social life is a pragmatic response to the practical problems of earthly existence. To this end, Harris argues that the role played by culture or ideology is subordinate to the constraints imposed by ecological, political, economic, and other behavioural conditions. For example, Harris argues that the Indian taboo on the slaughter of cattle, and the Jewish taboo on eating pork, have their origin as adaptive responses to infrastructural conditions in both regions, rather than the result of cultural or religious beliefs.

Availability of food

Mela (1999: 154) argues that food availability is one of the basic rules governing food choice and, that "if it is not available, it will not be eaten. If it is available, it is likely to be eaten. If there is no alternative, it will be eaten". When conceptualising food availability, two aspects are important. The first is that food must be produced and that this depends on the reliability of rainfall (for those that rely largely or solely on rain-fed agriculture), and on the existence, and efficacy of irrigated schemes for those that can afford this option. Second, availability can be dependent on the procurement of food from market sources although this is still contingent on food being produced. For the poor, physical availability of food in the market does not translate into economic access because of limited financial means.

Therefore, the argument here is that, for those that are poor and live in rain-fed areas such as the Doggoh and Tie villages of North-west Ghana, climate decides what food is available to them, as variability or change in climate would impact on the nutritional, and the cultural uses of foods. This, for example, can manifest in the availability of less food, which coupled with high demand for the food could trickle down into rising food prices, and it would be the poor that would be most vulnerable.

It is noteworthy that the conceptualisation of 'availability' has always been narrow. The reason being that it is usually assumed that food can always be there for people to make a choice of one type as against another based on preference. However, in discussing the discourse on food availability, it may be more useful to factor in additional forces, such as the impacts of climatic factors in influencing what can be produced, as well as economic capacity in terms of accessing the available food in the market. For example, the availability of food may be constrained by the impacts of climate variability and change. Therefore, people may choose the foods that are available because of climatic conditions, and the chosen foods may not necessarily be that which would be preferred (Mela, 1999).

'Mere' exposure to food

It has been documented in the literature how all foods are initially unfamiliar to a child. Fieldhouse (2002: 195) notes that a child must learn what new foods tastes like and ascertain the safety of the concerned food (s) and hence make a judgement of the edibility of specific foods. To Birch (1999), a minimum of eight to ten exposures are necessary before a child accepts a type of food. However, Rozin (2015) argues that if the repeated consumption is for a short period of time, this can translate into boredom and reduced pleasure known as sensory – specific satiety (Rozin, 2015). The importance of repeated exposure to a given food has been recognised in two ways: (i) it reduces food neo-phobia (i.e. the fear to try new food), and (ii) repeated consumption of the same food on different occasions is likely to translate into increased preference (Rozin, 2015).

This has implications for how we understand food preferences under the impacts of climate change and variability.

The sensory properties of food

The acceptance or rejection of some foods has been documented to be influenced primarily by the degree of pleasantness of the sensory effects in the mouth, the odour or appearance (Birch, 1999). Similarly, Birch (1999) notes that accepted foods are on these grounds can be labelled as “good tastes” and those rejected as “distastes”. It is argued that within a given culture (Birch, 1999), that individual differences on sensory affective grounds (i.e. liking or disliking for rice for example) could probably account for variation in food preferences among people. The literature (see Birch, 1999, Drewnowski, 1997, Garcia-Bailo et al., 2009) document basic tastes (i.e. sweet, sour, bitter, salty and umanmi) together with odor and texture as the sensory characteristics of food that determine the preference for food. Fieldhouse (2002: 196) agues even though the sensory properties of food are vital in shaping the preferences for food, highly preferred food will sometimes be avoided if there is an unpleasant visceral experience associated with their consumption.

Taste as a sensory property that shapes preferences for food has been documented to decrease with age. For example, Fieldhouse (2002: 197) explains that taste sensitivity decreases in later years as taste buds decline.

Parental feeding practices

The literature on food preferences (see Birch, 1999, Vereecken et al., 2010) identify modelling, restriction of foods, and pressuring a child to eat as the parental feeding practices that influence children’s development of food preferences. Parental feeding may be a strong influence on the development of food preferences during infancy and early childhood as that is the period that children share longer time with parents. However, as they grow, go to school and get integrated into the wider society, other factors may come in to play.

2.5 Understanding Smallholder Farmer Decisions under Climate Variability and Change

2.5.1 Theoretical ideas on smallholder production decisions

There is no consensus in the literature to explain the behaviour of smallholders in relation to household production decisions. Whereas some theories posit that smallholders are inclined toward profit maximisation, others are premised on the proposition that smallholders are irrational, unmotivated by profit hence unresponsive to economic incentives (Umar, 2013).

The profit maximisation theories (PMT) epitomised by work from scholars such as Schultz (1964), Lipton (1968), and Stiglitz (1989) argue that the motive of smallholders is to maximise profit. Hence, smallholders are treated as business entities, whose main aim of production is to allocate more resources to maximise profit (Umar, 2013).

PMT assume that resources and production conditions confronting smallholders are homogenous, and that markets, farmland, labour, capital and inputs and outputs, are fully competitive – as in where producers all apply the same prices, workers are paid according to the value of their marginal product and inefficient firms go out of business (Friss-Hansen, 1995). The theory also assumes that smallholder farmers in developing countries will respond positively to price incentives (Sauer and Mendoza-Escalnate, 2007) - that cropping decisions for instance will be influenced by market forces, particularly the prices of goods, and farmers would then cultivate crops that will fetch the best prices. There is recognition in the literature about the responsiveness of smallholders to changes in relative market prices between crops which reveals a strong element of economic calculation on the part of smallholders everywhere.

Ellis (1992) however proposes what he called *conditional profit maximisation.* Smallholders maximise profit subject to: i) trade-offs with other goals; ii) resource constraints; and iii) the working of markets.

This view suggests that the goals of smallholder farmers could include catering for their traditionally appropriate food needs. It is critical to note that the theory is not devoid of critiques.

Farmers, particularly in the context of the developing world will want to try make maximum yields, which they can sell the surplus in order to cater for other needs of their households but that is subject to satisfying their consumption needs first - hence the theory neglects the consumption component of farmer households. Also, the theory neglects the role of risk and uncertainty in household production decisions. Households in the developing world are not risk neutral and multiple external factors influence their decisions. (Lipton, 1968) for instance, observed that Shultz's hypothesis was applicable to individual utility maximisation, under perfect competition. In the event of market failures, even if farmers allocate their resources efficiently from everyone's point of view, there may still be collective inefficiencies- as market completeness does not exist everywhere especially in the context of the developing world (Ellis, 1992). Also, it is worth adding that smallholders will obviously want to make more profit if the crops that enable them to get their socio-cultural food needs do well under the current climate.

Contrary to profit maximisation theories, utility maximisation theorists (UMT) are of the view that the process of decision making of smallholder farmers involves both production and consumption aspects. Hence, they critiqued the profit maximisation theories for ignoring the consumption side of farmer households which they see as constituting the major component of smallholder farmers' decision making (Chanyanov, 1986). Chanyanov (1986) posits that the goal of any smallholder household is simple production rather than profit maximisation.

UMT assert that smallholder economy cannot be studied by applying profitability-oriented capitalist economic principles. Many case studies have shown resource and production conditions in smallholder societies to be highly heterogeneous. Land for instance in African smallholder societies is traditionally owned and therefore not subject to sale and its allocation and use is guided by cultural, social and political relations (Ball and Pounder, 1996). Labour is not freely available for sale in some smallholder societies, and work is primarily carried out by family labour.

The availability of capital in smallholder societies is clearly limited and competitive capital markets are not developed (Friss-Hansen, 1995). Based on the above, utility maximisation theorists consider smallholder households as both families and enterprises and therefore consider the consumption side of smallholder decision making (Mendola, 2005).

Both the Profit maximisation and utility maximisation theorists assume that smallholder farmers are risk neutral and are devoid of uncertain conditions. However, risk aversion theories believe farm households produce under a very high level of uncertainty because of natural hazards (e.g. weather, pests, and disease amongst others), market fluctuations and social uncertainty (Ellis, 1992). Smallholders are reported to exhibit risk aversion in their decision making (Binswanger and Sillers, 1983, Moscardi and de Janvey, 1977) and to be risk- averse out of necessity because they must secure their household needs from their current production or face starvation. There is no room for aiming at higher income levels by taking risky decisions (Lipton, 1968).

2.5.2 Key debates explaining human behaviour

Several theories explain the behaviour of human beings. This section focuses on Social Cognitive Theory (SCT), the Theory of Reasoned Action (TRA), the Theory of Planned Behaviour (TPB), and the Social Identity Theory (SIT) as the most relevant to this study.

Social Cognitive Theory

Social Cognitive Theory (SCT) dwells on the premise that individuals observe the behaviour of others, transform that into cognitive representations and execute the behaviour if it is associated with benefits, rewards and incentives (Muro and Jeffrey, 2008). To Bandura (2001), Social Cognitive Theory (SCT) constitutes three dimensions; observational learning, vicarious reinforcement and self-efficacy. Observational learning deals with people shaping their behaviour based on what they observe within their neighbourhoods.

Vicarious reinforcement believes that repeated exposure to an observation will result in positive enhancement, which will translate into behavioural change. Self- efficacy posits that, behaviour is changed if one has confidence in performing a given behaviour. The theory has gained some application in a quest to promote behavioural change in natural resource management (Muro and Jeffrey, 2008), participatory water management (Pahl-Wostle et al., 2007) and participatory rural development projects (Rist et al., 2007). Although the theory provides some insights to understand the processes of behavioural change, some concerns are also worth noting. Confidence as posited by the theory is a necessary but not a sufficient condition for a given behaviour to be performed as it has to go with a corresponding 'capacity' for instance in the form of asset ownership.

Also, capacity changes temporally, that is, it is not all the time that someone will always have the capacity to do what they intend to do as some external forces can interrupt that. Observation and experience alone cannot shape behavioural change (Muro and Jeffrey, 2008).

In the domain of agricultural practices, for example, peasant farmers can observe that some farmers (say business oriented and economically sound) are resorting to high yielding varieties of crops (that require fertilizer, pesticides and weedicides) which in tend is depended on their purchasing power to procure such inputs - they definitely have seen that it is a good initiative but they cannot put that into action as they lack the ability to afford that.

It is true that humans are rooted in a social system and their lives are shaped by the activities that take place daily. However, not all behaviours can be attributed to learning from others. Some decisions can be made by humans independent of the influence of others. Self-efficacy will also influence behavioural change, but what is worth noting is that there are other external forces that have a large potential influence on the behaviour of humans.

Theory of Reasoned Action and Theory of Planned Behaviour

In the 1970s, the Theory of Reasoned Action (TRA) was developed (Fisbein and Ajzen, 1975). TRA posits that human behaviour is driven by behavioural intention, which is a function of two components - attitude and subjective norms. The former talks about a persons' positive or negative feeling about performing a given behaviour while the latter represents the pressure from society about the performance of the behaviour. TRA assumes that behaviour takes place under volition; that is an individual deciding to perform a given behaviour or not at will. This really does not hold in all circumstances. For instance, a farmer who depends entirely on rainfall to go about farming activities cannot always guarantee that they will plant crops as climate determines their fate. Also, it is worth noting that behavioural intentions can change if they do not follow the intentions directly as some unforeseen contingencies may contribute to a change in intentions (Singh et al., 2018).

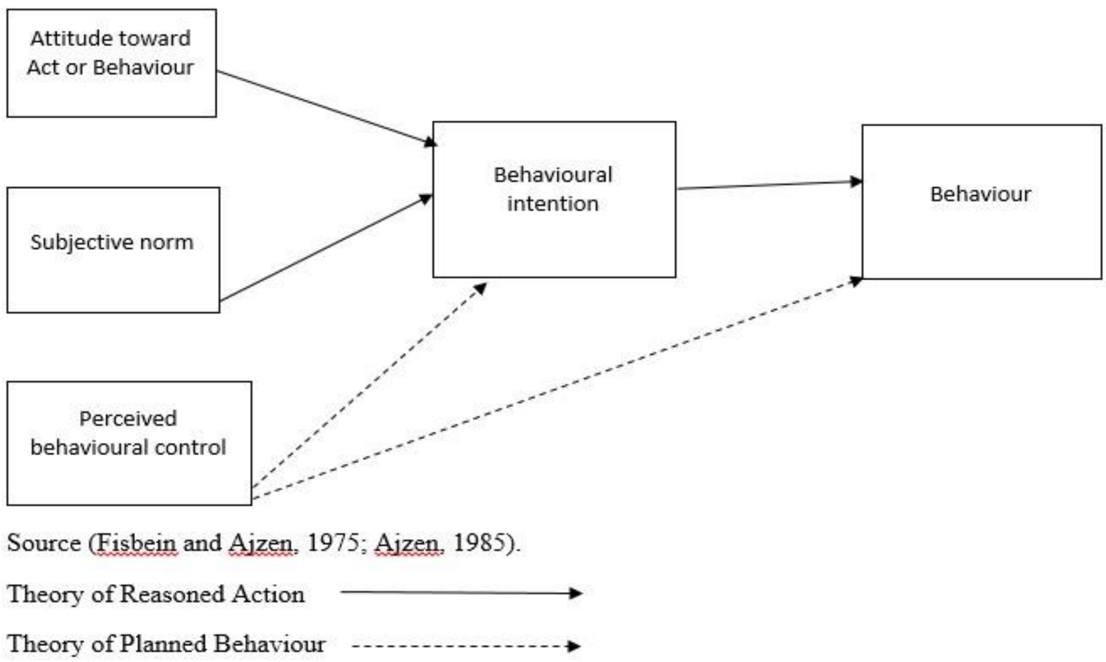
Having realised that certain forces outside an individual's volition could contribute to their intentions and behaviour, the TRA was expanded by adding a third component that would influence an individual's intention; perceived behavioural control by Ajzen in the 1980s. Perceived behavioural control refers to people's perceptions of their ability to perform a given behaviour.

The theory of Planned Behaviour (TPB) therefore predicts deliberate behaviour. Regarding perceived behavioural control, this does not apply to all situations and cannot be applied in all spatial contexts. Not all humans have control over certain behaviours they exhibit.

For instance, certain behaviours of humans are influenced largely by climate variables. The case of smallholder farmers in northern Ghana is one example. These farmers rely on rainfall to go about their farming activities and do not have control over when to plant once it does not rain. Also, they do not have the capacities in terms of irrigation schemes that would permit them make decisions at will by for instance farming throughout the whole year.

This suggests, for instance, that, in the domain of agriculture, the TPB will work better when there is some form of policy support for farming activities[6].

Figure 2. 2The Theory of Reasoned Action and the Theory of Planned Behaviour



Source (Fisbein and Ajzen, 1975; Ajzen, 1985).

TPB has been applied in several academic disciplines. Hence there is empirical support for the theory of planned Behaviour (TPB). For example, TPB has been applied to farmers' intention to adopt improved natural grassland (Borges et al., 2014), understand oil palm smallholder planter's intentions (Chin et al., 2016), cattle farmers' intention to use improved

[6] See Figure 2.2 for a diagrammatic representation of the TRA and TPB

natural grassland (Borges and Lansink, 2016), smallholder farmers' behavioural intentions towards sustainable agricultural practices (Zeweld et al., 2017) as well as smallholder farmers' intention to diversity their agricultural production (Senger et al., 2017).

Despite the wide application of TPB, researchers have identified several difficulties. For example, the conceptualisation of the social component of the theory; the subjective norm has been critiqued as a weak predictor of behavioural intention (Terry and Hogg, 1996, Terry et al., 1999, White et al., 1994).

Also, the perceived behavioural control component of TPB has been critiqued for lack of clarity about its conceptualisation (Chan and Fishbien, 1993). Some (Terry and Hogg, 1996, Terry et al., 1999, White et al., 1994) argue that one reason for the relatively weak relationship may be the way that the subjective norms have been conceptualised in the TPB. Subjective norms are conceived as the pressure we feel from important others to perform or not perform behaviour. In contrast, Terry et al. (1999) argued that it is the norms of behaviourally relevant reference groups that are most likely to influence intentions. Thus, rather than being influenced by aggregated impressions of important others, many behaviours will be influenced by the expectations and behaviour of group members who are relevant to that behaviour.

Nevertheless, these ideas can be helpful to this study. For example, where a farmer positively evaluates the cultivation of a given crop under climate variability and change, they will go ahead to select such a crop. Thus, the favourable evaluation of the benefits of some crops have either led to farmers to displace them or still cultivate them.

Due to the weaknesses of TPB, it has been applied together with other theories. Terry and Hogg (1996), Terry et al. (1999) and White et al. (1994) have provided evidence for the predictive utility of including behaviourally relevant group norms in TPB.

For example, in understanding safer sex behaviour, White et al. (1994) replaced the subjective norm component with Social Identity Theory (SIT) arguing that perceptions of both the attitude and behaviours of members of the referent group would contribute significantly to people's intentions to engage in safer sex. Similarly, Fielding et al. (2008) integrated the SIT and TPB to understand decisions to engage in sustainable agricultural practices. Therefore, the next sub-section reviews the SIT.

Social Identity Theory

The theory of social identity originates from two British social psychologists called Henri Tagfel and John Turner in 1979. Turner (1982) claimed that a person's sense of who they are is dependent on the group to which they belong. The main argument is that, a person does not just have a personal selfhood, but a multitude of selves and identities associated with their affiliated groups. The key message from the SIT is that when a person perceives themselves as part of a group, that is an 'in-group', and the other comparable groups that person does not identify with are called the 'out-groups'. To Turner (1982), SIT comprises three main processes that create the distinction between the in-group and the out-groups: *social categorisation*, *social identification*, and *social comparison*. The social categorisation element of SIT posits that categorisation is important to understand and identify people. The main rationale is that by people knowing the categories they belong to, they can understand themselves, and can define appropriate behaviour in accordance with the groups to which they and others belong. With the social identification element, the key message is that identification with an in-group goes along with the adoption of the group, and therefore people act according to the norms of the in-group. The last but not the least of the components of SIT; social comparison means that the in-group members compare themselves with other groups (i.e. out-groups). To maintain their self-esteem, Turner (1982) suggest that people and their group members compare their group favourably against other ones.

Social Identity Theory (SIT) has received application. For instance, in understanding the intentions to practice safe sex, White et al. (1994) showed that group norms were a significant predictor of intentions to practice safe sex behaviours. Similarly, group norms have been linked to intentions to engage in household recycling, regular exercise and sun-protective behaviour for those participants for whom group membership was the salient basis for self-definition (Terry and Hogg, 1996, Terry et al., 1999).

In the domain of agricultural practices, Fielding et al. (2008) incorporated a 'social identity approach' to replace the 'subjective norms' component of TPB. They argued that if behaviours, for example agricultural practices, are centrally linked to a social identity (e.g. rural landholder), it will be norms of that group that will influence behaviour rather than the expectations and desires of generalised others**.** It is however worth noting that 'social identity' is a relative concept that can take place anywhere; as in people can be part of groups outside their origin of birth hence the likelihood that such people may take up traits of the group which may be entirely different from that of their original cultural values and traditions.

This study recognises that, like White et al. (1994), and Fielding et al. (2008) it is useful to replace the subjective norm component of TPB with SIT to explain smallholder farmers' decisions to respond to or not to respond to climate variability and change via crop-selection. In the context of this research, identification with a given social category (in this context, the Dagaaba tribe[7] in Ghana) comes with many expectations, which to large extent influence farmers' intentions regarding their cropping decisions. Identifying oneself as of Dagao[8] comes naturally through birth, and secondarily via marriage or people from other areas coming to settle in the Dagaaba land, hence they become Dagaabas.

[7] Dagaaba tribe is the ethnic group the villages of Doggoh and Tie belong to (see chapter 3, section 3.3.3 for detailed information on the Dagaaba tribe

[8] A Dagao is someone that belongs to the Dagaaba ethnicity (GSS, 2014)

To White et al. (1994), as people identify themselves with social group, hence learn the stereotypic norms of the group, they assign these norms to themselves and therefore, their attitudes and behaviour agree more with the in-group norms. To White et al. (1994), such norms are provided by the perceptions of the referent group's general attitude toward performing the behaviour (considered as group attitude) and by the judgement that the significant others perform the behaviour themselves (considered as behavioural norm).

2.6 Conceptual Framework

Based on the review of theoretical underpinnings of smallholder farmer production decisions in this chapter, the study adapts Ellis' definition of smallholder farm households as households which derive their livelihoods mainly but not exclusively from agriculture, predominantly utilise family labour in farm production, are characterised by a partial engagement in input and output markets and are both producers and consumers of agricultural goods and services (Ellis, 1992).

Similarly, based on the review in sections 2.3.2 and 2.5.2, this study draws on the Theory of Planned Behaviour (TPB), the Social Identity Theory (SIT), and the Theory of drought perception (TDP) to conceptualise the different aspects of the thesis. In figure 2.3, the researcher posits that the food security of households (i.e. culturally preferred foods) in the Doggoh and Tie villages of north-west Ghana is largely a construct of what food households are able to produce under climate variability and change. The justification been that, the literature suggests farmers in the two villages rely on their own production for their food needs (GSS, 2014, WFP, 2013). Similarly, even though the study acknowledges that food security goes beyond relying only on one's own production to include the procurement of food from market sources, and food gifts from friends and relations, the researcher contends that this is a minor option as the people of the Doggoh and Tie villages are among the poorest in the country (GSS, 2014).

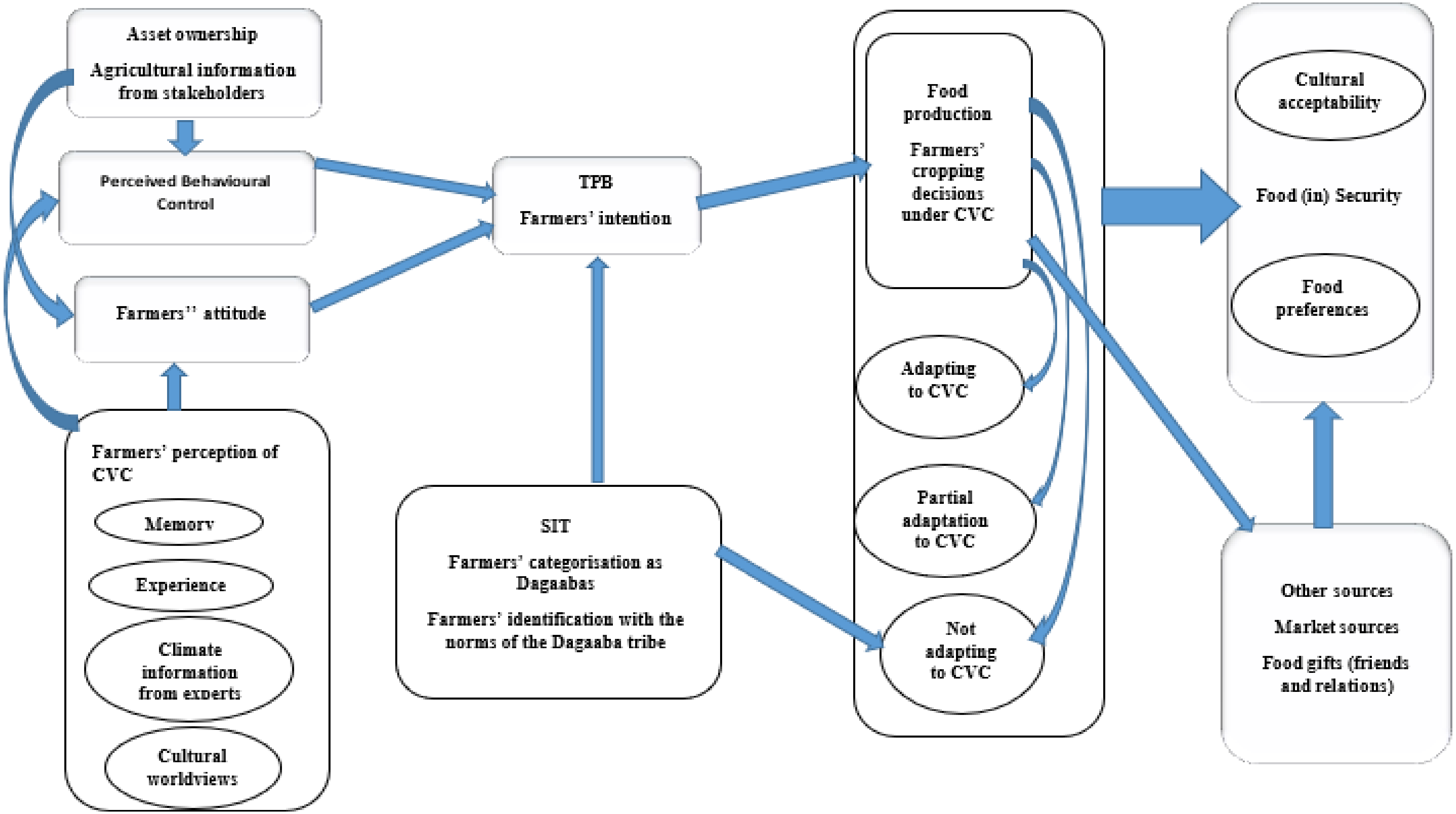
In figure 2.3, the researcher argues that farmers' food production (i.e. cropping decisions) starts with farmers' perceptions of climate variability and change (CVC). Farmers' perception of CVC is shaped by farmers' memory, past experiences, climate information farmers receive from experts, and the cultural world views of the research communities. In the framework, the researcher again argues that farmers' perceptions of CVC shape farmers' attitude and perceived behavioural control about cropping decisions under CVC.

Similarly, the climate information that farmers receive from experts and the assets of farmers construct farmers' ability or inability to select crops under climate variability and change (i.e. Farmers' perceived behavioural control- PBC) and farmers' attitude. Working together, farmers' attitudes, farmers perceived behavioural control and farmers' social identification with the in-group shape farmers cropping decisions under CVC.

The expectation is that farmers' attitudes and perceived behavioural control will influence them to respond to CVC by selecting crops and crops varieties that are appropriately suited to the prevailing changing climate. Similarly, farmers' identification with the Dagaaba tribe and the norms of the in-group shaping intentions and behaviour may not adapt to CVC because of the value of certain crops vital to the practices of the in-group that may not do well under the prevailing changing climate.

In this study, farmer cropping decisions under CVC are conceived along three pathways: (i) farmers focusing on yield maximisation by cultivating crops or crop varieties that are better suited to the prevailing climate or, farmers displacing crops or crop varieties that are not better suited to the prevailing climate as the literature suggests (Kurukulasuriya, 2008, Issahaku and Maharjan, 2014), (ii) farmers not adapting to climate variability and change by still cultivating crops or crop varieties that are not suited to the prevailing climate (Ziervogel and Ericksen, 2014, Chipanshi et al., 2003), and (iii) farmers cultivating both the varieties of crops that are suitable and not suitable to CVC. The researcher in this study (see in section 1.2.1), argues that, with respect to the former, adaptation to CVC via crop selection could translate into farmers trading off the access to and utilisation of culturally preferred foods if the crops that do well under the current climate are not the ones that enable farmers to have access to those culturally preferred foods. Similarly, the researcher contends that (see section 1.2.1), farmers may still go ahead to cultivate crops that do not give better yield and are not economically viable (for instance in terms of market value) because of cultural reasons.

Figure 2. 3 Conceptual Framework



Source: Author's construct adopting the Theory of Planned Behaviour, the Social Identity Theory and the Theory of Drought Perception.

CHAPTER THREE

RESEARCH METHODOLOGY

3 Research Methodology

3.1 Introduction

This study draws on the social constructivist epistemological position to understand smallholder farmer decision making under climate variability and change via crop selection, and the implication on their culturally preferred foods. This chapter discusses and justifies the different mixed method research techniques that were employed in the data elicitation and analysis stages. The chapter also justifies the selection of the study villages and sampling of respondents within northern Ghana.

3.2 Research Approach

In planning a study, Creswell (2014: 5) advises that researchers need to reflect carefully about the philosophical worldview and assumptions that they want to employ, the research design that is related to this worldview, and the specific methods or procedures of the research that translate the approach into practice. Worldview as used by Creswell is also referred to as *paradigms* (Mertens, 2010), *epistemologies* and *ontologies* (Crotty, 1998). In terms of worldview assumptions, Creswell (2014) identifies post positivism, constructivism, transformative and pragmatism as the ones widely discussed in the literature.

Adopting a positivist approach focuses on scientific method (that is the deductive pathway) where a researcher begins with a theory, collects data that either supports or refutes the theory, and then makes necessary revisions and conducts additional tests (Creswell, 2014: 7).
Quantitative research adopts this philosophical stance.

Constructivism holds a different worldview. Social constructivists for instance, believe that individuals seek understanding of the world in which they live and work. Meanings can be varied and multiple hence the need for the researcher to understand complexity of views rather than narrowing meanings into few categories or ideas (Creswell, 2014). Rather than starting with a theory (as in post positivism), researchers using this philosophical stance inductively develop a theory or pattern of meaning i.e. from observation to theory generation (Creswell, 2014). Creswell (2014:7) argue that the postpositivists hold a deterministic philosophy in which they believe effects or outcomes are determined by causes. To Creswell, the knowledge that develops from the postpositivists lens is based on careful observation and the measurement of the reality that exist out there. It is documented that the transformative worldview believes that research contains an action agenda that may change lives of participants, the institution in which individuals work or live, and the researcher's life (Creswell, 2014: 9). Similarly, it has been documented that research that is based on a transformative worldview deals with topics related to inequality, oppression, domination, suppression and alienation. In addition, it has been documented that the researcher works collaboratively with the participants in the questions design, data collection, information analysis, and reaping of the rewards of the research so that the latter are not further marginalised (Creswell, 2014: 10).

Epistemologically, this research uses a social constructivist approach and thus was directed by past research on food security, which has overlooked the cultural aspects of the utilisation dimension of food and from nutrition and biological perspectives (Gross et al., 2000: 5). The study is anchored in a inductive pathway of learning as farmer decisions to adapt or not to adapt are socially constructed and need an in-depth exploration through a bottom-up approach. This, however, does not necessarily translate into theoretical disregard.

The Theory of Drought Perception (TDP), the Theory of Planned Behaviour (TPB), and the Social Identity Theory (SIT) were used to guide the study conceptually[9]. Observations and

[9] See sections 2.2.2 and 2.5.2 for detailed review of the Theory of Drought Perception (TDP), the Theory of Planned Behaviour (TPB) and the Social Identity Theory (SIT)

findings from the field were used to generate a conceptual framework for the research inductively.

Based on the research question and objectives, mixed methods were employed with the dominance of qualitative data collection tools. The value of mixed methods approach has been documented. Denscombe (2017: 163) identifies several benefits of mixed methods. For example, Denscombe (2017: 163) is of the opinion that researchers can improve the confidence in the accuracy of findings through the use of mixed methods to investigate the same subject. Similarly, mixed methods are known to enhance triangulation, that is, they provide researchers the opportunity to complement the strengths and weaknesses one another to provide detailed findings (Denscombe, 2017: 163). Notwithstanding the strengths of using mixed methods, it is time consuming, and one needs to develop the necessary skills to make good use of them (Denscombe, 2017: 176).

3.3 Research Design

This section outlines the research strategy, the unit of analysis, the sampling procedure, data elicitation tools and methods of analysis.

3.3.1 Research Strategy

The research uses a case study research strategy. Yin (2014) identified two advantages of the case study approach over other strategies. First, it is appropriate for "how" or "why" research questions.

Second, when a researcher has little or no control over behavioural events, and thirdly when the focus of the study is contemporary as opposed to entirely historical phenomenon (Yin, 2014: 5). The study views a case study as a more appropriate strategy based on the following reasons. First, the study sought to understand social phenomenon of smallholder farmers' climate change adaptation decisions based on crop selection and the impact for food security as identified in Yin (2014). Second, it offers an opportunity to explore a complex issue, carefully, and in depth.

A case study strategy allows the study to retain the holistic and meaningful characteristics of real events such as smallholder farmer decision making.

3.3.2 Case study: why North-west Ghana?

North-west Ghana was chosen as an appropriate setting to tease out the nexus between climate variability and change, and food security because of the following:

(a) Semi-arid and uni-modal rainfall regime

The north-west area is semi-arid and characterised by a uni-modal rainfall regime. It experiences the impacts of climate variability and change (MoFA, 2011). On average, the northern Savanna ecological zones experience an annual rainfall of 1,100 mm compared to 1,300mm, 1,500mm and 2,200mm in the transitional, deciduous forest and rainforest belts respectively (MoFA, 2011). As agriculture is almost entirely rain-fed in the north-west, rainfall is a key driver of agricultural production. Intra-seasonal rainfall characteristics, such as the onset and cessation of rains, have been reported to be changing, shortening the length of the growing season (van der Geest, 2004). It is therefore an ideal location to explore the nexus between climate variability and change, and adaptation to sustain food security, as many households rely on their own production to achieve their food needs (WFP, 2013).

(b) Limited income generating activities and natural resource-based livelihoods

The north-west is characterised by limited income generating activities with most people having family farms and dependent on natural resource-based livelihoods (GSS, 2014). In northern Ghana, 88% of households rely on crop production whereas in the south, most people rely on the service and industrial sectors (WFP, 2013) hence the north is particularly vulnerable to the impacts of climate variability and change, including extremes such as drought and flooding and food insecurity.

(c) North-west Ghana is one of the poorest areas nationally

The northern belt of Ghana is among the poorest in Ghana. The 2009 Comprehensive Food Security and Vulnerability Assessment (CFSVA) identified significant disparity in development indicators between the three northern regions and the rest of the Ghana (WFP, 2013). The three northern regions in Ghana have continued to record higher incidences of poverty, food insecurity and malnutrition (WFP, 2013). For example, communities in the northern belt of Ghana constitute around 63% of the overall number of people living below the poverty line of $ 1.25 a day (WFP, 2013). Poverty for instance hinders the adoption of the latest agricultural technology and technical support by farmers in this part of Ghana. Poverty also limits household ability to access food at market and limits their own production success. Limited infrastructure exacerbates isolation from market and poverty in rural areas. The legacy of policy during the colonial period isolated the north with investment in the south due to cash crops (Sutton, 1989). Post-colonial policies, such as the Structural Adjustment Programmes (SAPs) during the 1980s, did little to improve the situation for the north, with the focus remaining on cash crop quotas from the south (Songsore, 1992, Songsore and Denkabe, 1995). Capacity building and employment was slower to be supported by government in the north (Benning, 1990).

3.3.3 Selection of research location

Within North-west Ghana, the Jirapa Municipality[10] was selected, which is one of eleven districts that constitute the Upper West region see (figure 3.1). In understanding farmer decision making under climate variability and change, the researcher selected the Jirapa Municipality because of the following conditions in the area:

- The municipality is semi-arid hence prone to drought.

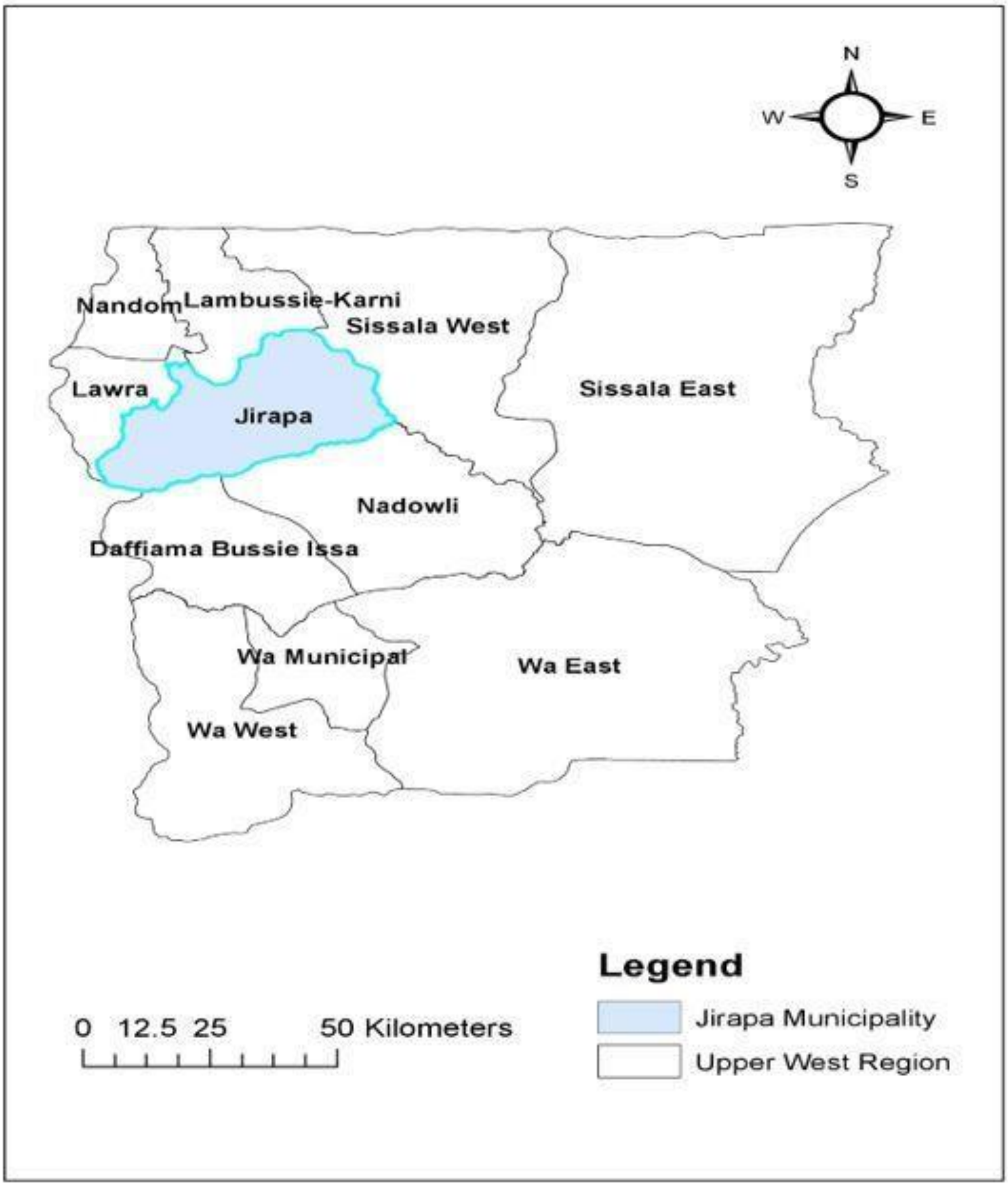
[10] Note: during the fieldwork in 2016, Jirapa was a district – It attained the status of Municipality in 2018

- The municipality is characterised by a uni-modal rainfall regime which permits farming to take place only once in a year.

- The people make their staples mainly from cereals (GSS, 2014) which have been projected to be the most at risk to climate variability and change impacts (IPCC, 2014).
- High poverty levels make it difficult for households to depend mainly on market sources for their food needs.
- The researcher hails from the municipality - that helped concerning accessing the research villages. Also, having a fair understanding of norms and cultural values permits the teasing of useful information from respondents[11].

[11] However, the researcher took the position of an 'outsider'- this was truly helpful as it helped him in teasing out relevant information

Figure 3. 1 Map of the Upper West region showing the Jirapa Municipality



Source: Author's Construct (Geographic Information Systems, 2018)

The geographical setting, population dynamics and livelihood activities

The Jirapa municipality lies approximately between latitudes 10.25^0 and 11.00^0 north and longitudes 20.25^0 and 20.40^0 west with a territorial size of 1, 188.6 sq. Km representing 6.4 % of the regional landmass (GSS, 2014). It shares borders to the South, North, West and East with the Nadowli-Kaleo, the Lambussie-Karni, the Lawra and the Sissala West districts respectively (GSS, 2014).

The 2010 Ghana Population and Housing Census (PHC) reports that the municipality has a population of 88,402 representing 12.6% of the population of the Upper West region. Statistics from PHC indicate that the proportion of males to females is 47% to 53% respectively with the population being youthful as 42.8% of the population is under 15 years (GSS, 2014). The municipality is made up of one main indigenous ethnic group namely the Dagaaba, which constitutes the Jirapa Paramountcy, the Ullo Paramountcy with eight (8) divisional areas. The literature reports that the Dagaaba people of north-western Ghana inhabit five administrative jurisdictions: Nadowli, Jirapa, Lawra, Nandom and Lambussie- Karni local government areas (Doggu, 2015). Even though there exists dialect differences among the above areas, with dagara being spoken by the people of the Nandom area, dagaare being spoken in the Jirapa, Nadowli, and Lambussie-karni areas and losaale being spoken in the Lawra administrative area (Woma, 2012), the Dagaaba people share similar norms that identify them as an ethnic group. For example, it has been documented that Dagaabas within each of these administrative areas consider *tuo-zaafi* (locally known as saabo- made largely from maize, sorghum or millet) as their main staple food. Similarly, the drinking of *pito (*an alcoholic beverage made from sorghum), the wearing of smocks, the playing of xylophones, and the dancing of bine or bawaa are core elements of their cultural norms (Doggu, 2015). To Doggu (2015), the drinking of pito is a leisure time activity and entertainment among the Dagaabas particularly the youth who during the evenings, weekends, and public holidays roam from pito bar to another.

Based on agro-ecological division, the Jirapa municipality is in the semi-arid Guinea Savanna zone. This zone, unlike others, (e.g. the coastal savanna, the deciduous forest, the transition zone, and the rainforest belts) is characterised by a single rainfall pattern which translates into farming taking place only once in a given year (MoFA, 2011). Rainfall within the district lasts for about 5-6 months beginning from May to October, with a long-term mean precipitation of 900mm Naab and Koranteng (2012). During April/May to October, the municipality experiences a single rainfall season induced by the moist monsoon winds with an intensity of 100mm-1100mm per annum (GSS, 2014). Mean annual temperature ranges between 28^0C to 31^0C.

During the dry season (usually November to April) which however is variable, the area comes under the influence of the dry North-eastern trade winds affectionately called harmattan (Naab and Koranteng, 2012). The municipality is characterised by intermittent tributaries of the Black Volta River- including Kaaba, Bapkong, Dazugri and Telenbe (GSS, 2014). These tributaries, however, do dry up during the long dry season, leaving the district with surface water catchment for domestic and agricultural purposes. The valleys of these tributaries have the potential for irrigation dams and dug outs-however, there are only a few small-scale dams and dugouts scattered around places such as Konzokalaa, Tizza, Chariea and Ullo (GSS, 2014). These dams, however, face many challenges including drying up quickly hence dry season agricultural activities do not go on for long (GSS, 2014).

The municipality is predominantly characterised by agrarian activities with services, agro-processing and other small-scale manufacturing activities on the low side. The 2010 PHC indicates that 67.1% of the population is engaged in agriculture, which is mostly subsistence in nature except for some few farmers who are engaged in large-scale production of cereals and legumes in Han and Mwankuri areas (GSS, 2014).

The report further indicates that most households who are into farming are engaged in crop farming –that is 96.2% of the households in the district are engaged in crop farming (GSS, 2014).

Compound and bush farming systems are practised with the integration of livestock rearing mainly poultry and small ruminants like sheep, goats, pigs and cattle (Naab and Koranteng, 2012). Van de Geest (2004) explains that compound farms are the fields that surround the houses and are cultivated permanently, and the bush farms are the ones that are at varying distances from the houses and are periodically left to fallow. To him, the compound farms are important than the bush farms. Naab and Koranteng (2012) identify intercropping; relay cropping and sole cropping as the main types of cropping patterns in the district. The principal crops grown in the district are cereals (maize, sorghum, millet and to lesser extent rice), legumes (i.e. groundnuts, cowpea, bambara groundnuts and soybeans) (Naab and Koranteng, 2012).

The literature identifies gender differentiation in terms of ownership and access to agricultural land, the cultivation of crops (with a distinction between "men's" and "women's" crops) and labour sources for agricultural activities. It has been documented that family lands and kin lands are prominent in the Upper West Region of Ghana constituting about 90% of available lands for agricultural activities (Abdulai, et al. 2007). Similarly, Anaglo et al. 2014 report that men own more land than females due to the patriarchal lineage system that characterise the Upper West region of Ghana. To Anaglo et al. 2014, the male inheritance system does not permit females to inherit land as these lands may be transferred to other family members after the death of a husband or when the female member leaves her father's home to marry elsewhere. Other reasons cited to explain why women do not own lands in the Upper West region of Ghana include women being considered as "visitors" in the community and not from the community (AFC, 2012), and women acknowledging their strength is in their husbands hence no need to own land as they can always get that from their husbands as and when they need it (Anaglo et al. 2014).

The question therefore is that, do women (both married, and those unmarried and still living in their fathers' houses) have access to land to farm their own crops? The literature suggests that women get farm fields land by making request from their fathers (in the context of the unmarried) and the husbands (in the case of the married) to grow crops such as bambara groundnuts, groundnuts and beans. For example, it has been reported that men decide on what proportion of the land they want to cultivate as "household land" and what proportion they can give to the wife and children upon request (AFC, 2012). The above tenure rules imply widows are vulnerable to loosing land. On the dimension of "men's" and "women's" crops, the literature suggests that men control most of the decisions regarding the planting, size, acreage and quality of staple crops (e.g. maize, millet, sorghum and yam) as men are regarded as the providers of the main staples (AFC, 2012). Similarly, women are traditionally seen as providing the complimentary – soup ingredients which supports the family's meals by cultivating beans, vegetables, b. groundnuts, spices, dawadawa (AFC, 2012).

Even though the focus of this study is largely focused on understanding the cultural aspects of the uses of food, it is important to have a sense of the nutritional value of the crops that are cultivated in the villages of Doggoh and Tie of rural North-west Ghana. The literature suggests that cereals are the crops that are largely cultivated in the villages of Doggoh and Tie just like other areas in the Jirapa Municipality (GSS, 2014). The nutritional value of cereals in both the developed and developing world is well documented (Mckevith, 2004). For example, Mckevith (2004) explains the nutritional value of cereals in the regard of important sources of energy, carbohydrate, protein and fibre. Similarly, Mckevith (2004) considers the nutritional value of cereals also in terms of their content of micronutrients such as vitamin E, B vitamins, magnesium and zinc. Table 3.1 illustrates the nutritional values of the main staple crops of the Jirapa Municipality.

Table 3. 1 An illustration of the nutritional values of the main staple crops of the people of Jirapa Municipality.

Nutritional value	Literature source (s)
Minerals	• Cereals are a good source of potassium, in common with most plant foods. Whole grain cereals also contain considerable amounts of iron, magnesium and zinc, as well as lower levels of many trace elements (Kulamarva et al., 2009).
Carbohydrates	• Carbohydrates – cereals are classified as carbohydrate rich foods- as they are composed of 75% carbohydrates (Mckevith, 2004) • The literature documents that starch is the principal storage form of carbohydrate in sorghum and on the average sorghum contains 69.5% starch content (Kulamarva et al., 2009). • Several uses of sorghum around the globe has been documented including baked bread, porridge, tortillas, couscous, gruel, steam-cooked products, alcoholic, and non-alcoholic beverages, and so on (Kulamarva et al., 2009).
Vitamins	• Cereals are an important source of most B vitamins, especially thia-min, riboflavin and niacin (Kulp and Ponte 2000, Mckevith, 2004). Cereals also contain appreciable amounts of vitamin E.
Protein	• Cereals contain about 6–15% protein (Gold-berg 2003, Mckevith, 2004). The major storage proteins in wheat are gliadins and glutenins, while in rice it is glutelin (oryzenin), in maize it is prolamin (zein).

On the aspect of agricultural labour, Anaglo et al. 2014 reports that labour for farming in the Upper West Region comes from family labour sources and hired labour. On the aspect of gender, the literature (see e.g Anaglo et al. 2014) suggests that men have more access to labour than women. Growing up in rural north-west Ghana, I have witnessed how female farmers relied on hired labour and voluntary labour (largely from their sons and brothers) to till their farm fields but they (women) engage largely in the weeding of b. groundnuts farm fields. Similarly, it has been reported that men have control on women's labour and women are expected to work on their husband's farm first before working on their own (women's) farms.

The sale of surplus crops from the family land is the decision of the men who occasionally consult their wives (AFC, 2012).

3.3.4 Choice of research villages

The main factors considered in the selection of the Doggoh and Tie villages for the fieldwork include: First, proximity to a rainfall station (about 20km away from MET station) which enabled comparison of farmer perceptions regarding climate variability and change and analyses of meteorological data. Second, the extent to which communities benefited from NGO intervention projects. The aim was to allow an understanding of different influences, with one village receiving little support while the other hosted NGO intervention programmes on agriculture, food security and climate change adaptation. The assumption was that community interaction with the NGOs may have influenced people's perceptions of risk and cropping decisions, and even decisions around acceptable culture and food trade-offs. For example, communities that benefit from NGO programmes could be more likely to adopt new agricultural technologies as compared to those with little information about innovations or seed varieties.

With the above criteria in mind, the researcher's reading was guided by identifying villages within the Jirapa Municipality that have received many intervention programmes particularly in the realm of agriculture and food security. This was achieved through reports on NGO interventions within the Municipality. In that regard, the researcher found out that Doggoh has received many NGO interventions from CCAFS, OXFAM GB, RAAP, then it is less than 20KM away from the Babile Meteorological Agency. Similarly, even though other villages within the municipality could have been selected as the village without much NGO interventions, Tie was selected as it is closer to the Babile Station than other villages.

Unit of Analysis

Smallholder farm households were the primary unit of analysis. The rationale is that decisions about production, investment and consumption are primarily taken at the household level in the northern part of Ghana (van der Geest, 2004). Within the study households, the researcher particularly sought to understand intra-household differentials such as who grows what in term of gender. The term household has been defined differently in Ghana. For example, the Ghana Statistical Service (GSS) defined a household as a person or a group of persons who lived together in the same house or compound and shared the same house-keeping arrangements (GSS, 2012). Similarly, Yaro (2006:129) defined a household as consisting of a group of people who own the same productive resources, live together and feed from the same spot".

It is noteworthy that, determining who belongs to a given household is problematic particularly in the context of northern Ghana. A given compound can have two brothers who are married and may exhibit the following characteristics: one, they may farm together but have a separate granary, two; they may have different farms but the same granary and may farm together and share the same granary. In the realm of this study, a household is one that consists of people who farm together and share the same granary. This tells us that, in a given compound, there may be more than one household even though they may share the same ancestral route. The researcher chose this definition because later in this thesis (chapters 5 and 6) the study will seek to understand household farming decisions and food choice under climate variability and change hence those that would be interviewed can be representative of the views of other household members as they farm and eat together. Farm households alone cannot give the researcher the necessary information needed to answer the research questions-hence the study also elicited information from key informants.

They were selected by expertise, profession and knowledge regarding the research topic, covering a wide range of relevant sectors. Government (focusing on the Ministry of Food and Agriculture), Non-governmental organisation (NGOs) working in agriculture, food security and adaptation related projects in the study district as well as people within the research villages who are 'experts' and grounded concerning community affairs. This ensured triangulation of the results with other research tools.

3.3.5 Selection of respondents

Studying an entire population can be possible if the population is not large and once the necessary resources are available. Due to the mixed methods approach used in this study, the sampling was multi-stage involving probability and non-probability sampling techniques.[12] Sarantakos (2013: 169) considers probability sampling technique as one in which the respondents are chosen by the probability principle, in which every unit of the target population has an equal, calculable and non-zero probability of being included in the sample. Unlike the probability sampling, Sarantakos (2013: 177) notes that non-probability sampling does not employ the rules of probability, hence does not ensure representativeness.

Specifically, purposive sampling, snowballing and stratified random sampling techniques were used for the selection of the research respondents. The details are discussed below.

Purposive and snowballing sampling techniques

In the selection of stakeholder research respondents, purposive sampling technique was used. Specifically, the stakeholders included the Ministry of Food and Agriculture (MoFA) office at the Municipality level, and non-governmental organisations (NGOs). The NGOs included Climate Change, Agriculture, and Food Security (CCAFS), Literacy Bridge Ghana (LBG), and

[12] See Figure 3.2 which gives a diagrammatic representation of the sampling procedure

the Association of Church-based Development NGOs (ACDEP) working in association with Canadian Feed the Children (CFC).

It was necessary to use purposive sampling technique as these are the organisations that work with farmers in the provision of agricultural information hence relevant to this research (Sarantakos, 2013: 177). Similarly, for the selection of the village individual key informants, the sampling technique was purposive. The reason being that the village key informants are people who are 'experts' in certain aspects of the lives of the villages.

Stratified random sampling technique

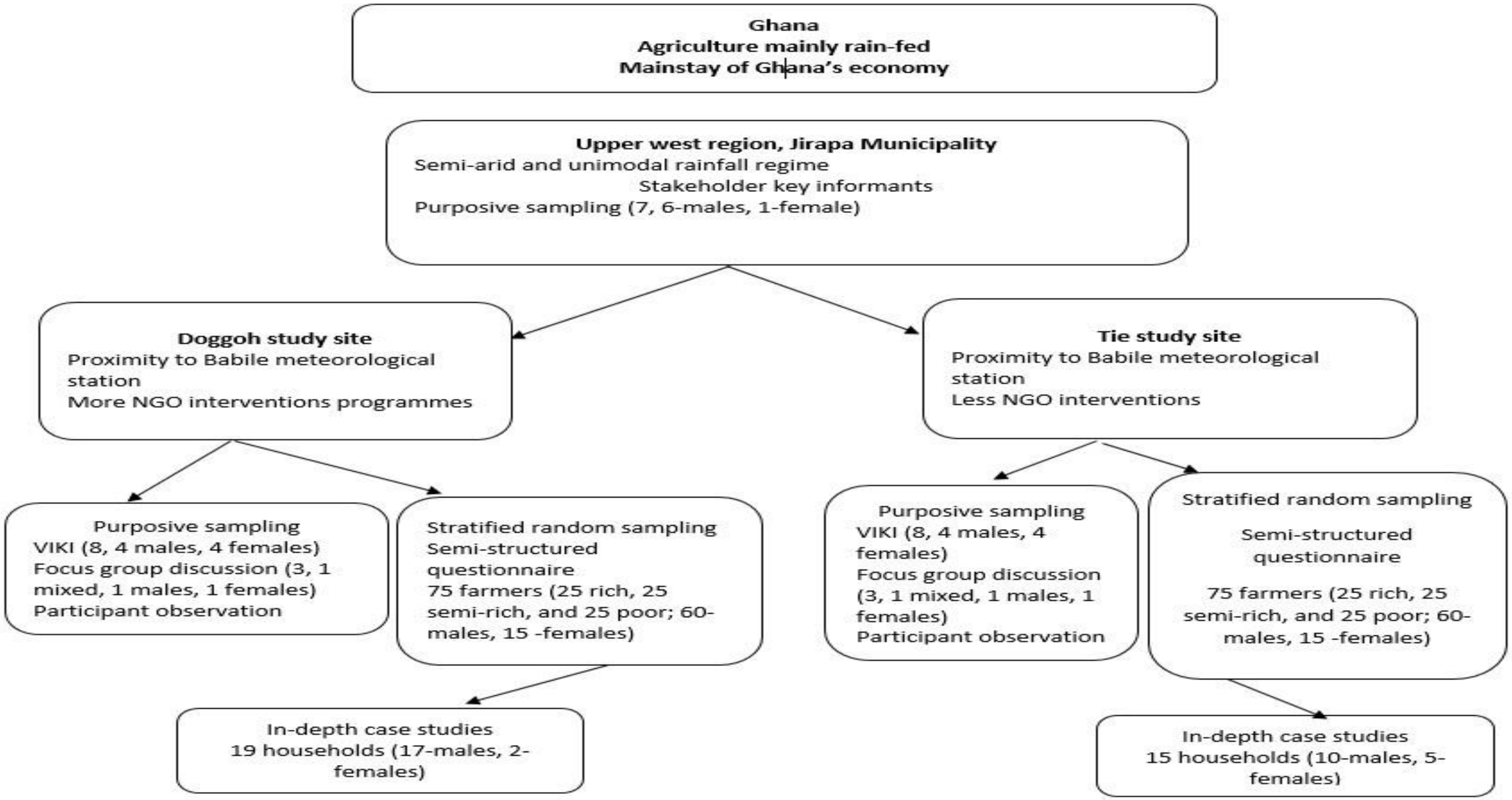
The selection of the 150 respondents (75 for Doggoh village, and 75 for Tie village) for the semi-structured questionnaire (SSQ) was via stratified random sampling technique. The target was to cover at least 60% of the households in each of the research villages. Through the village social mapping (see section 3.5.1 for the details of the social mapping) and the research team later moving around to ascertain the number of households in each village, 125 households were identified within the 107 houses in Doggoh and 122 households within the 95 houses in the village of Tie (see appendixes G and H that show the number of houses in each village). With limited resources, 75 households were covered in both villages covering 60% and 61% of the total households respectively for Doggoh and Tie villages. The social mapping and the wealth ranking that were done in the two villages enabled the stratification of the households into three wealth strata: rich, semi-rich, and poor[13]. After stratifying each of the communities into the three wealth strata, simple random sampling was employed in selecting the male headed households that participated in the study. This gave every male headed household within each of the wealth strata in the two research villages an equal chance of been selected (Bryman, 2016: 176)- however, simple random sampling technique was not applied in the selection of female

[13] See section 3.5.1 for the details of the social mapping and the wealth ranking exercises

headed households (see section 3.5.1 for details of how the female headed households were selected in the field to participate in the study).

Similarly, if the study had ended up by selecting only poor households, their responses may have indicated they are not changing their crops because of their lack of financial strength. Therefore, this decision enabled the researcher to reduce the bias.

Figure 3. 2 Schematic representation of the sampling procedure



3.3.6 Research tools

By adapting a mixed method approach, the study used both quantitative and qualitative research tools with emphasis on qualitative. The quantitative research tool was the semi-structured questionnaire. The qualitative research tools involved key informant interviews, focus groups, and in-depth interviews. The following sub-sections discussed in detail each of the research tools[14]. Table 3.2 has a summary of the relationship between the research objectives, questions and the research tools.

Semi-structured questionnaire (SSQ)

Vaus (2014) used 'questionnaire' as a general term and distinguished between face-to-face, telephone and mail as different methods of administration. The literature documents that the semi-structured questionnaire contain both open-ended and close-ended questions (Gilbert, 2008: 192). There is documentation on the functional strengths and weaknesses of open-ended and closed-coded questions. For example, Gilbert (2008: 192) opines that closed coded questions make the analysis process easier as responses can be easily inputted into a computer system thereby saving some time and money.

Notwithstanding the easy inputting and processing of closed-ended questions, Gilbert (2008: 192) notes that closed-ended questions restrict respondents by forcing them to choose between the answers provided. Recognising this weakness of the closed-ended questions in limiting respondents to the alternatives provided in the alternative lists, the researcher modified them. Explicitly, in the design of the questions for the semi-structured questionnaire the researcher incorporated "if other, please specify".

[14] Section 3.5 details how each of the research tools discussed here were applied in the field

In cognisance of the functional strengths and weaknesses of open-ended and the closed-ended questions, the researcher combined the two for the flaws of one to be catered by the strengths of the other (Denzin, 1970: 308).

Key informant interviews

Marshall (1996) considers a key informant as an expert source of information. He further suggests that key informant interview is an ethnographic technique which has its origin from cultural anthropology and is now being used widely in other social science disciplines (Marshall, 1996). The literature also suggests that not everyone in a given village, community or society can be a key informant (Marshall, 1996). For example, Marshall (1996) argues that most members of a community do not know the full repertory of forms, meanings, and functions of their culture. Because of the personal skills or positions of key informants within a society, they can provide a deep insight into what goes around them (Marshall, 1996). In characterising "ideal" key informants, Burgess (1989) highlights the following: (i) role in community, (ii) knowledge, (iii) willingness (iv) communicability, and (iv) impartiality.

Focus group discussions

While recognising that focus groups are somehow similar to group interviews, Gray (2014: 468) is of the view that in a group interview, many people are interviewed at the same time whereas the purpose a focus group is to generate interactions and discussions within the group. The purpose of focus groups as distinguished from individual interviews is that they allow for group interaction and provide greater insight into why certain opinions are held (Kruger, 1998). To Howitt (2016: 89), the critical characteristic of a focus group discussion is that it gives members of the discussion an opportunity for interaction among themselves when responding to the questions posed by the moderator.

It has been documented that a standard focus group comprised of six to eight people who meet once and considered to last for a half to two hours (Ricthie et al., 2014).

Several factors have been suggested to enhance the success of focus group discussions. For example, Ricthie et al. (2014: 225) recommend that researchers have to restrain the contributions of individuals that dominate the discussions. Also, it is documented that researchers should create space for everyone to contribute in focus group discussions (Ricthie et al., 2014: 224).

Focus group as a research tool for eliciting data is not devoid of criticism. Some scholars have contested the idea of a moderator of a focus group having so much control during discussions as suggested by Howitt (2016: 89). For Gray (2014: 471), the moderator has less control or influence over processes and outcomes. He further advanced that getting participants for a focus group can be a challenge. The use of convenience sampling limits the generalisation of the findings hence focus groups have been critiqued (Gray, 2014: 471).

Participant observation

Kumar (2011: 141) considers a participant observation as entailing the researcher participating in the activities of the group being observed in the manner as its members, with or without them knowing they are being observed. As a research tool, some setbacks of participant observation have been identified. For example, Kumar (2011) documents observer bias in the realm of variation in the interpretation made of the same activity made by different observers.

Similarly, it has been documented that observation and recording may not happen at the time hence the variation in interpretation (Kumar, 2011).

In-depth interviews

To Hawtin and Percy-Smith (2007: 86), an in-depth interview involves one person, the interviewee, talking to another person, the respondent. It is documented that in-depth interviews provide for the establishment of a good rapport between the researcher and the participant (Ricthie et al., 2014: 184). Therefore, it creates an atmosphere where the interviewee can respond free ranging and full way (Ricthie et al., 2014: 184). In-depth interviews have been considered as opportunities for the respondent to talk in-depth about a topic, taking into consideration non-verbal communications (Hawtin and Percy-Smith, 2007: 86).

In-depth interviews take a variety of forms, Russell categorised as informal interview, semistructured, structured and unstructured (Russel, 2011). Structured in-depth interviews are based on a standard prepared questionnaire, which the interviewer works with the respondent (Hawtin and Percy-Smith, 2007: 86).

Even though Hawtin and Percy-Smith (2007: 86) recognises that structured in-depth interviews allow for comparison of answers from different people because they are asked the same questions, they note that they produce less useful information because respondents are not probed for further information based on their responses to previous questions.

Table 3. 2 Summary of the relationship between the research objectives, questions and research tools

Research objective	Research questions	Research tool (s)
Objective 1: To understand farmer perceptions of climate variability and change, and how perception is socially differentiated	What are farmers' general perception of climate variability and change?	Semi-structured Questionnaire, Focus Group Discussion, Key Informant Interviews, Participant Observation, Household In-depth Interviews
	Are there any perception differentials among farmer groups	Semi-structured Questionnaire
	What shape farmers' perceptions of CVC?	Key Informant Interviews, Household In-depth Interviews
	What matches and mismatches exist between farmer perceptions, and analyses from meteorological data?	Semi-structured Questionnaire
Objective 2: To understand farmers' adaptation behaviour under climate variability and change via crop selection	What crops are selected, where, and when in the agricultural cycle?	Semi-structured Questionnaire, Participant Observation, Household In-depth Interviews
	How have the cropping systems changed now, as compared to that of the past?	Semi-structured Questionnaire, Focus Group Discussion, Key Informant Interviews, Participant Observation, Household In-depth Interviews
	Who are adapting, and who are not adapting?	Semi-structured Questionnaire
	Why do farmers adjust, or not adjust their crops under climate variability and change?	Focus Group Discussion, Key Informant Interviews, Household In-depth Interviews
Objective 3: To understand the social aspects of the uses of food, and the impacts of adaptation to CVC on culturally preferred foods	What is the value of *tuo-zaafi*' beyond biological and nutritional uses?	Semi-structured Questionnaire, Focus Group Discussion, Key Informant Interviews, Participant Observation , Household In-depth Interviews
	Who eats first, why, and with whom?	Focus Group Discussion, Household In-depth Interviews
	How has the pattern of consumption of *tuo-zaafi* changed now, as compared to that of the past?	Semi-structured Questionnaire, Focus Group Discussion, Household In-depth Interviews
	Are the forms of *tuo-zaafi* available now what households prefer to eat? Why, or why not?	Semi-structured Questionnaire, Focus Group Discussion, Key Informant Interviews
	How the preference for tuo-zaafi is socially differentiated?	Semi-structured Questionnaire, Focus Group Discussion Household In-depth Interviews

3.3.7 Pre-testing of research tools

Before actual fieldwork, the data collection instruments (as explained in section 3.3.6) were pre-tested with colleague PhD students. The purpose was to get feedback regarding how the questions have been structured and ordered. Such comments were incorporated to shape the data collection instruments.

3.3.8 Training of research assistants

Some research techniques are quite difficult for one researcher to single handedly coordinate. Focus group discussions for instance, need a moderator and some research assistants for the purposes of recording and taking of notes. Also depending on the number of respondents that the researcher has to elicit data from particularly in the case of surveys, there was the need to employ some research assistants to help in administering of questionnaires to the limited schedule of the study. To ensure quality of data collected, research assistants were trained using the questionnaire as well as briefed on the ethical implications of the study concerning anonymity and confidentiality. In all, 10 research assistants were recruited for the data collection exercise.

The researcher considered both males and females with attention to involving research assistants from the research villages with an advanced diploma or higher degree and considerable experience in research. A key criterion in the selection of the research assistants is those who understood the local dialects of the research villages and could speak it fluently. Training was offered to research assistants before data collection and after they returned from the field.[15] The rationale was to clarify complex terms and agree on how 'technical' terms were going to be interpreted in the local dialect.

[15] In picture 3.1, research assistants were trained how to do direct matrix ranking in the village of Tie

Upon return from the field, the research team had to meet, share experiences and identify questions that needed special attention concerning either interpretation, probing or prompting.

The researcher never employed a translator, as he is a native of the research district. However, he exercised maximum care in probing severally to understand some words that were ambiguously used by respondents or difficult to understand to document the exact information given by research subjects.

Picture 3. 1 Research Assistants undergoing training on how to do direct matrix ranking using marbles

Source: Fieldwork (Direct matrix ranking exercise in a case study, Tie Village, 2016)

3.3.9 Reconnaissance, scoping and piloting

Reconnaissance

Having selected the Jirapa Municipality and specific villages for the research, upon arrival in Ghana, the researcher had to pay preliminary visits to the Municipal capital, and the villages of Doggoh, and Tie. Reconnaissance visits at the Municipal capital involved meeting key stakeholders including the Municipal Chief Executive (MCE)[16], the Presiding Member (PM), the Municipal Planning Officer (MPO), and the Municipal Director of the Ministry of Food and Agriculture (MOFA).

At all these meetings, the researcher introduced the research mission and presented introductory letters from the University to them requesting for relevant and useful documents to the PhD research. The reconnaissance visits were fruitful in the following ways: (i) meetings with the Municipal planner, for instance, gave the researcher useful information on the population of communities in the district including the research villages, (ii) again, meetings with the PM of the Municipal assembly gave the researcher the contact details of Assembly Members of the pilot villages as well as that of the research villages.

Piloting

Before the community entry in Doggoh and Tie, the researcher piloted the research tools in three villages; Tizza Boi, Duori Guo, and Baazu (see Picture 3.2). The choice of the pilot villages was based on villages that share similar characteristics with the research villages as Walliman (2005:282) suggests. Some of the research assistants trained assisted in the piloting

[16] The MCE is the political head of the local government system. As at the time of the fieldwork, the political head was a District Chief Executive (as explained in section 3.3.3).

of the research tools particularly during focus group discussions where the researcher needed someone to take notes. Details of the piloting are indicated in Table 3.3.

Table 3. 3 Summary of piloting of research tools

Piloting activity	**Pilot locality**		
	Baazu	Duori-Guo	Tizza Boi
When	Jan-Feb	Jan-Feb	Jan-Feb
Focus Groups	1, mixed (15 participants)	1, Mixed (7 participants)	1, mixed (8 participants)
Semi-Structured Questionnaire (SSQ)	2	2	2

Source: Fieldwork (January-February, 2016)

Picture 3. 2 An illustration of a focus group discussion during piloting

Source: Fieldwork (Piloting of focus group guide, Tizza-Boi, 2016)

The usefulness for piloting research tools before the central data collection has been recognised and documented (Howitt, 2016). To Howitt (2016: 70) for example, one cannot guarantee that quality data would be produced during the early interviews in the data elicitation processes. Howitt (2016:70) justifies that the skill of the interview, as well as the adequacy of the interview guide, could potentially affect the quality of the data elicited.

The piloting was useful in several ways: first, it broadly tested the effectiveness of the research techniques (Parfitt, 2005). Second, piloting aided the clarity of the questions, likely responses and participant conduct in responding to questions (Hoggart et al., 2002). Third, it improved the researcher's interviewing skills and assisted in the creation of rapport with research subjects.

Four, during the piloting in the village of Baazu for example, everyone wanted to participate in the discussion because the villagers initially agreed that the discussion should be conducted at the market centre.

The lesson was that, during the fieldwork, the researcher avoided conducting focus groups near busy central places, such as market squares, to prevent pressure from every villager wanting to participate. The long-run benefit was the revision of the research tools by considering local realities. The need for revision of research tools after piloting has been documented. To Denscombe (2017: 181), after piloting and the realisation of the need to improve some areas of the research tools, researchers should incorporate such changes before the research goes 'live' to avoid some problems.

Scoping

It is worthy to note that piloting took place alongside scoping exercises of the research villages. The researcher paid keen attention to identifying the livelihood activities of the inhabitants in the research villages mainly in the domain of agriculture as the scoping was carried out in the dry season. The villages of Doggoh and Tie are located close to the Charee and Konzokalaa dams respectively. Tomatoes, cabbage, onions, okra, pumpkin and bean leaves are among the significant vegetables cultivated in the two dams. The two dams together with other dams such as the Tizza dam and Karni dam[17] supply the vegetable needs of the Jirapa Municipality and beyond (interviews with gardeners, Charee and Konzokalaa dams, 2016)[18].

---

[17] The Tizza and Karni dams are other dams in the Tizza and Karni communities respectively where people that live around them go about gardening activities particularly during the dry season

[18] See Chapter 5 (section 5.2.3 for a detailed discussion of the results of the scoping exercises)

3.4 Access to Research Villages

A significant challenge to conducting successful research is the inability of researchers to obtain access to communities or research subjects to be studied. Access to research subjects becomes more problematic if the researcher is looking at a sensitive topic. Similarly, when the study involves an in-depth study of the field (Okumus and Altinay, 2007). In the light of the above, it is suggested that access to research is crucial and should not be taken lightly (Van Maanen and Knolb, 1985).

Access to the research villages was not difficult as the researcher hails from the Municipality, had some knowledge of the villages and also had some 'connections' within the study villages. Notwithstanding these, to gain the trust and acceptance of the participants, entry to the research communities was through using vital societal structures (Wasserman and Jeffrey, 2007). Upon several meetings and discussions with the research villages and the Assembly Member (who happens to be the 'political manager' of the two villages as they all come under one electoral area), dates were agreed on and fixed for the community entry. During the respective community entry dates, the researcher, the Assembly Member, the chiefs and their elders had a meeting where the researcher introduced the research mission to them and made them know it was purely for academic purposes. It is interesting to note that upon the researcher mentioning his full name as part of the introduction at the village of Doggoh for example, the elders said his father is well known in that village as the researcher's grandmother hails from the village. They added that the researcher's father regularly participates in the primary social functions of the village including funeral celebrations hence the researcher was most welcome to his own home.

In both Doggoh and Tie, *pito*[19] was bought by the chiefs and elders of the two villages for us (i.e. the researcher and the Assembly Member even the latter hails from Doggoh) as tradition demands in north-west Ghana. There is a famous saying in the local parlance that *"baale ka baale la baa deene"* literally translated as *"once a dog falls, and another dog falls, that is dogs play"*. Upon due consultation with the lead persons (people in the two research villages that were introduced to the researcher by the AM to assist the researcher with relevant information) and the Assembly Member, we had to also order for three (3) gallons of pito for the consumption of the entire group. While drinking the *pito*, the respective chiefs of the two research villages cautioned the villagers present that the researcher was a student and not coming from any nongovernmental organisation (NGO) hence no one should expect any cash reward once he comes to them to elicit information from them. The researcher had to subsequently introduce the concerned research assistants to households or groups to whom they were assigned to elicit some data from before the day of data collection.

3.5 Data Collection: Application of Research Tools

Having done the community entry in the two research villages, the next was for the research team to commence the data collection. The data was collected in three different phases as discussed below.

[19] Pito is a local alcoholic beverage that is used brewed from sorghum. It is an important part of the people of Doggoh and Tie during funerals, marriage rites, market days, and during group farming (VIKI-1-D-M, VIKI-1-T-M)

3.5.1 Phase I data collection: Individual village key informant interviews and participatory exercises

The next step of data collection dealt with getting to know each of the research villages. Similar participatory exercises, some in groups, and others with individuals were carried out with research subjects in both the Doggoh and Tie villages.

These include social mapping with carefully selected village analysts, interviews with village individual key informants, and wealth ranking with village leaders.

Village social mapping

Social mapping in the two villages involved both males and females who know the geography of their respective villages well known locally as 'village analysts'[20].

The 'village analysts' (both males and females) were suggested by the village lead persons after the researcher carefully discussed with them the objective of the exercise[21]. The criteria included involving villagers from the different sections of the village, both men and women. The social mapping helped in several ways. It gave the researcher a sense of the geographical frontiers of the two villages indicating key landmarks such as the nearest irrigation dams, schools, clinics, market squares, farmlands and the chief palaces amongst others.

In addition, the social mapping eased the researcher's familiarisation with the location of houses in the two research villages. Furthermore, the social mapping subsequently became useful in the sampling of households for the semi-structured questionnaire administration.

[20] The researcher considered the village participants who took part in the social mapping process as 'village analysts' because he detailed to the village lead persons that the participants should be selected based on knowledge of the geographical frontiers of the village and how the villages relate with their neighbours.

[21] Picture 3.3 depicts how the social mapping was done by the 'village analysts' in the village of Doggoh

The maps produced from social mapping enabled research assistants to find their way to their respective assigned households without much difficulty[22].

Picture 3. 3 Social map produced by village analysts in the village of Doggoh

Source: Fieldwork (Participatory exercise, Doggoh village, 2016)

[22] Appendixes G and H show the maps produced in the villages of Doggoh and Tie respectively during the social mapping exercises.

Wealth ranking

Wealth ranking was undertaken by village leaders who came out with locally defined criteria for the stratification of their villages into three wealth strata; rich, semi-rich and poor. Criteria used in the wealth stratification in the two villages included ownership of livestock, number of educated persons in a household, the nature of the household building, size of farm holding (reference was made to maize-w[23] farm size holding in the Doggoh village), number of married wives and number of children of the head of the household. In the two research villages, there were some differentiations concerning the defined criteria concerning numbers[24]. Other criteria used for considering households as rich included the ownership of corn mills, stores and drinking spots. Both men and women leaders were involved in the wealth ranking exercise.

---

[23] Maize- w refers to maize (white colour)

[24] See the detailed criteria for the villages of Doggoh and Tie in tables 3.4 and 3.5 respectively

Table 3. 4 Wealth stratification by village leaders in Doggoh

Criteria		Household type		
		Rich	Semi-rich	Poor
Ownership of livestock	Cattle	≥ 8	5-7	< 5
	Sheep	≥ 30	10- 29	< 10
	Goats	≥ 40	10-29	< 10
Size of maize-w farm holding		≥ 7	3-6	< 3
Number of educated persons in household		≥ 5	3-4	3
Number of wives married by household head		3	2	1
Number of children		≥ 10	3-9	< 3
Nature of household building		Block house with iron roofing	Bricks house with iron roofing	Mud or grass roofing

Source: Fieldwork (participatory exercise, Doggoh, March 2016)

Table 3. 5 Wealth stratification by village leaders in Tie

Criteria		Household type		
		Rich	Semi-rich	Poor
Ownership of livestock	Cattle	≥ 6	3-5	< 3
	Sheep	≥ 15	10- 14	≤ 9
	Goats	≥ 30	20-29	< 15
	Ducks	≥ 20	15-19	≤ 14
Size of farm holding		≥ 10	5-9	≤ 4
Number of educated persons in household		≥ 7	4-6	≤ 3
Number of wives married by household head		3 or more	2 wives	1 wife
Nature of household building		Block house with iron roofing	Bricks house with iron roofing	Mud or grass roofing

Source: Fieldwork (participatory exercise, Tie, March 2016)

The wealth ranking exercise was useful in a couple of ways. It gave room for the researcher to stratify the village into different strata; rich, semi-rich and poor based on villagers' perception. The exercise was essential as there was no data at the district level on the number of households in Doggoh and Tie, and the differentiation of households based on wealth status, and sex status of household heads (i.e. whether male or female-headed).

Having had the criteria for wealth status differentiation and the village map, the researcher had to move around the various houses to ascertain the number of households in each house. The objective was to establish the number of male and female-headed households in each house, tease out necessary but relevant information from each household based on the wealth stratification criteria defined. It is worthy to note that, from the stratification, results revealed that females headed few households under conditions such as the demise of their husbands or migration of husbands in search of greener pastures in southern Ghana. Hence, the researcher exercised caution by including female-headed households from the various wealth strata even though many fell within the poor wealth stratum. With male-headed households dominating, the researcher had to apply the simple random sampling technique. Again, the researcher exercised care by giving various sections of the Doggoh village an equal opportunity to be selected to be part of the semi-structured household questionnaire administration.

Village individual key informant interviews

Through the community entry process, the Assembly Member (AM) for the two research villages introduced two persons (one from Doggoh, and the other from Tie) to serve as community lead persons. The village lead persons were helpful in the selection of the village key informants. The researcher drew on Burgess (1989) criteria in the selection of the respondents. Specifically, the role of the key informants in the villages and their knowledge were used for the selection. In interactions with the village lead persons, it emerged that the two villages had representatives that coordinate the activities of NGOs in the villages. Therefore, such people were better in giving information on agricultural information that the two villages receive from NGOs and not everyone as Marshall (1996) argues that not everyone in a community can be an ‘expert’.

The village lead persons were made to suggest four persons (two males and two females) as potential key informants. On the basis of their knowledge of the following thematic areas: (i) farming systems, and the challenges confronting agricultural activities, (ii) agricultural information dissemination in the village, (iii) the social functions in the village, and the value of crops social function, (iv) cultural uses of food, and food preferences.[25]

Then based on availability, the researcher finally selected two (a male and a female) for each of the respective thematic areas. It was purposive in the sense that not every member of either the village of Doggoh or Tie was knowledgeable concerning the respective thematic areas. For example, on the aspect of 'farming systems' amongst other objectives, the scope was also to understand how the cropping systems have now changed as compared to that of the past. In that regard, younger farmers could not ideally serve as key informants as they would only know a little about the farming systems in the past via oral messages from their ancestors and fathers.

With tentative maps of Doggoh and Tie and the identification of potential individual key informants, the researcher sometimes moved with the village lead persons for Doggoh and Tie to conduct the village individual key informant interviews. The reasons for the absence of key informants included migration to southern Ghana, funeral attendance as well as the performance of traditional rites and rituals at neighbouring villages.

[25] Picture 3.4 illustrates a ranking exercise that was carried out with a village key informant in the village of Doggoh in attempts to understand the changing nature of food preferences.

Picture 3. 4 Participatory exercise with a village key informant in Doggoh village

Source: Fieldwork (Village key informants interviews, Doggoh, 2016).

3.5.2 Phase II of data collection: Semi-structured questionnaire, key informant interviews with stakeholders, focus group discussions

In the second phase of data elicitation, the objective was to tease out informants from smallholder farmers and triangulate that with information from stakeholders. Hence, this phase involved data elicitation via semi-structured questionnaire, key informant interviews with stakeholders as well as focus group discussions with villagers.

Semi-structured Questionnaire (SSQ)

In the case of this research, the researcher administered the semi-structured questionnaire via the face-to-face method. The face-to-face technique permitted the interpretation of the survey questions in the local dialect (i.e. Dagaare) to the research subjects. This was more appropriate as many of the respondents were illiterate, and it helped the research team to ask the questions in the local dialect. This led to a better understanding of the questions, with the respondents addressing the questions appropriately.

Similarly, the face-to-face allowed for high response rates as some respondents could have decided not to answer some questions or could have refused to return the questionnaire in the case of self-administration. That apart, face-to-face allowed for prompting and probing which enabled respondents to understand and answer questions appropriately. However, the researcher was careful not to 'lead' respondents in giving out specific answers (Gilbert, 2008: 195).

During the interviews, care was exercised as the respondents were asked personal questions and questions that involved other household members. For example, on farmer perceptions, the assumption was that responses were personal and associated with the respondent and not the whole household. However, on the aspect of food preferences, the respondent was asked about foods that the household as a unit preferred in the past and now (recognising that household food preference is a function of what the majority of the household members preferred, intra-household food preferences were teased out during the household case studies- see section 3.5.3).

With the SSQ involving both open-ended and closed coded questions, the research team observed several issues during the application of the tool in the field. Unlike the pre-coded categories, the open-ended questions required more thought. They also produced responses that were ambiguous, wide-ranging and difficult to categorise (Gilbert, 2008: 193). Nevertheless, the researchers noted that the open coded questions allowed the respondents to express their opinions freely.

Similarly, the addition of "if other, please specify" teased out much useful information that was not included in the alternative responses provided in the interview sheet.

Stakeholder level key informant interviews

Having had some information from the research villages via the village key informant interviews, and semi-structured questionnaire, the researcher realised it was necessary to triangulate that with information from policymakers (i.e. NGOs and government agencies). The focus was on stakeholders that operate in the research villages. These included the Ministry of Food and Agriculture (MOFA) Municipal level office,' Climate Change, Agriculture and Food Security (CCAFS), Literacy Bridge, Canadian Feed the children/Association of Church-based Development Programmes (ACDEP)- RESULT[26] project and ESOKO Ghana.

[26] Resilient and Sustainable Livelihoods Transformation Programme (RESULT)

Focus group discussions

In the two research villages, the researcher convened six (6) focus group discussions. Three (3) in each research village. The participants for the focus group discussions were purposively selected. To that end, the village lead persons assisted in the selection of the focus group participants based on several characteristics including the length of experience and involvement in agriculture and extent of knowledge about each of the communities. The discussion had the researcher as the facilitator and four (4) research assistants; two in each research village assisted in the conduction of the focus group discussions. In each research village, one research assistant was responsible for taking general notes and the other, wrote down the unique codes assigned to participants and first few words of the participants to make it easier for the transcriber to identify voices Russel (2011: 176). In all the focus group discussions, the moderator was careful in handling participants who wanted to over-dominate the discussions by giving other participants the chance to contribute (Ricthie et al., 2014: 213).

In conducting the focused group discussions, several matters emerged. It typically occurred that the females were so silent and occasionally contributed. Even though it has been documented that focus groups are avenues for all participants to present their views and experiences and hear from other people in the discussion (Ricthie et al., 2014: 212) that was not the case in the villages of Doggoh and Tie. It emerged that the women were mainly quiet. With the researcher acting as the moderator and having some control hence coordinating the discussion (Howitt, 2016: 89), the researcher had to 'push' the female participants by asking 'what do the women too have to contribute". Having noticed that the women were 'quiet' during the mixed focused group discussions, the researcher in the subsequent discussions had to organise separate focus groups for the males and the females. This was very useful and translated into the researcher eliciting relevant information from females in the focus group discussions.

Similarly, it emerged from the focused groups that some participants particularly males wanted to dominate the discussion. The researcher as the 'moderator' and having control over the group as suggested by Howitt (2016: 89) had to lessen the way the 'dominant' members contributed as well as giving the 'less dominant' members some chance to contribute their opinions.

3.5.3 Phase III of data collection: Household case studies, and participant observation

In-depth interviews

In-depth interviews were used to validate and clarify the information that was collected in the survey, key informant interviews and focus group discussions. The selection of households for the in-depth interviews was based on a preliminary analysis from the quantitative survey.

With the research questions in mind, the researcher considered primarily among other factors to select households who were adapting or not to climate variability and change via crop selection. Other factors included age, gender and wealth status of the head of the household.

Thirty-four (34) households were selected from the three wealth categories (19 from Doggoh village, and 15 from Tie)[27]. In this study, semi-structured interviews were used for the data elicitation. The in-depth interview entailed the researcher asking questions, listening to, and recording the answers and then posing additional questions.

---

[27] The difference in the number of case study participants was explained by availability of the participants. Initially, the researcher had a target of getting 40 households (20 from each research village).

During the in-depth case studies, it emerged that the respondents opened up and freely discussed issues that did not emerge in the focus group discussions. The tool also enabled the researcher to have a deeper understanding of smallholder farmers' decisions.

Participant observation

According to May (2011: 63), participant observation gives the researcher flexibility and no firm assumption about what is essential as it enables researchers to immerse themselves in the day-to-day activities of the people whom they are attempting to understand. Participant observation brought useful results to this research in several regards: It enabled the researcher to understand actions within the context of an observed setting (May, 2011: 63).

For example, through participant observation, the researcher got to know the location of farm fields, and the crops that cultivated on each of them. Similarly, the researcher got to establish gender differentiation regarding cropping decisions. Participant observation enabled the researcher not to impose his reality on the social world he seeks to understand.

Notwithstanding the above strengths, participant observation is not devoid of weaknesses. One, it involved spending a great deal of time in surroundings which were not familiar to the researcher. Two, the research team had to secure and maintain relationships with people with whom they had little personal affinity. Third, it involved taking copious notes on what would typically appear to be everyday life.

The researcher had a diary for keeping records and participated in the activities of households. Involvement in the daily affairs of the research villages gave a better understanding of socio-cultural dynamics.

3.6 Gaining Farmers Trust

Besides formally going through the community entry process where the researcher duly introduced the mission of the study to the villages and participated in the activities of the villages. For example, during funerals, the researcher had to go to sympathise with the bereaved family and the entire village.

Similarly, the researcher had to occasionally participate in some farming activities of some households mainly weeding of crops (his best farming activity). All the above translated into the researcher being 'identified' as a member of both villages of Doggoh, and Tie. The long-run benefit was that some participants had to suspend their farming activities to grant the researcher interviews, and the common theme that emerged to justify why they agreed that was that “we all are one here on a daily basis so why would we not grant you interviews”. Picture 3.5 indicates the researcher enjoying food with some youngsters in the village of Tie after raising the mounds of groundnuts. Similarly, Picture 3.6 depicts the researcher helping a household to process groundnut seeds for sowing.

Picture 3. 5 An illustration of the researcher’s involvement in farming

Source : Fieldwork (Participant observation, Tie Village, 2016)

Picture 3. 6 An illustration of the researcher participating in farming

Source: Fieldwork (Participant observation, Tie Village, 2016)

3.7 Data Analysis

3.7.1 Secondary data analysis

The secondary data analysis involved daily rainfall, and monthly maximum and minimum temperature for the Babile station [28] obtained from the Ghana Meteorological Agency (GMET)[29].

3.7.2 Quantitative data analysis

- Data collected from the survey was subjected to statistical analysis using the Statistical Package for the Social Scientist (SPSS).
- Questions with pre-coded alternatives were entered directly into the SPSS spreadsheet.
- In the case of open-ended questions, the researcher spent a considerable amount of time in going through all the questionnaires before editing and assigning codes.
- The researcher initially generated descriptive statistics to have a general sense of characteristics of the research respondents
- Results from the SPSS spreadsheet were presented in the form of tables, charts and graphs.
- Bivariate and cross-tabulation analyses were employed to understand the relationship between variables.

3.7.3 Qualitative data analysis

Interviews from qualitative data were first transcribed into English. The transcripts were inputted into NviVo and read through carefully by the researcher bearing in mind the significant themes and sub-themes of the research objectives and questions. The essence was to label words,

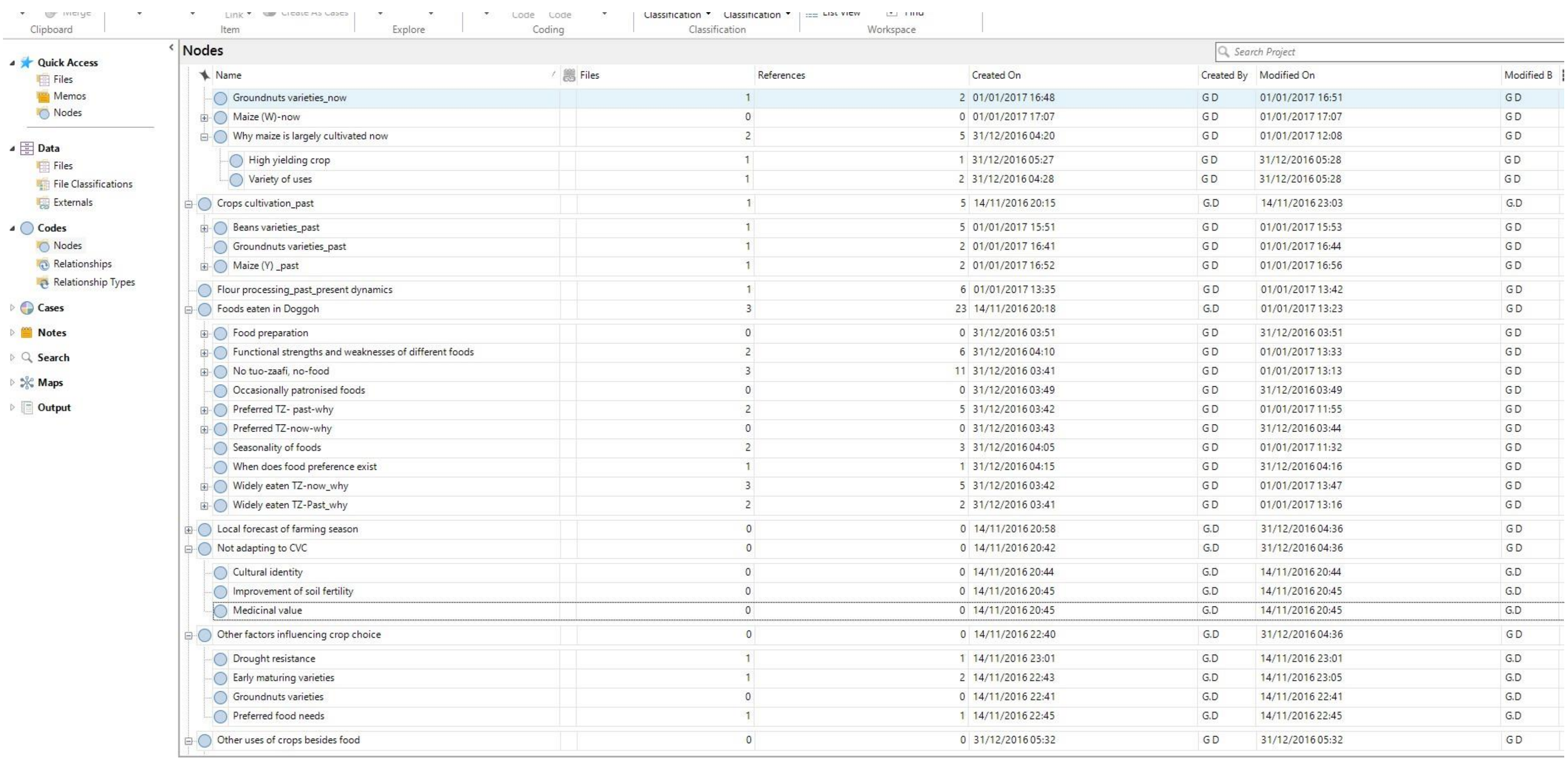
[28] In chapter 4 (section 4.2.1), the researcher justifies why the data for the Babile climate station was used and not any other station in North-west Ghana)

[29] Details of how the rainfall and temperature data were analysed is detailed in chapter 4 (section 4.2)

phrases and sentences through a process known as coding. Gibbs (2002: 57) defines coding as "the process of identifying and recording one or more discrete passages of text or other data items (e.g. parts of a picture) that, in some sense, exemplify the same theoretical or descriptive data". The coded data were put into relevant categories but carefully looking out for the connectivity among categories. The researcher had to develop a hierarchy of categories bearing in mind which ones were more useful to the research than the others.[30]

[30] See figure 3.3 for an illustration of how the interview transcripts were analyses in NviVo

Figure 3. 3 An illustration of coding of qualitative data in Nvivo



Name	Files	References	Created On	Created By	Modified On	Modified B
Groundnuts varieties_now	1	2	01/01/2017 16:48	G D	01/01/2017 16:51	G D
Maize (W)-now	0	0	01/01/2017 17:07	G D	01/01/2017 17:07	G D
Why maize is largely cultivated now	2	5	31/12/2016 04:20	G D	01/01/2017 12:08	G D
High yielding crop	1	1	31/12/2016 05:27	G D	31/12/2016 05:28	G D
Variety of uses	1	2	31/12/2016 04:28	G D	31/12/2016 05:28	G D
Crops cultivation_past	1	5	14/11/2016 20:15	G.D	14/11/2016 23:03	G.D
Beans varieties_past	1	5	01/01/2017 15:51	G D	01/01/2017 15:53	G D
Groundnuts varieties_past	1	2	01/01/2017 16:41	G D	01/01/2017 16:44	G D
Maize (Y) _past	1	2	01/01/2017 16:52	G D	01/01/2017 16:56	G D
Flour processing_past_present dynamics	1	6	01/01/2017 13:35	G D	01/01/2017 13:42	G D
Foods eaten in Doggoh	3	23	14/11/2016 20:18	G.D	01/01/2017 13:23	G D
Food preparation	0	0	31/12/2016 03:51	G D	31/12/2016 03:51	G D
Functional strengths and weaknesses of different foods	2	6	31/12/2016 04:10	G D	01/01/2017 13:33	G D
No tuo-zaafi, no-food	3	11	31/12/2016 03:41	G D	01/01/2017 13:13	G D
Occasionally patronised foods	0	0	31/12/2016 03:49	G D	31/12/2016 03:49	G D
Preferred TZ- past-why	2	5	31/12/2016 03:42	G D	01/01/2017 11:55	G D
Preferred TZ-now-why	0	0	31/12/2016 03:43	G D	31/12/2016 03:44	G D
Seasonality of foods	2	3	31/12/2016 04:05	G D	01/01/2017 11:32	G D
When does food preference exist	1	1	31/12/2016 04:15	G D	31/12/2016 04:16	G D
Widely eaten TZ-now_why	3	5	31/12/2016 03:42	G D	01/01/2017 13:47	G D
Widely eaten TZ-Past_why	2	2	31/12/2016 03:41	G D	01/01/2017 13:16	G D
Local forecast of farming season	0	0	14/11/2016 20:58	G.D	31/12/2016 04:36	G D
Not adapting to CVC	0	0	14/11/2016 20:42	G.D	31/12/2016 04:36	G D
Cultural identity	0	0	14/11/2016 20:44	G.D	14/11/2016 20:44	G.D
Improvement of soil fertility	0	0	14/11/2016 20:45	G.D	14/11/2016 20:45	G.D
Medicinal value	0	0	14/11/2016 20:45	G.D	14/11/2016 20:45	G.D
Other factors influencing crop choice	0	0	14/11/2016 22:40	G.D	31/12/2016 04:36	G D
Drought resistance	1	1	14/11/2016 23:01	G.D	14/11/2016 23:01	G.D
Early maturing varieties	1	2	14/11/2016 22:43	G.D	14/11/2016 23:05	G.D
Groundnuts varieties	0	0	14/11/2016 22:41	G.D	14/11/2016 22:41	G.D
Preferred food needs	1	1	14/11/2016 22:45	G.D	14/11/2016 22:45	G.D
Other uses of crops besides food	0	0	31/12/2016 05:32	G D	31/12/2016 05:32	G D

3.8 Research Ethics

Before travelling to North-west Ghana to commence the fieldwork, the researcher had to go through the necessary ethical clearance procedures within the University. Also, the researcher got an introduction letter from the supervisor that helped in identifying oneself and the research mission. In dealing with different research subjects, the researcher introduced the purpose of the study and also explained the intended uses of the data. The respondents permitted data elicitation and information sheets were given to all the respondents. Participants were made to understand that participation was entirely voluntary, and one could withdraw at any given stage. Furthermore, the researcher explained to participants about their pictures potentially been used in some aspects of the PhD thesis and participants consented to that.

3.9 Researcher Positionality

Before arriving to the Jirapa Municipality for the fieldwork, the researcher carefully thought about these two things: (i) how respondents were going to perceive him as either working with an NGO or coming from the developed world, and (ii) how his own perceptions (likely influenced by his long affiliation with the *Dagaaba* people, his education and role as a researcher may influence the research.

To that end, upon arrival in the Jirapa Municipality, the researcher formally introduced himself to relevant government agencies and non-governmental organisations (NGOs). These included the Ministry of Food and Agriculture (MoFA), Savannah Agricultural Research Institute (SARI) – that works with Climate Change, Agriculture and Food Security (CCAFS), Literacy Bridge, ESSOKO Ghana among others. Similarly, upon arrival in the villages of Doggoh and Tie, the researcher also clearly explained to the villagers that he was not affiliated to any government organisation or NGO. This reduced any expectations (e.g. financial rewards) from the research participants.

Also, as a native of the municipality who understands the local dialect; dagaare and also know certain things about the culture of the two villages, the researcher, however, took the position of an outsider. To that end, he never assumed he knew anything and therefore had to probe research participants in order to have a nuanced understanding of his subject of investigation. Additionally, to be accepted and build some trust, the researcher had to occasionally participate in farming activities, eat with households and play with children[31].

3.10 Challenges during Fieldwork

The researcher got confronted with many challenges ranging from environmental, relief to social elements. On the aspect of relief, Doggoh village is stony, hilly, and has some streams that cut across it. Hence, during the rainy season, the researcher rode his motorcycle occasionally through streams to access households.

In the villages of Doggoh and Tie, just like other villages in north-west Ghana, funerals are occasions that everyone is expected to attend. So when there was a funeral in any of the two villages or any of the nearby villages, it was challenging for the researcher to have access to research participants. The culture of the Dagaaba tribe expects everyone to go and sympathise with the bereaved family.

Communication network too was a problem as some sections of the two villages did not have sufficient communication network so making calls was occasionally a problem as the researcher had to move around searching for an excellent reception to make or receive calls.

[31] See section 3.6 for details

3.11 Conclusion

This chapter discussed the research approach that was used to guide this study. Similarly, this chapter justified why North-west Ghana was an appropriate setting to understand farmers' cropping decisions under climate variability and change and the impact on culturally preferred foods. Furthermore, the chapter discussed the research tools that were used for the data elicitation, the positionality of the researcher, and also the ethical procedures that were followed during the research, and how the data collected from the field were analysed. Chapter four discusses the results from the study on farmer perceptions of climate variability and change.

CHAPTER FOUR

FARMER PERCEPTIONS OF CLIMATE VARIABILITY AND CHANGE

4. Farmer Perceptions of Climate Variability and Change

4.1 Introduction

This chapter addresses objective one of the thesis: to explore smallholder farmers' perceptions of climate variability and change (CVC) – see chapter 1, (section 1.3). As argued in chapter 1 (see section 1.2.1), the discourse on farmers' perceptions of CVC has mainly focused on only teasing out farmer perceptions of CVC without comparing with climatic data (Asante et al., 2017, Derkyi et al., 2018), some studies though limited in Ghana attempt to compare farmer perceptions with meteorological data (Asante et al., 2017, Limantol et al., 2016, Yaro, 2013). Also, even though there are some attempts to understand how farmer perceptions of CVC are differentiated by social groups (Horsefield, 2016, Singh et al., 2018), little is understood in that regard. Similarly, the review in chapter 2 (section 2.2.2) suggests that studies on farmers' perception have focused on identifying what changes are perceived by farmers with little attention allotted to understanding how farmers interpretation of the changes in their local climate are constructed by cultural beliefs and values (Scoville-Simonds, 2018).

This chapter, therefore, contextualises farmers' perceptions with scientific analysis of local climate data. This is essential as it gives room for identifying matches and mismatches, and an opportunity to then understand the reasons behind this and where appropriately support farmers with better information and a possible forum for discussing the differences (Dohmen et al., 2009, Menapace et al., 2015). Similarly, notwithstanding the value of comparison approach, it is essential also to recognise that understanding how perceptions of CVC is differentiated is useful for understanding how those shape adaptation responses.

Furthermore, in order to address CVC in a socially just way, it is essential to have a nuanced understanding of how cultural values shape farmer perceptions of CVC (Scoville-Simonds, 2018).

Drawing on the theoretical ideas of memory, experiences, cultural values, climate information from 'experts' (see chapter 2, section 2.2.2), and employing both the secondary data (i.e. rainfall and temperature), and primary data (i.e. the semi-structured questionnaire, the village key informant interviews, the stakeholder interviews, the focus groups and the household case studies), the chapter is structured as follows: Section 4.2 presents results on the evidence for climate variability and change in the scientific data. Then in section 4.3, the results are presented on farmer perceptions of CVC. In section 4.4, attention is paid to teasing out how farmer perceptions are socially differentiated. Section 4.5 deals with understanding the factors that construct farmers' perception of CVC. The similarities and differences between farmer perceptions and analysis from meteorological data are discussed in section 4.6. Section 4.7 has the discussion and conclusion for the chapter.

4.2 The Evidence for Climate Variability and Change in the Scientific Data

The starting point of the analysis in this chapter is to explore the evidence in available scientific data of climate change and variability available from the Babile rainfall station. In particular, the focus will be to identify climatic characteristics that are important to agricultural practice, using an established approached for this type of research in Sub-Saharan Africa (Mubaya et al., 2012, Osbahr et al., 2011, Stern and Cooper, 2011, Thomas et al., 2007). This will include rainfall (the total annual rainfall distribution, number of rainy days in a year, monthly rainfall averages, number of rainy days in a month, the start of the rainy season, and the end of the rainy season), and temperature (the minimum monthly averages, and the maximum monthly averages).

The purpose of identifying these patterns will be to provide context to the perceptions of farmers and reveal any differences in views between the scientific evidence and farmers' perceptions. If there are differences, then it will be essential to understanding why and for whom, as these may reflect different experiences, individual memory, livelihood or identity and will have implications for cropping decisions.

4.2.1 Rainfall

In Sub-Saharan Africa, just like other areas in the developing economies, agriculture is mainly rain-fed. Northern Ghana is particularly vulnerable to the impacts of climate variability and change as the area experiences a single rainfall regime. In the analysis of rainfall data, the methodology of Stern and Cooper (2011) was followed.

Aspects of rainfall variability such as onset and end of the rainy season, change in rainfall intensity within a season, and the risk of within-season dry spells were explored (Hassan and Stern, 1988, Musyoka, 2009, Ovuka and Lindqvist, 2000). To achieve this, daily rainfall data from 1960-2016 (57 years) for Babile station acquired from the Ghana Meteorological Agency (GMET) were analysed. The following sections explain the sources of data, how the data was processed and analysed.

Why use rainfall data for the Babile station?

The Upper West region of Ghana has about 12 rainfall stations: Babile, Funsi, Lawra, Nandom, Wa, Dafiema, Charipkong, Han, Jirapa, Kaleo, Nadowli, and Wechaiu (GMET, 2016). Reports from GMET as presented in table 4.1 shows the percentage of missing and available data for all the stations.

Table 4. 1 Percentage distribution of missing and available data for rainfall stations in the upper west region

Station	Start year	End year	Number of years	Percentage missing	Percentage available
Babile	1960	2013	54	14.6	**85.4**
Funsi	1960	2013	54	60.5	39.5
Lawra	1960	2013	54	33.5	66.5
Nandom	1960	2013	54	59.4	40.6
Wa	1960	2012	53	0.00	100
Dafiema	1960	2013	54	66	34
Charipkong	1994	2011	18	53.3	46.7
Han	1960	2004	45	60.5	39.5
Jirapa	1960	1993	34	81.9	18.1
Kaleo	1960	2013	54	67.4	32.6
Nadowli	1960	2004	45	44.3	55.7
Wechaiu	1960	2013	54	74.5	25.5
Tumu	1960	2013	54	35	65

Source: Ghana Meteorological Agency (2016)

As indicated in table 4.1, concerning data availability, Babile station follows Wa station; that is 85.4% and 100% respectively. Jirapa station records the poorest (18.1%) that covers a short period of 34 years. Regarding proximity to the research villages, Babile, Lawra and Jirapa stations are the closest to the study villages. Personal communication with some GMET officials recommended that the researcher use data from a station that is not more than 20km from the research villages.

Per the quality of data, Wa station would have been the station, but it is about 65KM away from the research villages; therefore, that of Babile station (which is less than 20km) was used.

4.2.2 Processing rainfall data

The study employed R-Instat (a statistical software application developed by the African Mathematics Initiative) for analysis. Daily rainfall data was first saved in acceptable formats that R-Instat would recognise and was inputted into R-Instat application. The starting point was to summarise the data from 1960-2016 looking out for years with lots of missing data (see table 4.2). Of the years, 42 had very good data and 12 years (i.e. 1964, 1965, 1966, 1967, 1968, 1969, 1970, 1971[32], 1990, 2004, 2007, and 2008) were not good. R-Instat was used to perform statistical analysis for each of the rainfall events for the Babile station.

Table 4. 2 Summary of rainfall data for Babile Station

Station	No. of observations	Number not missing	Maximum	Minimum	Range	Mean	No. of observations less than 950 mm
Babile	57	52	1416.5	563.5	853	995.7	19

Source: Ghana Meteorological Agency (2016)

Amount of rainfall: annual averages

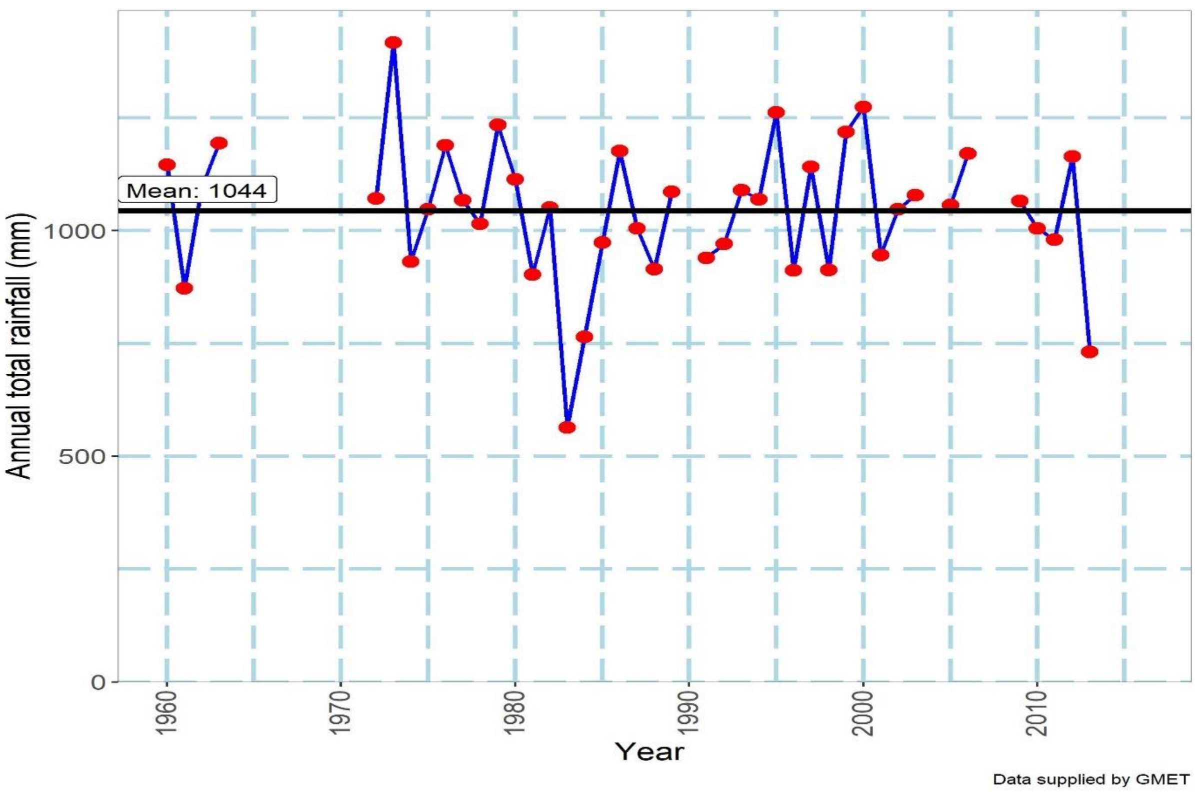
Rainfall totals for different years are a good starting point to understand rainfall pattern across different years to ascertain trend regarding change or variability. Annual totals were calculated from 1960 to 2016. The graph does not depict any vivid pattern as to whether annual rainfall totals have either increased or decreased throughout the period (as a p-value of 0.6 was recorded) but instead high variability of inter-annual rainfall distribution for the 57-year period (i.e. from 1960-2016)- (see figure 4.1).

Generally, rainfall distribution from the 1960s was erratic until the maximum was recorded in 1973 (1416.5 mm), then the erratic pattern continued until the lowest annual value of 563.5 mm

[32] Note: 1971 for instance has about 31 missing data but the missing data was for the month of January, which is irrelevant in terms of the definition of the onset of the rainfall.

was recorded in 1983 and from there it became variable, increasing and decreasing. The literature (see e.g. Codjoe and Owusu, 2011) reports that Ghana was characterised by drought between 1983-1984 hence that explains the low rainfall amount in 1983. Assan et al. (2009) report that at least 950 mm of rainfall is needed for crop production for vulnerable regions in Ghana and the Upper West region is not an exception. Summary of the annual rainfall for the 57-year period (as indicated in table 4.2) suggests that 19 years had annual rainfall totals below the threshold hence were precarious for crop production. As reviewed under section 2.2.1 even though there is an agreed pattern on temperature projections in Africa, there has not been a consensus on rainfall even though there is agreement mostly on decreasing trend in rainfall totals in Sub-Saharan Africa (Rowell, 2012, IPCC, 2014).

Figure 4. 1 Total annual rainfall distribution for Babile, 1960-2016.

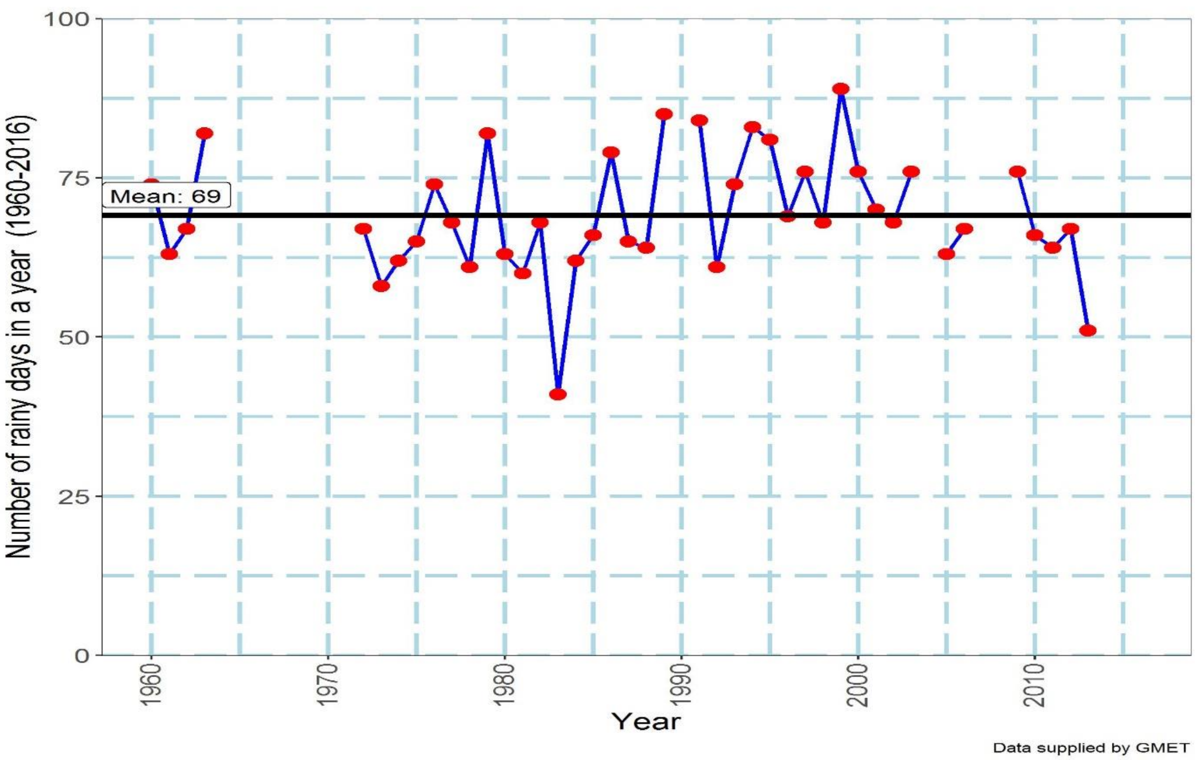


Source: Ghana Meteorological Agency (2016)

Number of rainy days in a year

To understand the number of rainy days in a year, it is important to understand what a ‘rainy day’ is. In the context of this study, a rainy day is defined as one with a threshold rainfall of 0.85 mm (Stern et al. 2006). The results showed no trend as in either the number of rainy days increasing or decreasing from 1960 to 2016 as the modelling showed a p-value of 0.74. However, the data shows high variability in the number of rainy days with the minimum being 41 rainy days which was recorded in 1983, the mean being 69 rainy days, and the maximum number of rainy days being 89 rainy days which was recorded in 1999 (see figure 4.2).

Figure 4. 2 An illustration of the number of rainy days by year

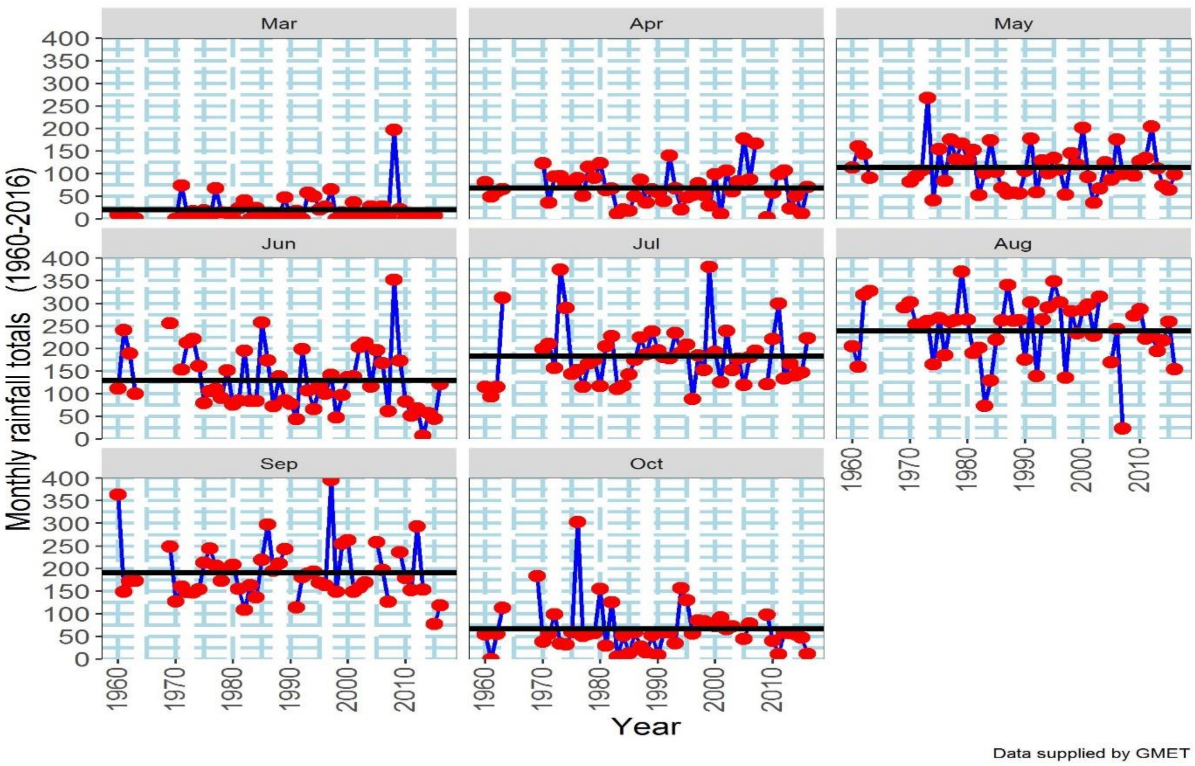


Source: Ghana Meteorological Agency (2016)

Amount of rainfall: monthly averages

Similarly, monthly rainfall totals were also computed for the same period (1960-2016). The objective was to find out about intra-annual variability in rainfall amount. The data showed very low rainfall amounts for the months of November to February hence those are dry months. Therefore, the graph only displays rainfall distribution for 8 months. The data shows the concentration of rainfall within July, August and September with more rainfall amount in August followed by September and July as indicated in figure 4. 3. Even though an increase in rainfall amount can reduce water scarcity impacts, it has been documented that such findings must be treated with caution as an accompanied increase in temperature can lead to for example evaporation (Singh, 2014).

Figure 4. 3 Monthly distribution of rainfall for Babile station (1960-2016)

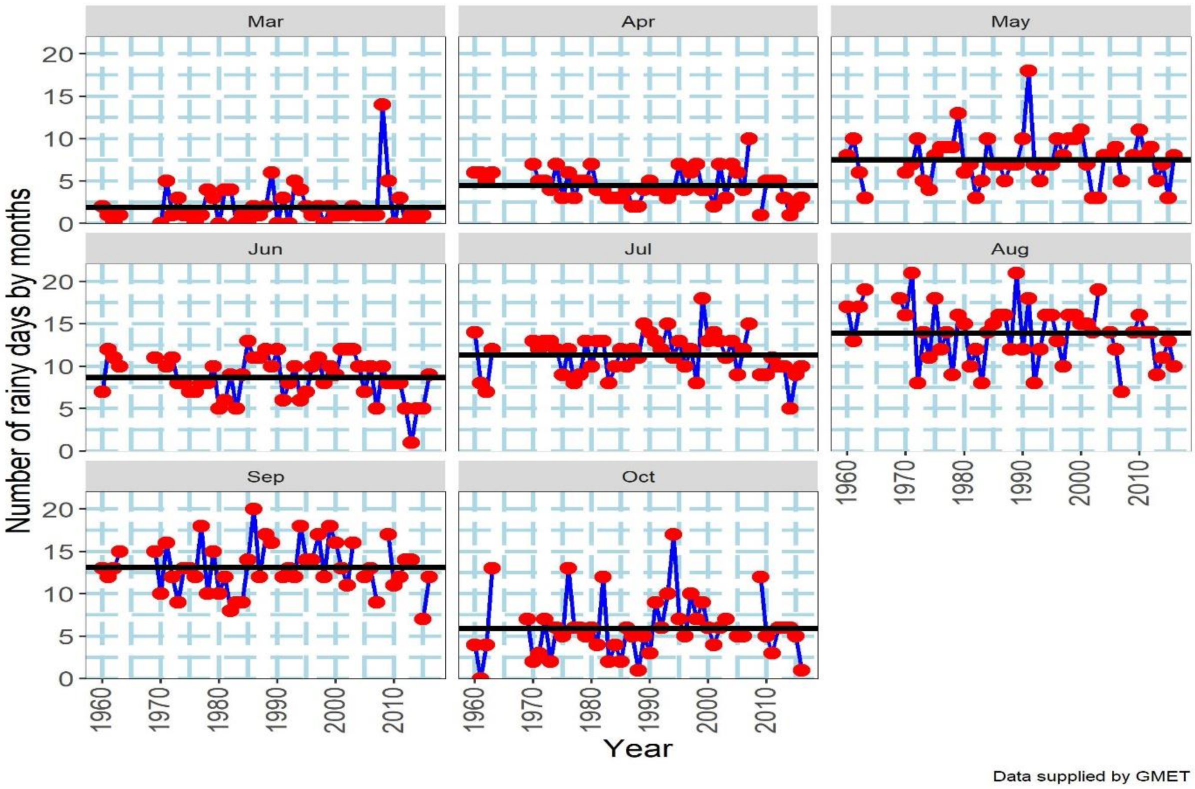


Source: Ghana Meteorological Agency (2016)

Number of rainy days in a month

A similar approach as applied to the number of rainy days in a year above was applied to understand the number of rainy days in a month. The results (see figure 4.4) indicate high degree of intra-annual variability in the number of rainy days with more rainy days in August and September.

Figure 4. 4 An illustration of the number of rainy days by month



Source: Ghana Meteorological Agency (2016)

The start of the rainy season

In as much as the amount of rainfall is important it is worth recognising that the start of the rain which influences the planting decisions of farmers is equally essential (Antwi-Agyei, 2012, Ingram et al., 2002). For example, if farmers plant early after the raindrops and there is a dry spell, there is the potential of the seeds getting affected after germination as soil moisture would be reduced. Similarly, if farmers' plant late, and there is torrential rainfall, there is the potential of inundation and future flooding that may wash away seeds (Horsefield, 2016). Therefore, this study computes the start of the rains with, and without the consideration of dry spell conditions. Daily rainfall data for the Babile station were examined to understand trends in the onset of the rainy season using four definitions as indicated in table 4.3. The following justify why four definitions have been used for the start of the season. To begin with, there are some farmers that may want to plant early in April once the rain begins to fall and some other farmers who would not want to take the risk hence will wait until May to begin to plant when they can say the rains are now reliable. Consideration of whether there has, or there has not been a dry spell is necessary because a rainfall that is followed by a dry spell is not an effective rainfall as farmers may have to replant and that translates into acquiring farm inputs (e.g. seeds) which is a challenge for the poor smallholder farmers in rural north-west Ghana (GSS, 2014).

In trying to make meaning from the results, two statistical steps were considered: one was to fit a model for the start of the rainfall against year, and two, to generate statistical summaries of the climate events.

Table 4. 3 Four definitions of the onset of the rainfall

Definition I	The first occasion after April 01st that records more than 20 mm of rainfall in one or two consecutive days without factoring in any dry spell condition
Definition II	Definition two draws on definition I but incorporates the element of no dry spell of more than 9 days in the next 30 days after the first day of recorded rainfall of at least 20 mm as suggested by Stern and Cooper (2011).
Definition III	The first occasion after May 01st that records more than 20 mm of rainfall in one or two consecutive days without factoring in any dry spell condition
Definition IV	Definition two draws on definition III but incorporates the element of no dry spell of more than 9 days in the next 30 days after the first day of recorded rainfall of at least 20 mm as suggested by Stern and Cooper (2011).

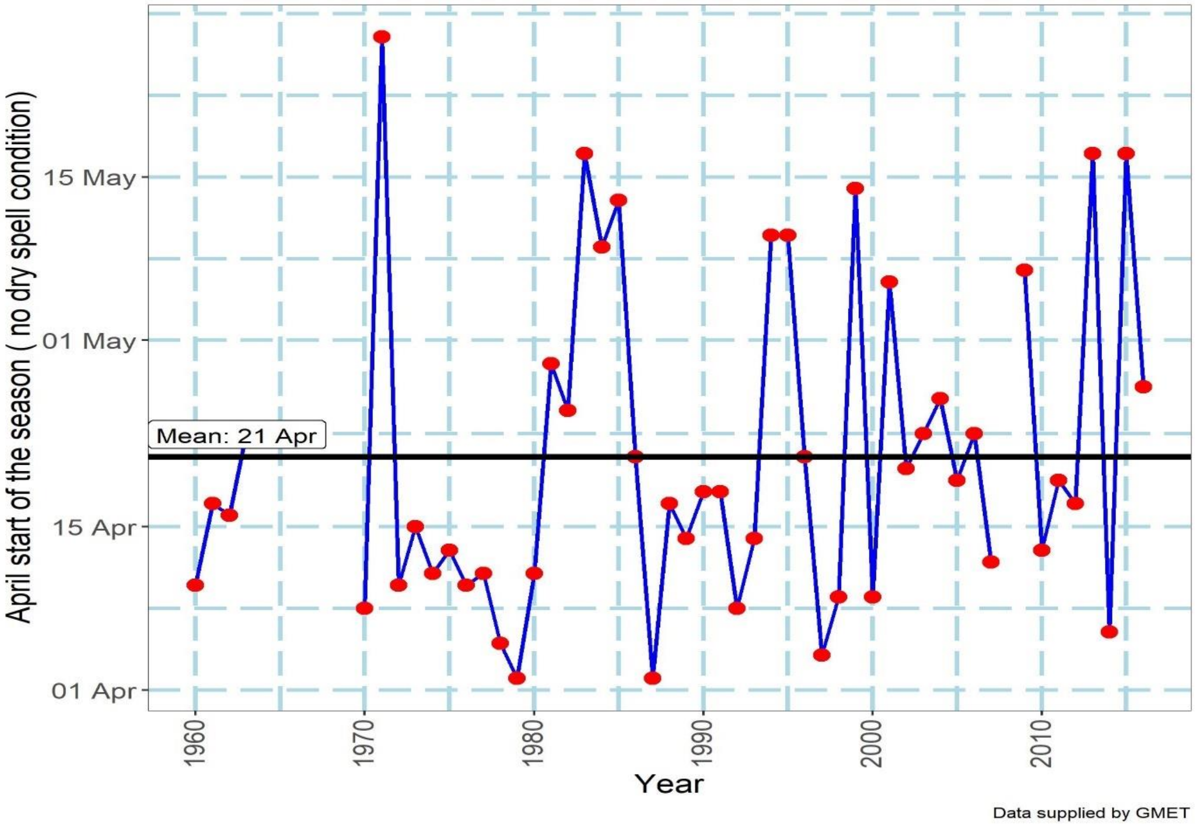
Source: Stern et al., (2006)

A dry spell here is defined as any day with less than 0.85mm of rainfall (Stern et al., 2006). R-Instat has commands for the various climatic events hence the respective commands were run, and graphs generated for each (as shown in figures 4.5, 4.6, 4.7 and 4.8).

April definition without considering dry spell condition

Figure 4.5 tells us that, without considering the occurrence of dry spell conditions, the earliest start of the rainy season was recorded twice on the 02nd of April in (1979) and (1987), and the latest was recorded on 27th May in 1971. The model showed no significance for the start of the rains for the definition I as the p-value (0.15) is greater than 0.05. Therefore, from the above, one can conclude that there is no trend in the start of the rain as in either the rainfall starting earlier or later now as compared to that of the past but rather variability in the start date.

Figure 4. 5 First occasion after 01st April that records more than 20mm of rainfall without factoring in dry spell conditions



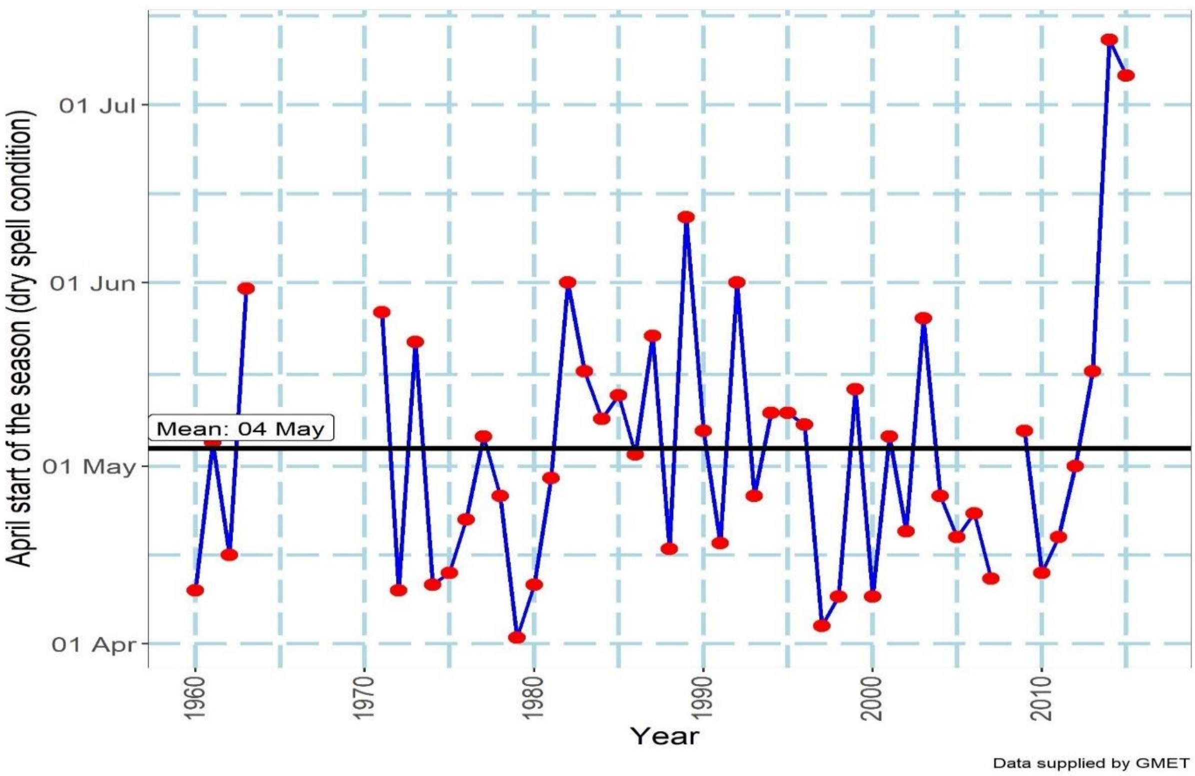
Source: Ghana Meteorological Agency (2016)

April definition with the consideration of dry spell condition

Having critically looked through the summary of the analysis, the data showed that over the 57-year period data, with 9 years recorded as missing, the start of the season occurs either within May or June. However, the start in 2014 and 2015 was recorded in July. To understand the possible problem with those two years, the researcher looked through the daily data for 2014 and 2015 (see Appendix K). The analysis showed that the rainfall data for those two years did not have any missing data for the months hence there was no issues with the data and crop cultivation could be possible in those two years as farmers could resort to early maturing varieties of crops.

The results of the start of the rains by factoring in no occurrence of dry spells showed no significance (p-value = 0.23). It was important to consider the effective definition as it eliminates pre-season shower and false start of the rainy season (Horsfield, 2016). The results indicate variability in the start date of the rainfall with the earliest recorded on 02nd April 1979 the mean start date as 4th May, and the latest recorded on 12th July 2014 as indicated in figure 4.6.

Figure 4. 6 First occasion after 01st April that records more than 20mm of rainfall with no dry spell of more than 9 days in the next 30 days



Source: Ghana Meteorological Agency (2016)

Table 4. 4 Details of the date of start of the April definition of the rainy season in Babile (1960-2016) with and without factoring in dry spell conditions

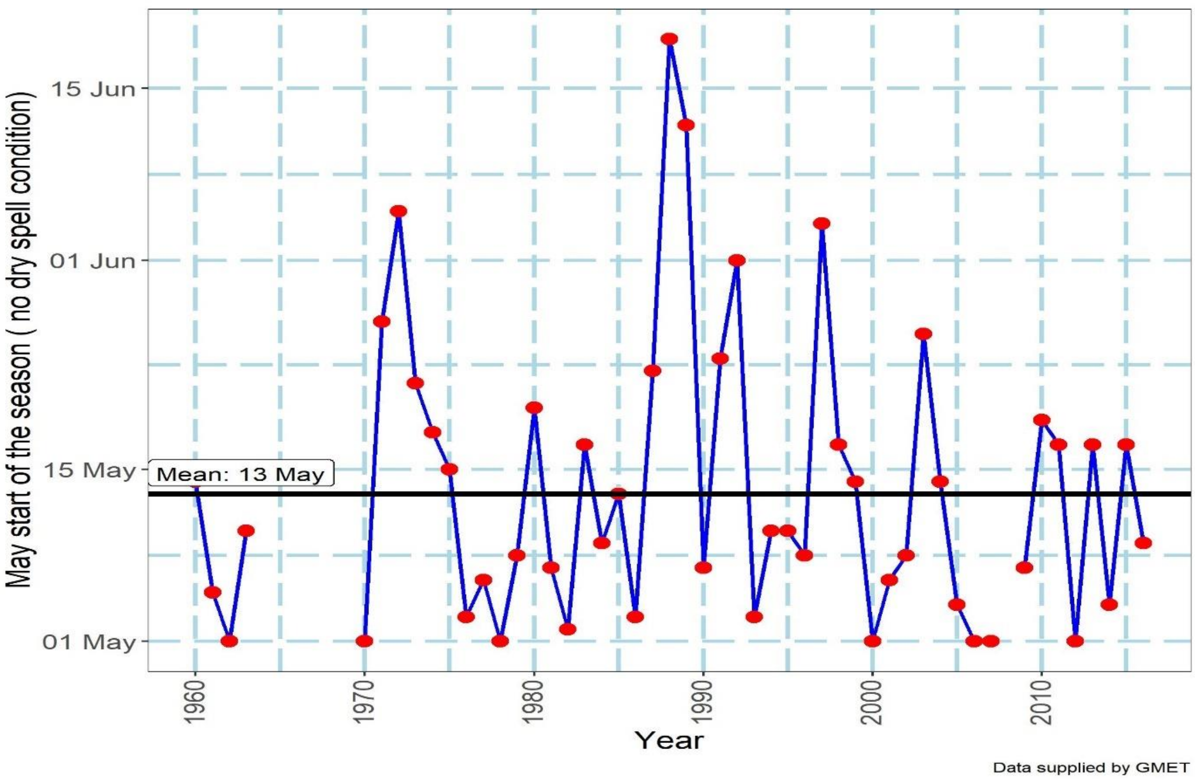
Definition	Earliest start date of the rainy season	Latest start date of the rainy season	Mean start date of the rainy season
April (no dry spell)	02nd April	27th May	21st April
April (dry spell)	02th April	12th July	04th May

Source: Ghana Meteorological Agency (2016)

May definition without considering dry spell condition

The earliest start of the rain after 01st May for the 57-year period without considering the possibility of a dry spell exceeding 9 days in the next 30 days was recorded on the 01st of May in seven years: 1962, 1970, 1978, 2000, 2006, 2007, and 2012. The latest start date was recorded on the 19th of June in 1988. Statistical test showed no significance (p-value = 0.74) but rather variability as indicated and the results in figure 4.7.

Figure 4. 7 First occasion after 01st May that records more than 20mm of rainfall without factoring in dry spell conditions



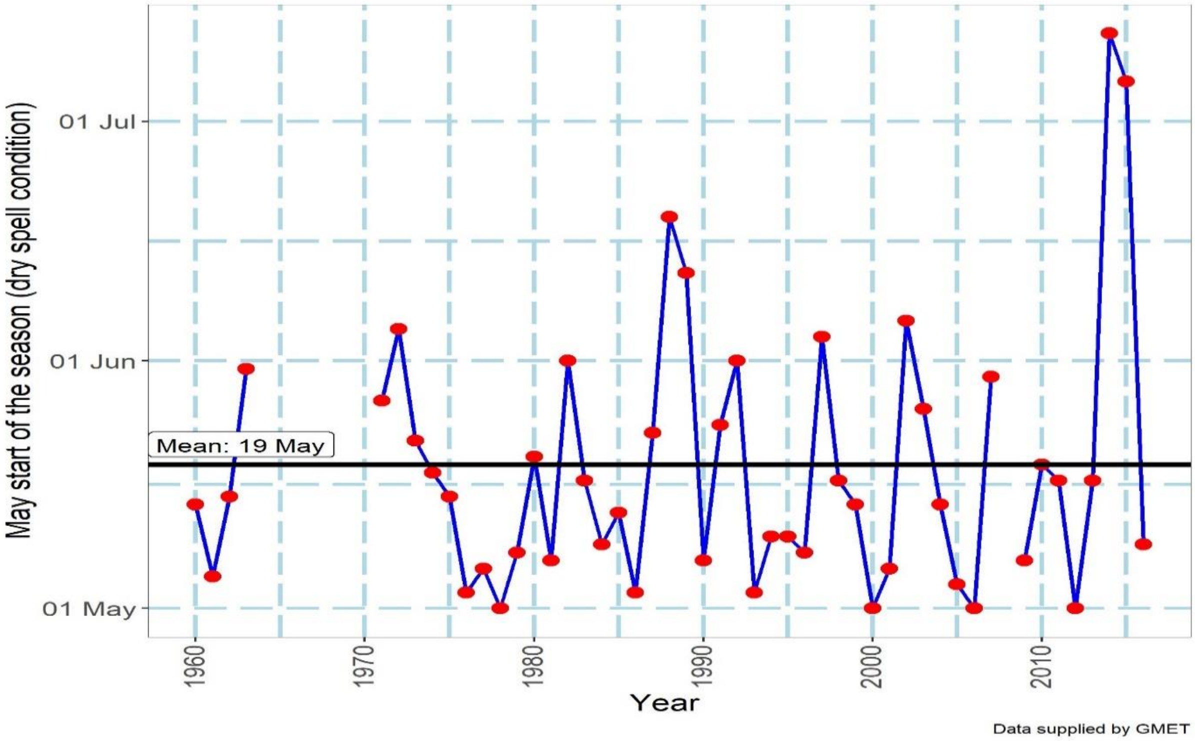
Source: Ghana Meteorological Agency (2016)

May definition with the consideration of dry spell condition

Similarly, just as in the case of the effective April definition of the start of the season, the researcher critically looked through the summary of the analysis, and the results showed that out the 57-year period data, with 9 years recorded as missing, the start of the season occurs either within May or June. However, the start in 2014 and 2015 was recorded in July. Again, a similar procedure was followed as in the April effective definition of the start of the season by looking at the daily rainfall data for 2014 and 2015 (see Appendix K).

Considering that there was no dry spell exceeding 9 days in the next 30 days after the start of the rains, the earliest state of the rain was recorded on the 1st of May in 1978, 2000, 2006, and 2012, the mean start date as 19th May, and the latest start of the rains was recorded on the 12th of July in 2014. Results from the statistical test did not show any significance (p-value= 0.33). The above indicates variability in the start of the rainy season using the May dry spell condition and one cannot say the rainy season is either starting earlier or later now than that of the past (see figure 4.8).

Figure 4. 8 First occasion after 01st May that records more than 20mm of rainfall with the consideration of dry spell conditions



Source: Ghana Meteorological Agency (2016)

Table 4. 5 Details of the date of the May definition of the start of the rainy season in Babile (1960-2016) with and without the consideration of dry spell conditions

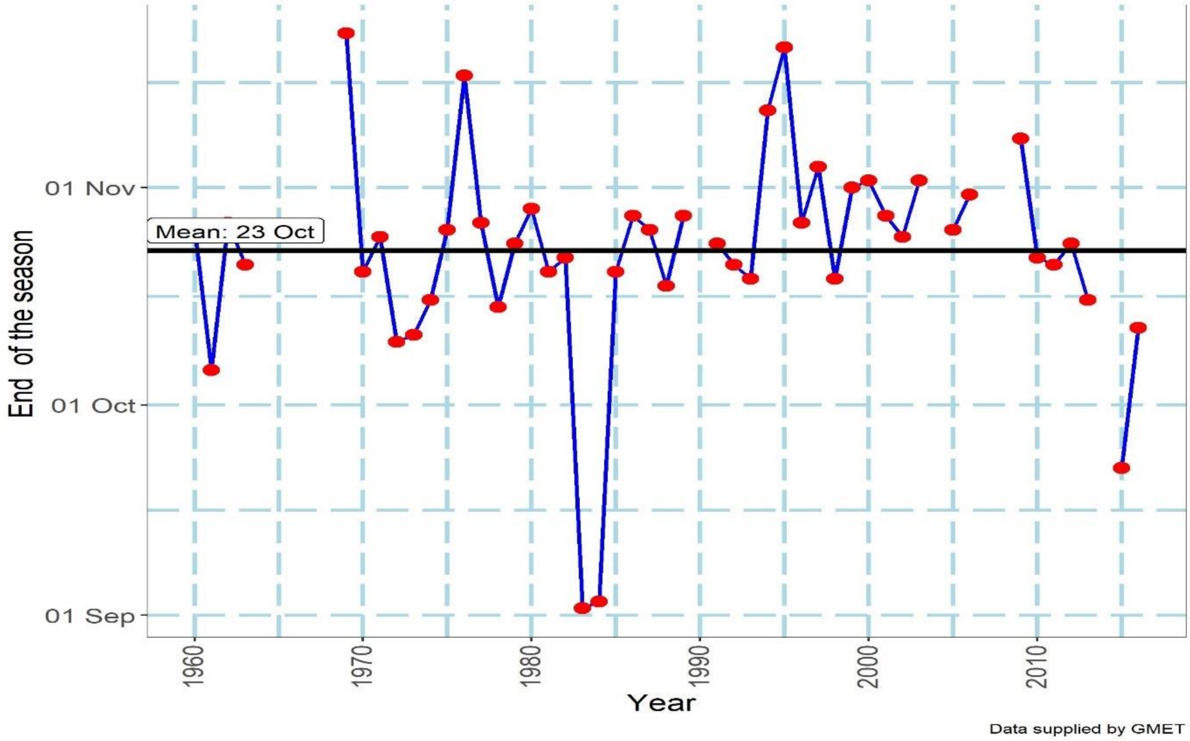
Definition	Earliest start date of the rainy season	Latest start date of the rainy season	Mean start date of the rainy season
May	01st May	19th June	13th May
May (dry spells)	01st May	12th July	19th May

Source: Ghana Meteorological Agency

The end of the rainy season

When the rainfall starts in each year is very important to farmers in the tropics particularly Sub-Saharan Africa (SSA) where agriculture is mainly rain-fed. Equally important is the end of the rainy season which determines how long or short a given agricultural season hence the decisions that farmers can make. In this study, the simple water balance equation as suggested by Stern et al. (2006) was used to define the end of the rainy season. In this definition, it is assumed that the soil capacity is 100mm, and evaporation is taken as 5mm per day. Based on these assumptions, the end of the rainy season is defined as the first occasion after the 1st of September when the water balance drops to zero. Having critically looked through the summaries of the end of the season, the results showed that for the 57-year period data with 9 years missing, the season for the 48 years either ends in October or November. However, the results indicate that the rainfall for 1983, 1984 and 2007 ended in September. The researcher had to critically look at the daily rainfall for those three years. The results indicate that the data for 1983 and 1984 are alright- however, for 2007, there was missing data for the months of October to December (see appendix L). Therefore, the researcher took the decision to eliminate the data for the year 2007. In R-Instat, descriptive summaries of statistics, and modelling were carried out to understand the nature of the end of the rainy season in the past and now. Figure 4.9 depicts no trend (p-value = 0.81) in the end of the rainy season from 1960 to 2016 but rather variability in the end with the earliest end being 02nd September 1983, the mean being 23rd October and the latest 23rd November 1969.

Figure 4. 9 The first occasion after the 1st of September when the water balance drops to zero



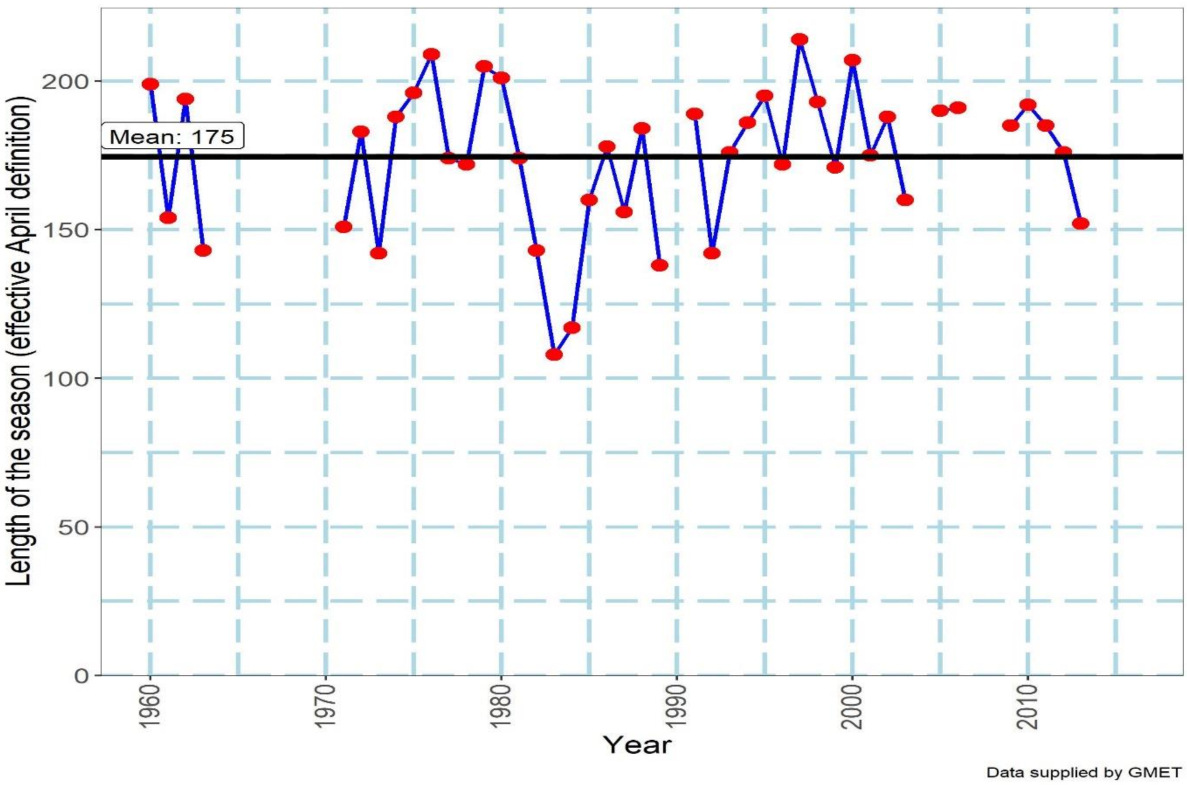
Source: Ghana Meteorological Agency (2016)

The length of the rainy season

With the start and the end of the rainy season computed, the difference between the two gives the length of the season. Here, the effective start date of the rainy season was used (i.e. with no dry spell of 9 days in the next 30 days). In R-Instat, the dialogue 'calculations' was used to compute the length of the season by subtracting the start of the rainy season from the end of the rainy season as represented in figures 4.10 and 4.11 respectively for April and May definitions. With both the April (p-value = 0.35) and May (p -value = 0.13) effective definitions, the statistical analysis showed no significance for the length of the season and years.

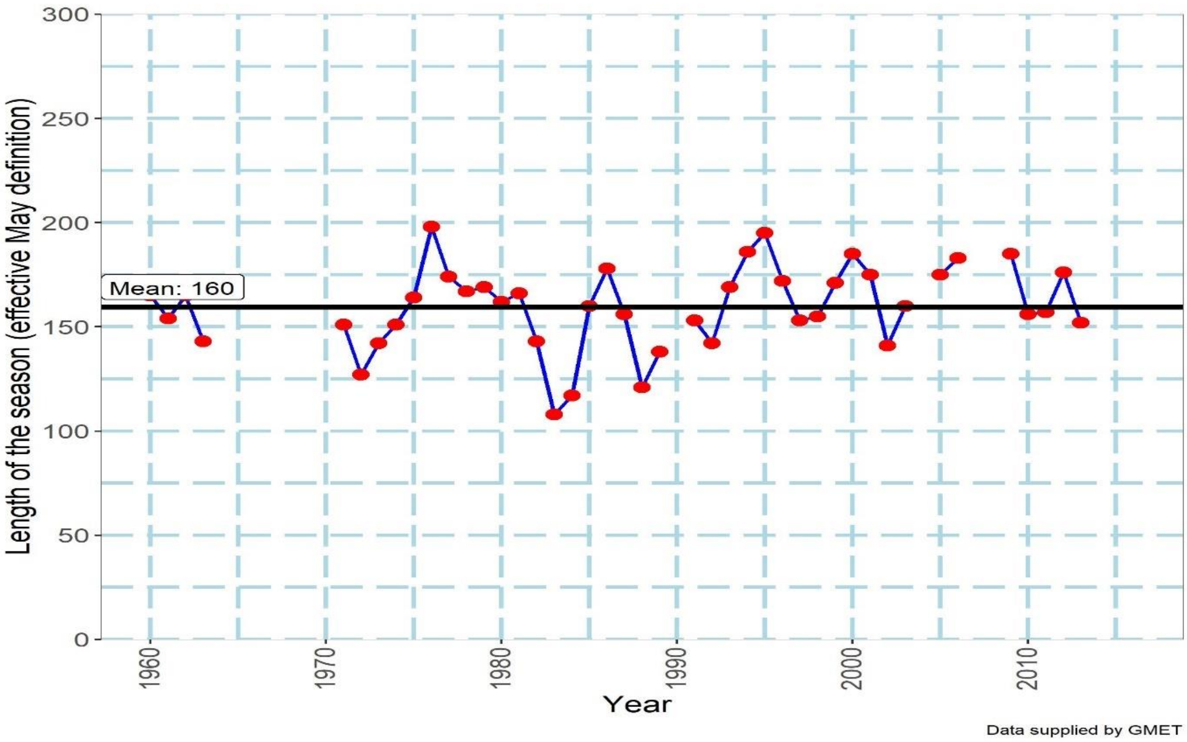
For the April effective definition of the start of the season, the shortest season (108 days) of rainfall was recorded in 1983, the longest season (214 days) was recorded in 1997, and the mean length of the season being 175 days (see figure 4.10). Similarly, for the May effective definition of the length of the season, the shortest length (108 days) was recorded in 1983, the longest (198 days) in 1976 with the mean being 160 days (see figure 4.11).

Figure 4. 10 Length of the season using effective April definition



Source: Ghana Meteorological Agency (2016)

Figure 4. 11 Length of the season using effective May definition



Source: Ghana Meteorological Agency (2016)

4.2.3 Temperature

In this section, the objective is to understand the temperature conditions in the Doggoh and Tie villages using scientific analysis of the available temperature data from the Babile weather station. Daily temperature is recommended as the best as compared to other forms for robust temperature analysis (Stern et al., 2006). However, the researcher obtained only monthly minimum and maximum temperature data from the Ghana Meteorological Agency (GMET) for the Babile Station as GMET did not have daily temperature data. Even though the value of the summaries of monthly averages of temperature data are acknowledged for example in showing seasonal patterns, one weakness of such data is that they are too long and typically out of phase with critical stages of crop development and essential field operations (Stern et al., 2006).

4.2.4 Processing temperature data

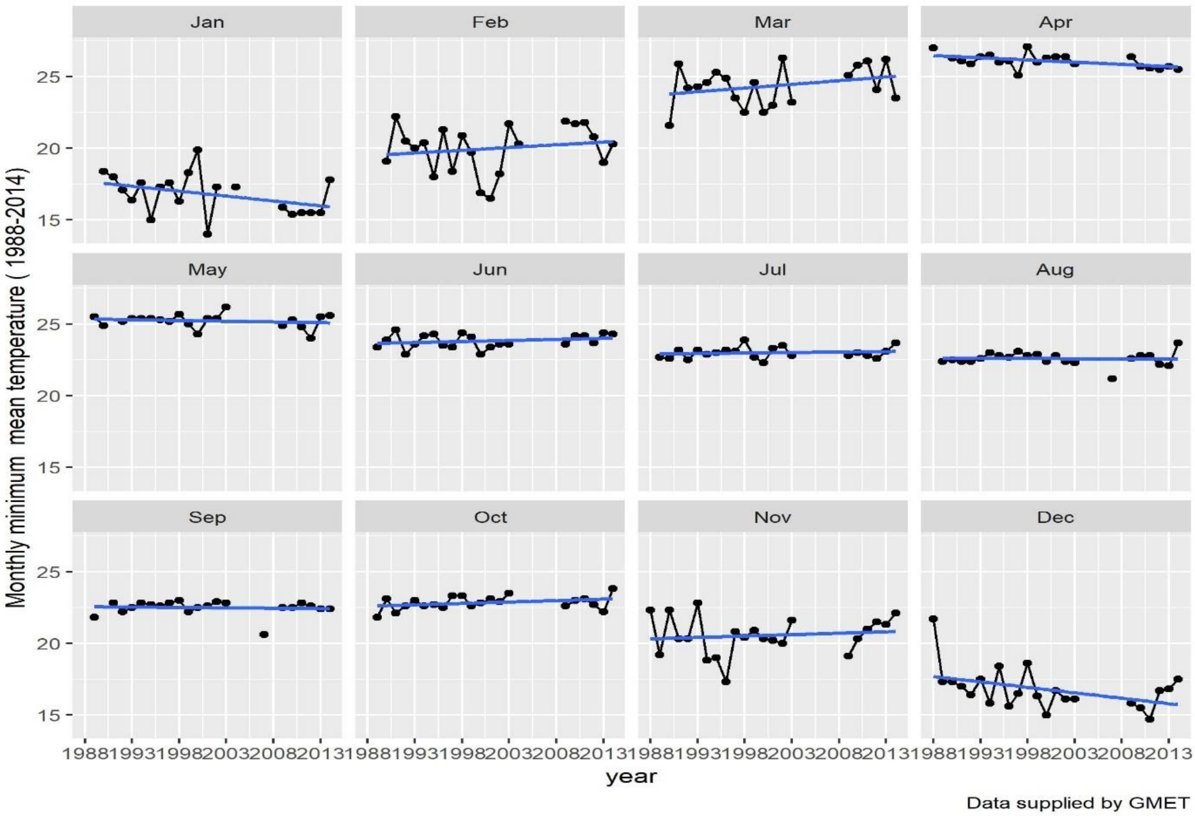
The monthly minimum and maximum temperature averages were for the period 1988 to 2014. However, having critically looked at the data, the following were observed about both the monthly minimum and maximum data: (i) there was full data for the years: 1992, 1993, 1994, 1995, 1996, 1997, 1998, 2000, 2001, 2002, 2009, 2010, 2011, 2012, 2013, and 2014 (ii) some of the monthly data were missing for the years: 1988, 1989, 1990, 1991, 2003, 2004, and 2007 (iii) there was no data for 2005, 2006, and 2008. Therefore, the analysis here, is restricted to understanding the intra-annual temperature distribution of the various years and no consideration of annual temperature distribution as any attempt to sum the monthly averages into yearly averages may not give the true reflection of the data as there are lots of data missing for some of the months and the years. Similarly, it has been documented that annual averages are irrelevant to farmers' decisions as crop physiology (e.g. flowering, pollination, grain filling) and productivity depend on seasonal maximums and minimums (Singh, 2014, Wheeler et al., 2000).

Monthly minimum and maximum mean temperature

The analysis here is only focused on understanding the nature of temperature distribution across the different months of the year. This is important because it has been documented that extremes in minimum and maximum temperatures can directly damage crops (See Singh, 2014, Horsfield, 2016). Similarly, it has been reported that, indirectly, temperature influences the rate of evapo-transpiration which trickles down to influence the amount of soil moisture for crop growth (Osbahr et al. 2011).

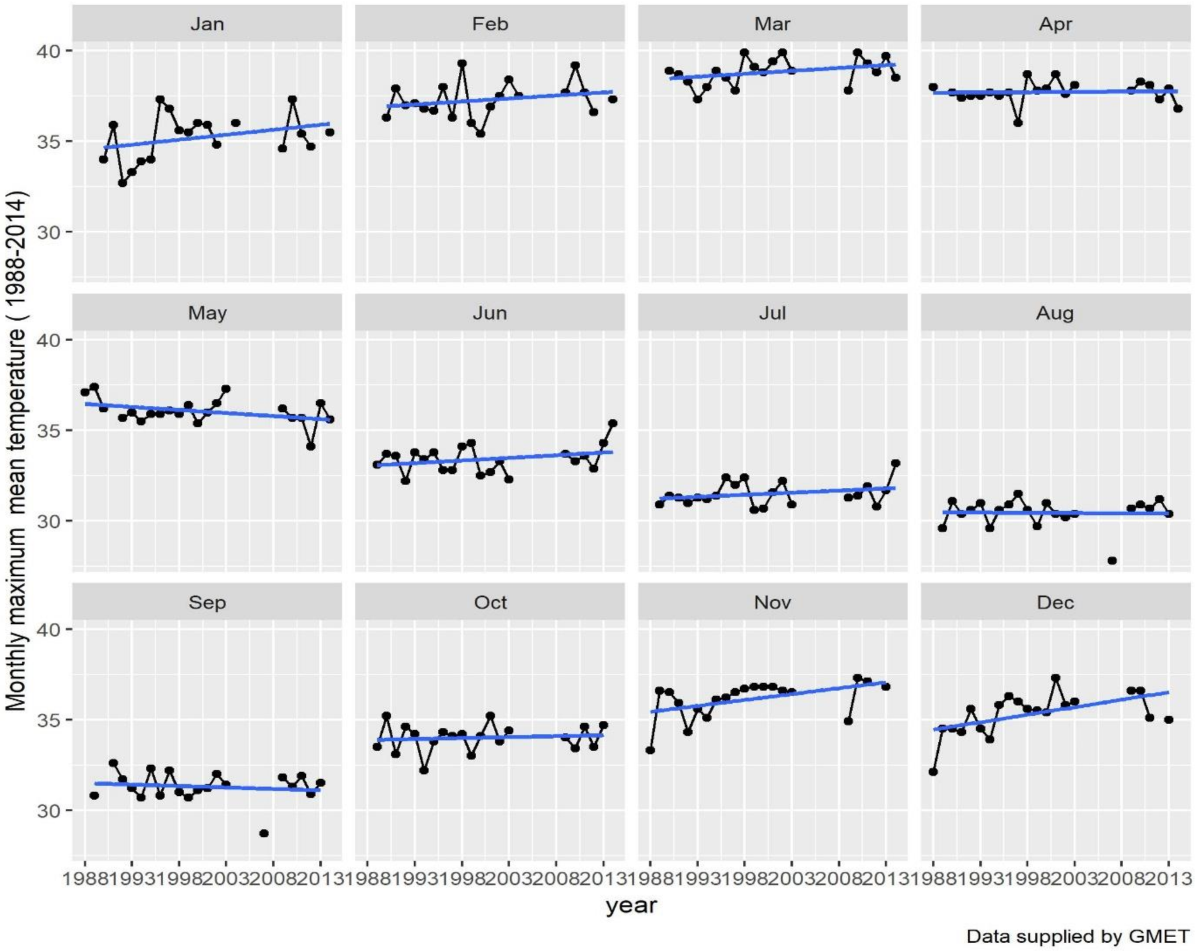
To that end, two graphs were produced using the monthly minimum and maximum temperature means. The results (see figure 4.12, and figure 4.13) indicate that both the minimum and maximum temperatures are variable with the minimum temperature showing low variability for April to October and high variability for the other months. However, what stands out clearly with figure 4.13 is low temperature for the months of August and September and this aligns with the peak period of the seasonal rainfall as depicted in figure 4. 3. This suggests that the months of August and September are wet periods for farmers in and around the Babile area.

Figure 4. 12 Distribution of monthly minimum mean temperature (1988-2014)



Source: Ghana Meteorological Agency (2016)

Figure 4. 13 Distribution of maximum monthly mean temperature (1988-2014)



Source: Ghana Meteorological Agency (2016)

4.2.5 Summary of climate data analysis

Finding 1: High variability of inter-annual and intra-annual rainfall

The results showed no trend in either the rainfall decreasing or increasing from 1960-2016 but rather high inter-annual and intra-annual rainfall distribution (see section 4.2.1). Statistically, the results showed no significance between total annual rainfall and years, and rainfall and months.

Finding 2: Variability in start and late dates of rainfall, and length of season

The statistical analysis showed no significance in the start, end and length of the season from 1960-2016 but rather high variability (see section 4.2.1).

Finding 3: Increasing temperatures

The results reveal an increasing trend of monthly maximum temperature.

4.3 Farmer Perceptions of Climatic Events

Having looked at the scientific version of changes in climatic events in section 4.2, the next step is to explore how farmers interpret these patterns, through their own memory, experience, the information they receive from experts, as well as the influence of their local cultural worldviews and values. The section teases out how these perceptions are differentiated by location, and social factors such as age, wealth, gender, and wealth status. This allows the study to draw insights on implications for farming decisions, particularly for adaptation in food crops. Understanding farmer perceptions of climate variability and change (CVC) has been documented to have diverse policy relevance including: (i) to understand farmers' behaviour about adjustments they (will) make in their farming practices in order to respond to climate change consequences (Maddison, 2007, Nguyen et al., 2016, Tambo and Abdoulaye, 2012), (ii) to understand how perception influences farmers willingness to adopt adaptation practices is critical for the development of effective and efficient climate response strategies (Habiba et al., 2012, Li et al., 2017, Nguyen et al., 2016), and (iii) understanding of farmers' knowledge of risk perceptions can enable policy makers and outreach professionals to target information or to 'de-bias' incorrect subjective beliefs (Arbuckle Jr et al., 2013, Dohmen et al., 2009, Patt and Schroter, 2008).

To achieve the objective of this section, the scope is limited to understanding farmer perceptions of climate variability and change using rainfall and temperature parameters. The researcher relied on data from quantitative, and qualitative data that were elicited from the field. The details of each of the data elicitation tools are discussed in the following sub-sections.

4.3.1 Farmer perceptions of rainfall

In this section, the researcher employed data from the village key informant interviews, the semi-structured questionnaire, the focus groups, and the household case studies. In the data elicitation stage, the respondents were asked about their perceptions of 'the onset, cessation, and duration of rainfall in the past[33], and now'. The data from the above research tools showed that the rainfall pattern in the past (i.e. 20-25 years ago) and now (i.e. 2016) are not the same for both the villages of Doggoh, and Tie. Respondents indicated rainfall changes were associated with the onset, and cessation of rainfall, the duration of the rainfall, as well as the rainfall amounts. The detailed results for the different villages are discussed below.

[33] Past in the context of this thesis refers to 25-30 years from 2016 when the fieldwork took place

Doggoh Village

In the semi-structured questionnaire, the researcher asked the respondents relevant questions like *'in which month did the rainfall start?', 'in which month does the rainfall start now?'.* Similarly, questions were posed on the cessation month of rainfall in the past and now. The objective was to understand how farmers recall rainfall events in the past and now as the literature suggests memory as one of the factors that shape farmer perceptions of climate variability and change (CVC) (Taylor et al., 2016).

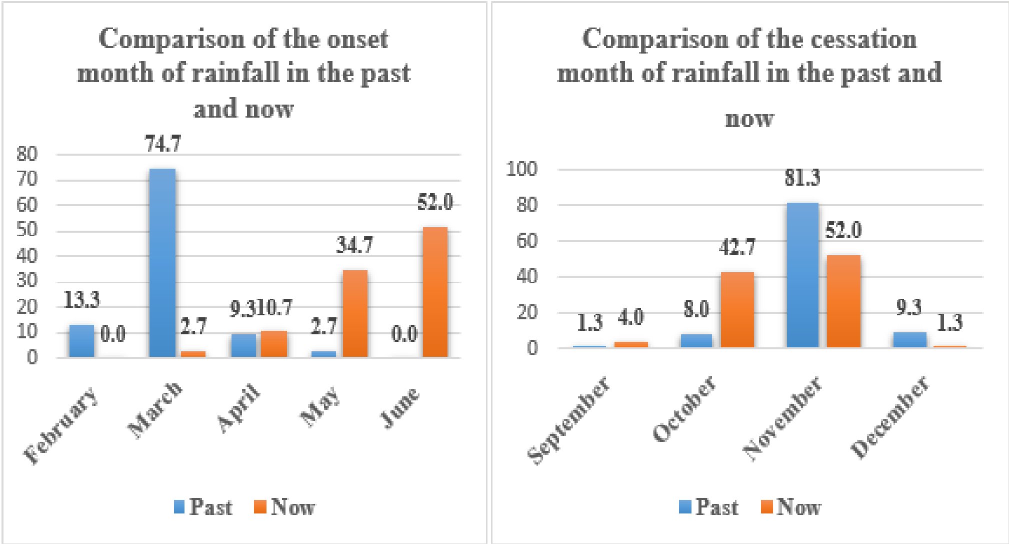
Drawing on data from the semi-structured questionnaire, the results showed that farmers perceive that the onset of the rainy season has shifted from March to June. In a study in the Afram plains of the Eastern region of Ghana, Codjoe and Owusu (2011) similarly found that farmers' have perceived a shift in the rainy season from February to March.[34] Similarly, the results indicated that there has been a perceived shift in the cessation of rainfall from November to October [35]. This finding is similarly reported by Amadou et al. (2015) in their study that focused on the Upper East Region of Ghana. Statistically, 98.7%, 98.7%, and 100 % of the surveyed respondents observed late onset of the rainy season, early cessation of the rain, and that the duration of the rainfall in the past was longer than that of now respectively. The descriptive data here are complemented by data from the qualitative interviews (see table 4.6).

---

[34] See figure 4.14

[35] See figure 4.14

Figure 4. 14 Percentage distribution of farmers' perceptions of the onset and cessation months of rainfall in the past and now in Doggoh village (N=75)



Source: Semi-structured Questionnaire (Doggoh village, 2016)

Table 4. 6 Farmer illustrations of the onset month of rainfall in the past and now (Doggoh village)

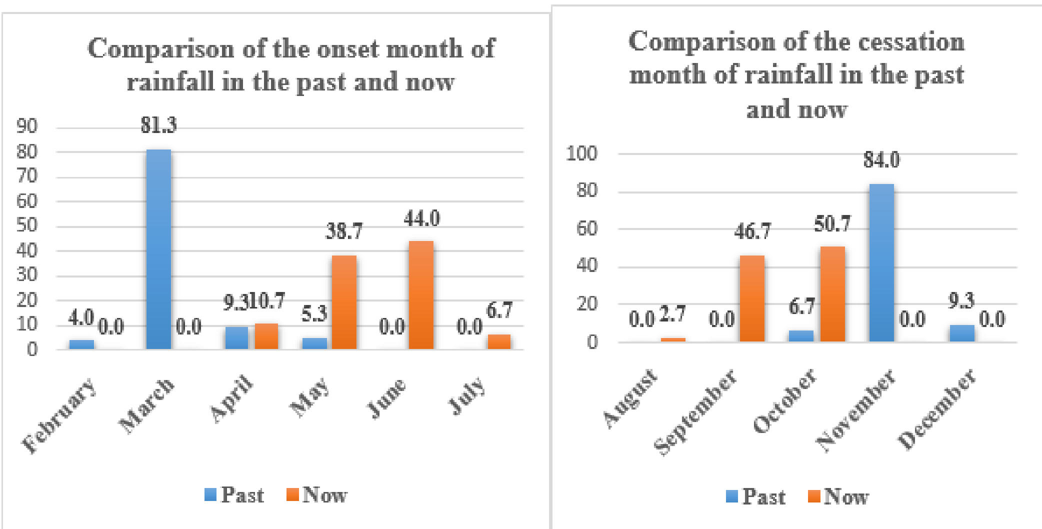
Onset month (past)	Farmer quotes
February	"There used to be rainfall around the 20th of February, then we will raise our yam mounds and then prepare the farm fields in the bush but now, it is no longer the same…" (HCS-5-D-Male) "There used to be a first rain in February and people could raise their yam mounds during that period" (HCS-15-D-Male)
March	"In the past, it used to start raining in March" (HCS-3-D-Male) "those days, there used to be *valungvuulongsaa* in February and everyone will prepare the farm fields for yam mound raising and then in March, it would rain heavily for us to raise our yam mounds" (HCS-4-D-Male) "March…it used to rain in the third month of the year" (HCS-4-D-Male) "I think in the past, the rain used to start in the 3rd month of the year when we would r4aise yam mounds and begin to plough the farm fields in the bush" (HCS-6-D-Male)
April	"Okay, in many cases it used to start raining in the month of April" (HCS-12-D-Male)
May	
Onset month (Now)	**Farmer quotes**
March	"well, it rains sometimes in March, but many people still do not plough their farm fields in that month but wait to do so" (HCS-15-D-Male).
April	"For now, in April ...but sometimes it rains only once around the ending of April" (HCS-4-D-Male) "For now, usually it attempts to rain in April, but the amount is usually not encouraging" (HCS-5-D-Male)
May	"Now it starts in the fourth month. But when it starts in the fourth month, it will not rain consistently as it used to do in the olden days" (HCS-9-D-Male) "If you check, it can rain in the fourth month here for us to farm the yams, but if you are not lucky, it will get to a time that you will not like to go to the yams farm. You will see that it will suffer from the drought to the extent that the yams are almost dying before it rains again. For rain to start raining consistently, it is in the fifth month" (HCS-9-D-Male)
June	"okay, for now, we have the first rain in June then people begin to raise their yam mounds" (HCS-7-D-Male) "The rainfall now starts in either June and sometimes latest by July" (HCS-14-D-Male)

Source: Household Case Studies (Doggoh village, 2016)

Tie village

Similarly, to understand farmers' perception of rainfall in the past and now, the researcher had to draw on both data from the semi-structured questionnaire, and household case studies. The results **(**see figure 4.15) indicate that the onset of the rainfall has shifted from March to June as opined by the majority of the surveyed respondents. Also, the data reveal that there has been a shift in the cessation of the rainfall from November to October. The shift in the onset of the rainy season are similarly reported in the literature. For example, Osbahr et al. (2011) in their study in Southwest Uganda reported a shift in the first and second rainy seasons. To Osbahr and others, the onset and the cessation of the first rainy season have shifted from February to March, and April to May respectively. They also reported a shift in the second season starting in September instead of August and ceasing in November instead of November.

Figure 4. 15 Percentage distribution of farmers' perceptions of the onset and cessation months of rainfall in the past and now in Tie village (N=75)



Source: Semi-structured Questionnaire (Tie village, 2016)

Table 4. 7 Farmer illustrations of the onset month of rainfall in the past and now (Tie village)

Onset month (past)	***Farmer Quotes***
February	In the past, the rainfall used to start in February, then in March, our fathers would raise their yam mounds but now it is no longer like that …" (HCS-6-T-Male)
March	"… it used to start raining three months after Christmas- the first rain known as sassaba. Within that period, yam mounds used to be raised and the yam would mature so well" (HCS-7-T Female) "You see, those days, it used to start raining three months after Christmas and we would raise our yam mounds" (HCS-11-T-Female) "Those days, it used to rain in the third month after Christmas- those that travelled down south had to return in March to farm" (HCS-13-T-Male) "You see, it used to start raining by exactly the beginning of March. You see, those days, anyone that migrated to the southern part of Ghana had to be back by March. We used to raise our yam mounds in March then in April, we started ploughing the farm fields for other crops" (HCS-13-T-Male)
April	*" You see, those days it used to start raining around the third month of the year and we will begin to clear our farmlands" (HCS-3-T-Female)*
May	*" okay ...i think it used to rain in May…then we will till the bush farms first then come home to plough the farms around the compound" (HCS-14-T-Male)*
Onset month (now)	***Farmer Quotes***
April	"Hmm, for now, it rains sometimes in April for our husbands to raise their yam mounds" (HCS-3-T-Female) They used to raise yam mounds and roam for some time before ploughing the other farm fields but now as soon as the raising of yams is over, they get straight into ploughing the other farm fields- it rains in April now" (HCS-6-T-Male) "Now, it starts in the April but sometimes it gets better in May" (HCS-14-T-Male)
May	- "...the onset month of the rainfall? Now, it rains in the fifth month of the year" (HCS-1-T-Male) - "…but now, it begins to rain in the 4th month after Christmas. If you do not apply animal waste to the yam, they will not do well" (HCS-7-T-Female) - But now, it begins to rain in the 5th month after Christmas" (HCS-11-TFemale)
June	- *"Now, it is the sixth month of the year that it begins to rain- well, there are always some attempts in May, but it begins well in the sixth month" (HCS-12-T-Male)*
July	*"hmmmm, now the rain sometimes come around July" (HCS-1-T-Male)*

Source : Qualitative interviews (Tie village, 2016)

Table 4. 8 Farmer illustrations of the cessation month of rainfall in the past and now (Tie village)

Cessation month (past)	***Farmer Quotes***
October	*"I can remember we still used to have good rain until October ending then it would cease" (HCS-15-T-Male)*
November	*"It used to rain up to the 11th month of the year before ceasing…" (HCS-6T-Male)* *"Okay, those days, it used to rain until September, when we used to harvest the dagarasinkaa then it would continue till November when we harvested bambara groundnuts in November and it still continued to rain until the middle of November" (HCS-7-T-Female)*
December	"You see, it used to rain until the 12th month of the year, then it would stop raining" (HCS-1-T-Male) "It used till the end of December- there were instances the rain had to destroy the harvested sorghum that needed sunshine to get dried" (HCS-13-T-Male)
Cessation month (now)	*Farmer Quotes*
August	*"The rainfall now hmmn…it is hard to tell, but by the middle of the 8th month of the year, it ceases and the whole place becomes dry" (HCS-11-T-Female)*
September	*"Now, if you do not cultivate the kyaana variety of groundnut, then by September when it ceases, you should be prepared to use a hoe to knock the ground to harvest it" (HCS-10-T-Female)*
October	*"Now, it is no longer regular as that of the past- by October, it ceases, and we leave all the livestock to graze around freely" (HCS-9-T-Male)*

Source : Qualitative interviews (Tie village, 2016)

4.3.2 Farmer perceptions of temperature, and extreme climate events

Farmer perceptions of temperature

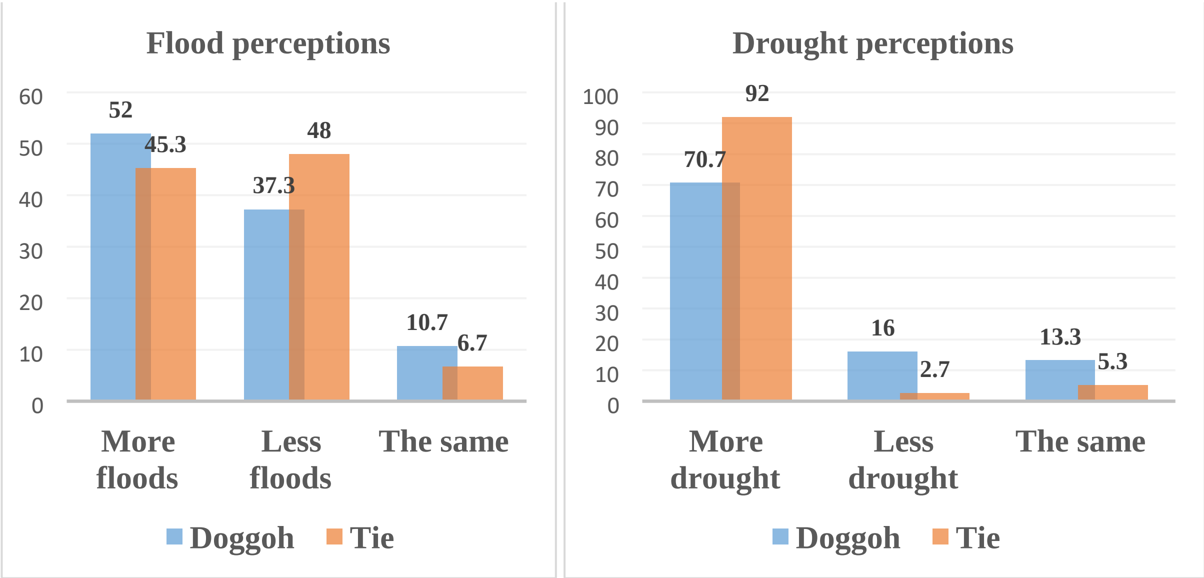
On the parameter of temperature, respondents in both the villages of Doggoh and Tie were asked about their judgements of the nature of temperature in the past and now. In both villages, all respondents surveyed (i.e. 100%) recognised that temperature is now warmer than that of the past. The results are similarly reported by (Codjoe and Owusu, 2011) in their study in the Afram Plains of the eastern region of Ghana.

Farmer perceptions of drought, and floods

Hassan and Stern (1988) recognise the vital role of adequate availability of rainfall in crop establishment and growth. However, rainfall amounts in the extreme; either very high or very low has the potential of affecting agricultural activities. For example, torrential rainfall has the potential of inundating farmlands that can eventually lead to flooding and crops can be carried away. Similarly, less rainfall can mean that soil moisture content can be reduced, and crops would wither hence would produce poor yield.

The majority of the respondents; 70.7% and 92.0% respectively in Doggoh and Tie believed that there is more drought now more than that of the past. Unlike drought that the majority of the surveyed respondents in the two villages recognised are on the increase now than the past, for floods, majority of the respondents in Doggoh and Tie perceived that differently. Whereas 52% representing the majority in Doggoh opined that floods have increased in recent times, majority in Tie (48%) noticed that there are less floods now as compared to that of the past as indicated in figure 4.16.

Figure 4. 16 Percentage distribution of farmers' perceptions of flood and drought conditions in Doggoh and Tie villages (N= 75 in each village)



Source : Semi-structured Questionnaire (Doggoh and Tie villages, 2016)

4.3.3 Summary of farmer perceptions of climate

Finding 1: late onset and early cessation of rainfall

The respondents in the villages of Doggoh and Tie shared similar perceptions of rainfall. They agreed there has been a shift in the onset of the rainfall from March to June, and the cessation of the rainfall from November to October.

Finding 2: Increased in number of warmer and days and warmer nights

The respondents similarly agreed that the climate now is warmer than of the past, and that there are more droughts now that of the past.

Finding 3: More drought now than that of the past

The farmers in both the villages of Doggoh and Tie agreed that the droughts have been on the ascendancy. However, they disagreed on the aspect of floods. Whereas the respondents in the village of Doggoh opined that floods are on the ascendancy, their counterparts in the village of Tie observed that floods are decreasing.

4.4 Who Perceives what about Climate Variability and Change?

The literature suggests that understanding how different farmer groups perceive climate variability and change is vital in understanding the current choices and attitudes of adaptation for supporting the development of appropriate adaptation strategies (Nguyen et al., 2016). However, as reviewed in section 2.2.2, little is understood on how perception of climate variability is differentiated by social groups. Therefore, this section contributes to the discourse on perceptions by extending beyond 'mere' description of perceptions of CVC and comparing farmer perceptions with analyses of climate data to tease out how CVC is perceived by different farmer groups.

It is noteworthy that, the scope of this section is limited to rainfall parameters as the results in section 4.3.2 show no perception differentials among the different social groups on the aspect of temperature. The first section has results that compares how the farmers in the villages of Doggoh and Tie perceive CVC teasing out the similarities and the differences. The second section deals with understanding how the different social groups interviewed (distinguished by sex, age, educational attainment, and wealth status) perceive CVC.

4.4.1 Spatial differentiation

The results revealed that respondents in the villages of Doggoh and Tie similarly observed the following: (i) that the onset, and the cessation of the rainfall has shifted from March to June, and November to October respectively (section 4.3.1), (ii) the weather is now warmer as compared to that of the past (section 4.3.2), and (iii) there are more droughts now than that of the past (section 4.3.2). However, there are perception differentials in terms of the flood conditions now as compared to that of the past.

Also, there are differences in terms of the proportion of respondents that perceived the onset timing of rainfall onset and cessation now and the past, as well as the duration of rainfall between, the villages of Doggoh and Tie.[36]

Table 4. 9 Illustrations of inter-spatial differentiation of farmer perceptions of CVC

Climatic event	Doggoh	Tie
Onset timing of rainy season	Many of the surveyed respondents (i.e. 98.7%) opined that the onset of the rainfall now starts later than that of the past	All the respondents (100%) opined that the onset of rainfall starts later now as compared to that of the past
Cessation of rainfall	Most of the surveyed respondents (i.e. 98.7%) opine that the rainfall ceases earlier now as compared to that of the past	All the respondents in the village of Tie (100%) opined that the onset of rainfall starts later now as compared to that of the past
Duration of rainfall	All the surveyed respondents (100%) observed that the duration of rainfall in the past was longer than now	The majority (96.0%) of the surveyed believed the rainfall in the past was longer than now
Flood conditions	Many of the surveyed respondents (52.0%) opine that there are more flood conditions now as compared to the past	Many of the surveyed respondents (48.0%) observe that there are less floods now than that of the past

Source: Fieldwork, Semi-structured Questionnaire (Doggoh and Tie, 2016)

4.4.2 Social differentiation

Moving beyond inter-spatial perception differentials, this section is tailored to understanding how different farmer groups in the villages of Doggoh, and Tie perceive climate variability and change. As argued in section 2.2.2, little is understood about how different social groups perceive climate variability and change. Therefore, this section seeks to bridge that gap. To achieve that objective, the researcher analysed data from questions that were posed to respondents in the study to understand how farmers recall the onset and cessation months of rainfall in the past and now. The semi-structured data were analysed using simple cross tabulations. The results are separately presented for the villages of Doggoh, and Tie.

[36] The details are illustrated in table 4.9.

The results in section 4.3.1 show subjectivity in farmers' memory of the onset and cessation of rainfall now, and that of the past. It is therefore necessary to tease out who perceives what about farmer climate variability, and change - the analysis here has been restricted to understanding what proportion of the different farmer groups (e.g. male versus females, educated versus uneducated, and so forth) who perceived that the rainfall started earlier (i.e. March) and ceased later (i.e. November) in the past, and now starts late (i.e. June) and ceases later in October. The reason being that those were the responses from the majority of the surveyed respondents in both research villages. Similarly, a table showing the full cross-tabulation showing all the months on farmers' perception of the onset and cessation of rainfall in the past and now has been done and attached as appendix "J".

Doggoh village

The results (see figure 4.14) suggests that farmers recalled February, March, April and May as the onset month of rainfall in the past, and March, April, May, June, and July as the onset months of the rainfall now. Similarly, the results from the semi-structured questionnaire indicate that farmers observed September, October, November and December as the cessation months of rainfall in the past; and August, September, October, and November as the cessation months of rainfall now[37]. This results clearly showed that different farmers have different memory of the onset, and cessations times of rainfall in the past, and now[38]. Therefore, to have a nuanced understanding of the characteristics of who perceives what about rainfall, a cross tabulation was carried out using the questions: *'when did the rainy season start in the past', 'in which month does the rainfall start now',*

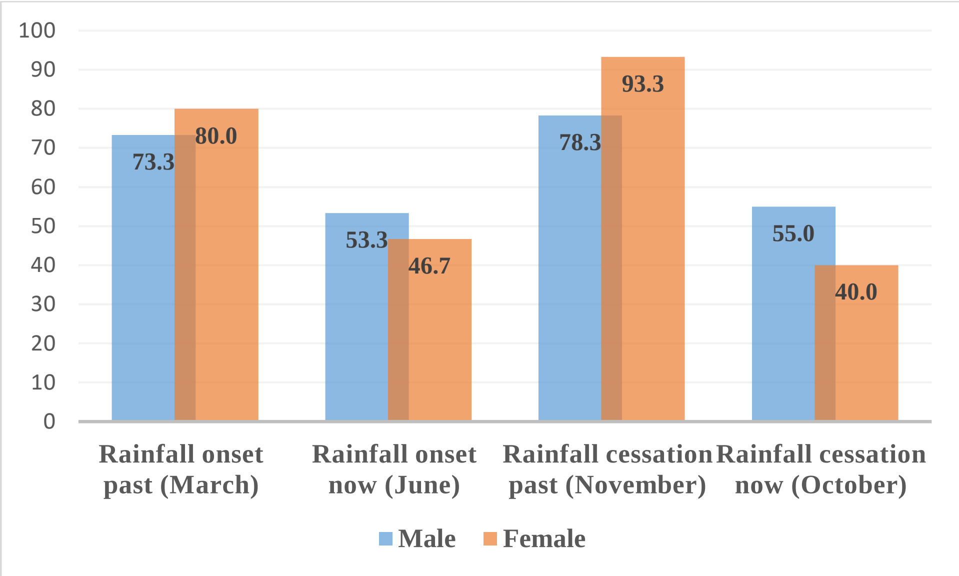
[37] See figure 4.14
[38] see section 4.3.1

'when did the rainfall cease in the past', and 'in which month does the rainfall cease now' against the variables: sex, age, wealth status, and level of educational attainment.

Sex, and perceptions differentials

The results (see figure 4.17) showed that more female headed households perceived that the rainfall started earlier and ceased later in the past than their male counterparts. However, the results pointed that more males than females observed the rainfall starts later and ceases earlier now than the past. Statistically, the data revealed the following: (i) more female headed households (80.0%) than the male headed households (73.3%) perceive that the rainfall used to start earlier in March in the past, (ii) more males (53.3%) than females (46.7%) are of the view that the rainfall starts later now in June, (iii) more females (93.3%) than males (78.3%) observe that the rainfall ceased later in the past, (iv) more males (55.0%) than females (40.0%) observe that the rainfall ceases earlier now.

Figure 4. 17 Percentage comparison of farmers' perceptions of climate variability and change in the past and now by sex in Doggoh village (Males = 60, Females =15)



Source: Fieldwork (Semi-structured questionnaire, Doggoh village, 2016)

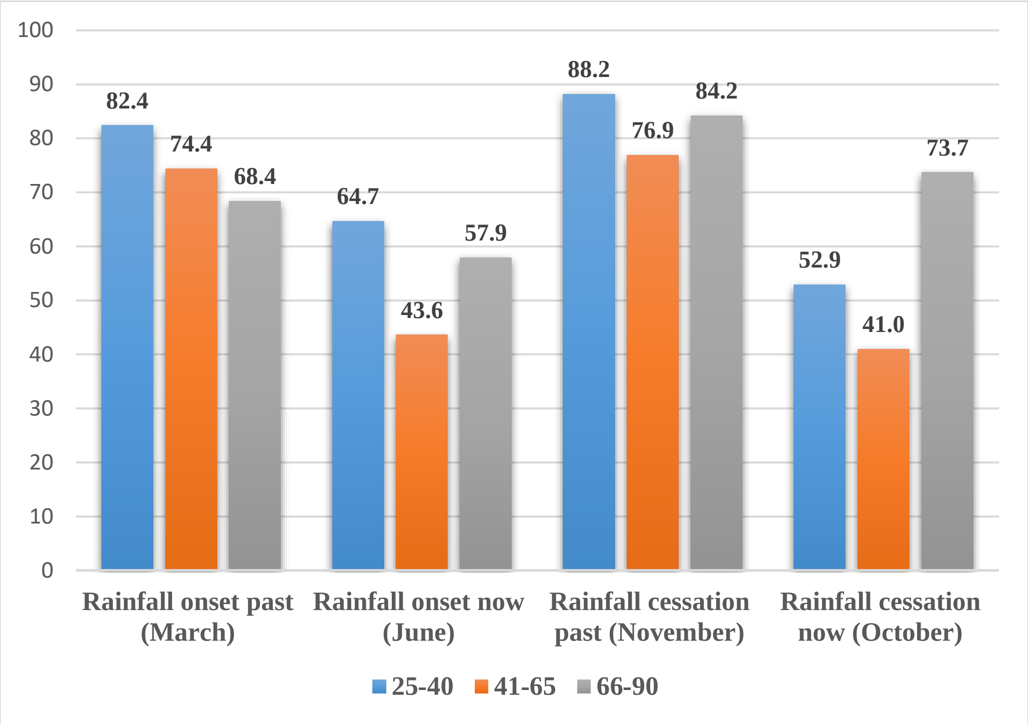
Age and perception differentials

Here, the results did not show a clear connection with age and farmer perceptions of climate variability and change. The following were specifically pointed out in the results[39]: (i) more young farmers (82.4%) than the middle age farmers (74.4%), and old farmers (68.4%) observe the rainfall used to start in March in the past, (ii) more young farmers (64.7%) than the old farmers (57.9%), and the middle age farmers (43.6%) observe the onset of the rainfall has shifted from March to June now, (iii) more young farmers (88.2%) than the old farmers (84.2%), and middle age farmers (76.9%) observe the rainfall used to cease later in November, and (iv) more older farmers (73.7%) than the young farmers (52.9%), and middle age farmers (41.0%) observe a shift in the cessation of rainfall from November to October.

[39] See figure 4.18

The results in this study suggests that other factors beyond farmer experience (for example information farmers get from climate experts in their area informing them about differences in the past and current climate) could shape farmers' perception of climate.

Figure 4. 18 Percentage comparison of farmers' perceptions of climate variability and change in the past and now by age in Doggoh village (25-40 = 17, 41-65 =39, 66-95=19)

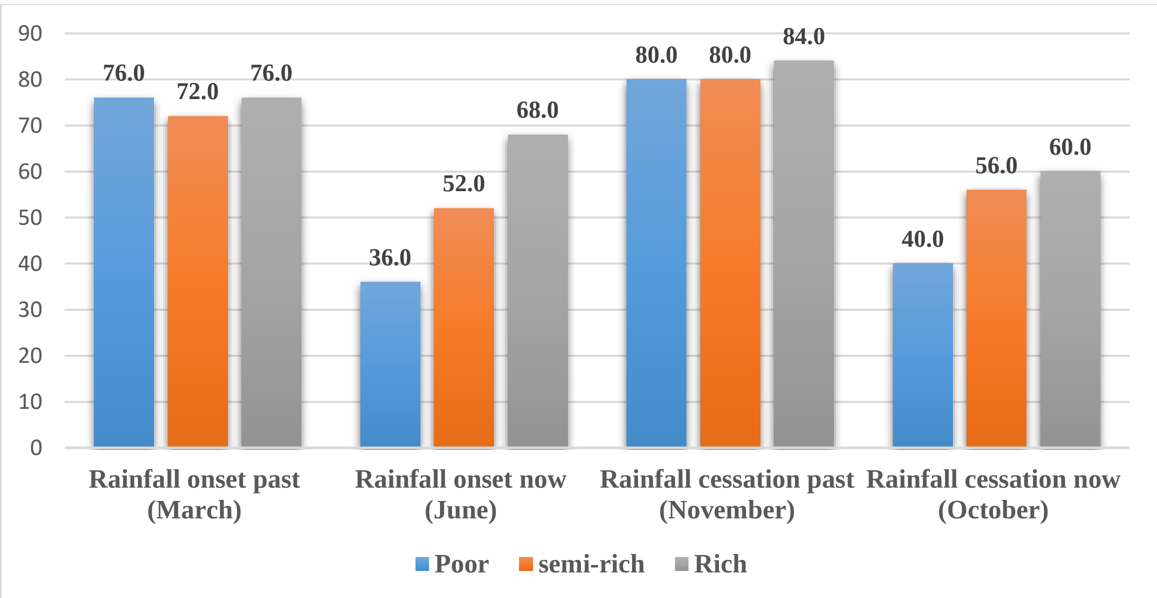


Source: Fieldwork (Semi-structured questionnaire, Doggoh village, 2016)

Wealth status

On the connection between wealth status and perceptions of CVC, the following were the observations: (i) more rich farmers (76.0%) and poor farmers (76.0%) than the semi-rich (72.0%) observe that the rainfall used to commence earlier in March in the past, (ii) more rich farmers (68.0%), than semi-rich (52.0%), and poor farmers (36.0%) observe a shift in the start from the rainfall from March to June, (iii) more rich farmers (84.0%) , than the same proportion (i.e. 80.0%) of semi-rich, and poor farmers perceive late cessation of rainfall in the past , and (iv) more rich farmers (60.0%) than semi-rich (56.0%), and poor farmers (40.0%) perceived that there has been a shift in the cessation of rainfall from November to October[40]. The above finding could be explained by the fact the wealthier farmers have the economic capacity to procure radio and television sets hence receive more climate information than the poorer farmers.

Figure 4. 19 Percentage comparison of farmers' perceptions of climate variability and change in the past and now by wealth in Doggoh village (Poor = 25, Semi-rich =25, Rich=25)



Source: Fieldwork (Semi-structured questionnaire, Doggoh village, 2016)

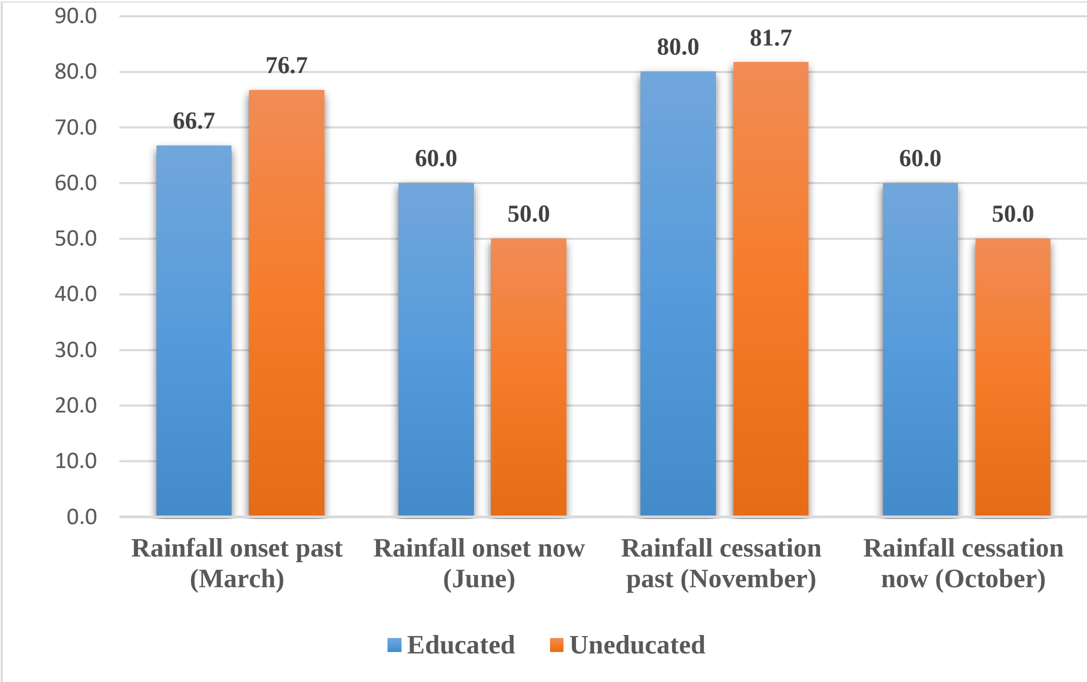
[40] See figure 4.19

Educational attainment

With regards to farmers' education and perception of climate variability and change, the following were the observation teased from the data: (i) more farmers with no education (76.7%) than the educated farmers (66.7%) perceived that rainfall used to start earlier in the past (i.e. in the month of March), (ii) however, more farmers with education (60.0%) than those with no education (50.0%) perceive that rainfall starts later now (i.e. in June), (iii) more uneducated farmers (81.7%) than the educated (80.0%) perceived that the rainfall used to cease in November, and (iv) more educated farmers (60.0%) than farmers the uneducated farmers (50.0%) perceived that the cessation of rainfall has shifted from November to October [41] .

[41] See figure 4.20 for details

Figure 4. 20 Percentage comparison of farmers' perceptions of climate variability and change in the past and now by education in Doggoh village (Educated = 15, Uneducated= 60)



Source: Fieldwork (Semi-structured questionnaire, Doggoh village, 2016)

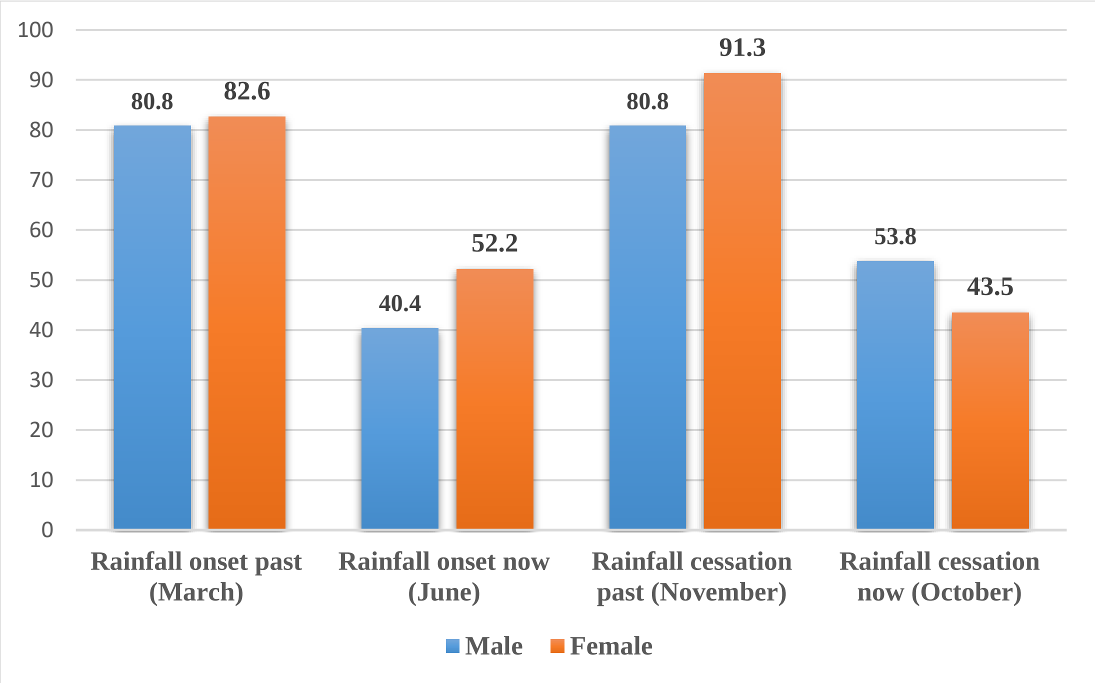
Tie village

For the village of Tie too, a cross-tabulation analysis was carried out using the questions: *'when did the rainy start in the past', 'in which month does the rainfall start now', 'when did the rainfall cease in the past', and 'in which month does the rainfall cease now'* against the variables: sex, age, wealth status, and level of educational attainment. A similar approach as applied in the village of Doggoh was used for the interpretation of the results of the cross tabulation focusing on the proportion of the various farmer groups out of the total sample of each farmer group that perceived that the rainfall started earlier in the past (i.e. March) and later now (i.e. June), and the rainfall ceased later in the past (i.e. November) than now (i.e. October).

Sex differentials

On the aspect of sex and farmer perceptions of climate variability and change, the following were the analysis from the data: (i) more female farmers (82.6%) than male farmers (80.8%) perceived the rainfall started earlier in the past (i.e. in March), (ii) more female farmers (52.2%) than male farmers (40.4%) perceived the rainfall now starts later in June, (iii) more female farmers (91.3%) than male farmers (80.8%) perceived the rainfall ceased later in November in the past, and (iv) however, more male farmers (53.8%) than female farmers (43.3%) perceived the rainfall now ceases earlier in October (see figure 4.21 for details).

Figure 4. 21 Percentage comparison of farmers' perceptions of climate variability and change in the past and now by sex in Tie village (Males = 52 Females=23)

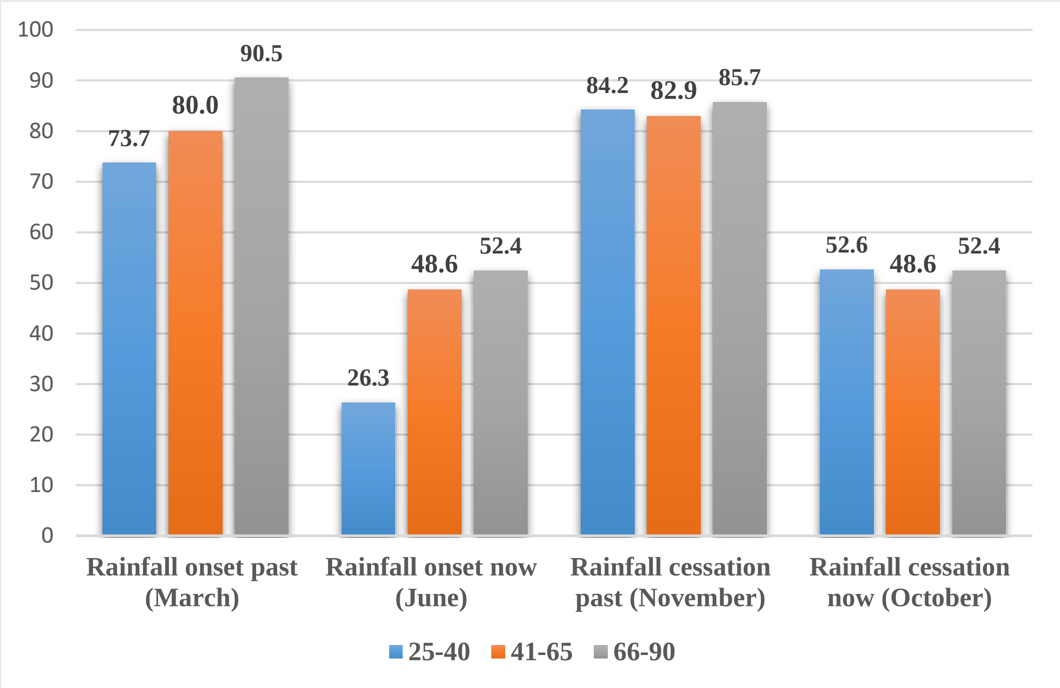


Source: Fieldwork (Semi-structured questionnaire, Tie village, 2016)

Age differentials

On the aspect of age and perception differentials, the data (see figure 4.22) indicate that more older farmers than the middle-aged and young farmers perceived that rainfall started earlier and ceased later in the past, and starts later now. The only exception is more proportion of younger farmers (52.6%) than older farmers (52.4%) that perceived that the rainfall now ceases earlier in October. However, the difference is only 0.2%.

Figure 4. 22 Percentage comparison of farmers' perceptions of climate variability and change in the past and now by age in Tie village (25-40 = 19, 41-65 =35, 66-90=21)

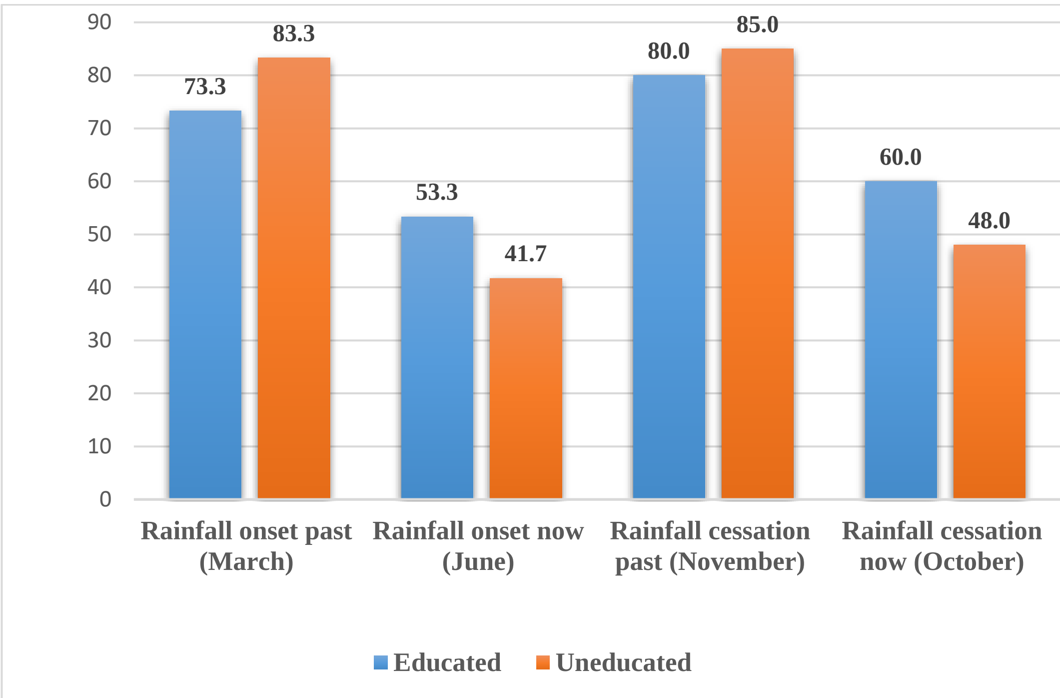


Source: Fieldwork (Semi-structured questionnaire, Tie village, 2016)

Level of educational attainment

On the element of when the rainfall started in the past and now, the following were the statistical observations (see figure 4.23): (i) more uneducated farmers (83.3%) than educated farmers (73.3%) perceived the rainfall started in March, (ii) however, more educated farmers (53.3%) than uneducated farmers (41.7%) observed the rainfall starts later now (i.e. in June). Similarly, on the cessation of rainfall in the past and now, the following results were found: (i) more uneducated farmers (85.0%) than educated farmers (80.0%) perceived the rainfall ceased later in the past, and (ii) more educated farmers (60.0%) than uneducated farmers (48.3%) perceived the rainfall now ceases earlier in October.

Figure 4. 23 Percentage comparison of farmers' perceptions of climate variability and change in the past and now by education in Tie village (Educated = 15, Uneducated = 60)



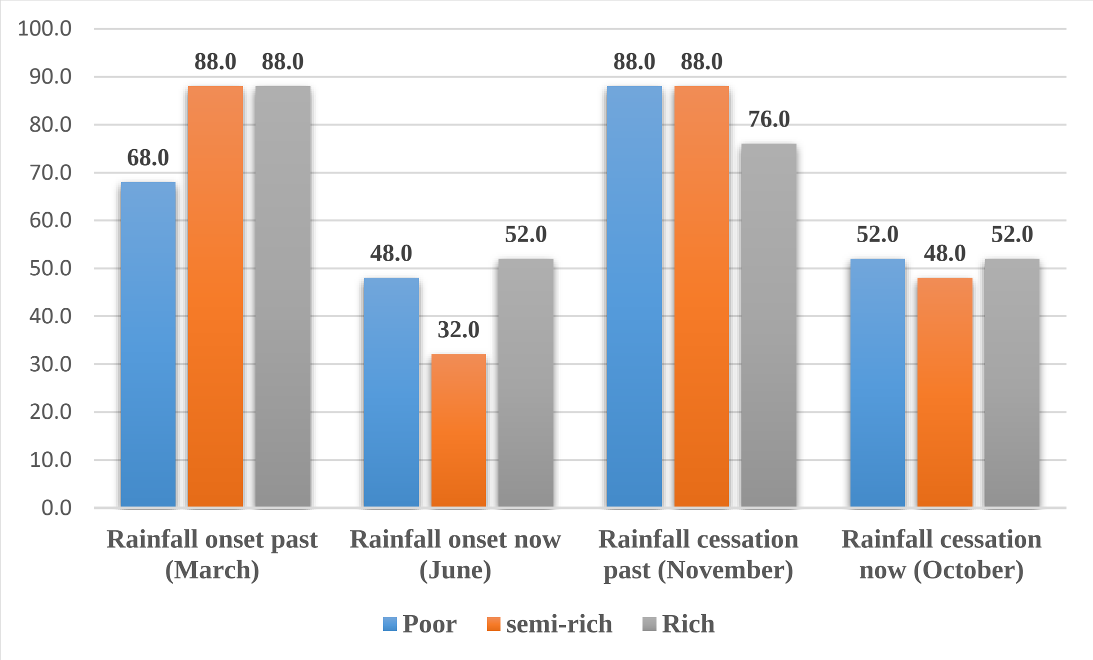
Source: Fieldwork (Semi-structured questionnaire, Doggoh village, 2016)

Wealth differentials

On the aspect of wealth status, the results revealed that the same proportion of rich farmers (88.0%) and semi rich farmers (88.0%), than poor farmers (68.0%) perceived that the rainfall used to start early in March in the past. However, more rich farmers (52.0%), than poor farmers (48.0%), and semi-rich farmers (32.0%) perceived that the rainfall starts later now in June. On the cessation of the rainfall in the past, the same proportion of poor farmers (88.0%) and semi-rich farmers (88.0%) than rich farmers (76.0%) perceived it used to cease later in November. On the cessation of rainfall now, the same proportion of poor farmers (52.0%) and rich farmers (52.0%) than semi- rich farmers (48.0%) perceived it ceases earlier now in October[42].

[42] See figure 4.24 for perception differentials by wealth status

Figure 4. 24 Percentage comparison of farmers' perceptions of climate variability and change in the past and now by wealth in Tie village (Poor = 25, Semi-rich =25, Rich=25)



Source : Fieldwork (Semi-structured questionnaire, Tie village, 2016)

4.4.3 Summary of spatial, and social differentiation of farmer perceptions of climate variability and change

With regard to differentiation of farmer perceptions of climate variability and change by different farmer groups, similar findings were found for the Doggoh and Tie villages on the category of education. In both villages, more uneducated farmers perceived rainfall started earlier in the past (i.e. in March) and ceased later in the past (i.e. November). Similarly, more educated farmers in both villages perceived rainfall starts later now and ceases earlier now. However, there were differences for the other variables[43].

[43] See table 4.10 and table 4.11 for the summary of perception differentials respectively for the Doggoh and Tie villages respectively

Table 4. 10 Summary of the social differentiation of farmer's perceptions of climate variability and change in Doggoh

Climate event	Sex	Age	Wealth	Education
Onset of rainfall past (March)	More female farmers than male farmers	More young farmers, than middle aged and older farmers	More poor and rich farmers than the semi rich farmers	More uneducated farmers than educated farmers
Onset of rainfall now (June)	More male farmers than female farmers	More young farmers than older and middle aged farmers	More rich than semi-rich and poor farmers	More educated farmers than uneducated farmers
Cessation of rainfall past (November)	More female farmers than male farmers	More young farmers than older and middle aged farmers	More rich than semi-rich and poor farmers	More uneducated farmers than educated farmers
Cessation of rainfall now (October)	More male farmers than female farmers	More older than young, and middle aged farmers	More rich than semi-rich and poor farmers	More educated farmers than uneducated farmers

Source: Fieldwork (Semi-structured questionnaire, Doggoh village, 2016).

Table 4. 11 Summary of the social differentiation of farmer's perceptions of climate variability and change in Tie

Climate event	Sex	Age	Wealth	Education
Onset of rainfall past (March)	More female farmers than male farmers	More older farmers than middle-aged, and young farmers	More rich and semi-rich farmers than poor farmers	More uneducated farmers than educated farmers
Onset of rainfall now (June)	More female farmers than male farmers	More older farmers than middle-aged, and young farmers	More rich farmers than poor and semi-rich farmers	More educated farmers than uneducated farmers
Cessation of rainfall past (November)	More female farmers than male farmers	More older farmers than young and middle-aged farmers	More poor and semi-rich farmers than rich farmers	More uneducated farmers than educated farmers
Cessation of rainfall now (October)	More male farmers than female farmers	More young and older farmers than middle-aged farmers	More rich and poor farmers than semi-rich farmers	More educated farmers than uneducated farmers

Source: Fieldwork (Semi-structured questionnaire, Tie village, 2016).

4.5 Farmers' Beliefs about Climate Variability and Change

In section 4.2, the results demonstrated that the local climate in the villages of Doggoh, and Tie has changed. However, up to date, little is understood about the factors that shape farmers beliefs of changes in their local climate. The review in section 2.3.2 revealed that farmers' beliefs about CVC is a construct of: (i) farmers' past experiences (Slegers, 2008, Taylor et al., 2016, Weber, 2010), (ii) farmers' access to climate information (Weber, 2010), (iii) farmers' definition of good and bad climatic years (Slegers, 2008, Taylor et al., 2016), (iv) Farmers' memory of climatic events (Slegers, 2008, Taylor et al., 2016), and (v) farmers' cultural worldviews and values (Weber, 2010). Again, there are limited empirical studies that have explored how cultural values and beliefs shape farmer perceptions of CVC (Scoville-Simonds, 2018).

Therefore, this section contributes to the discourse on farmer beliefs of climate variability and change particularly how cultural values and beliefs construct that. To achieve the objective of this section, the researcher draws on 'cultural worldviews and values', 'access to climate information from experts', 'farmer past experiences' to understand the determinants of farmer beliefs about climate variability and change (CVC). The narratives on the different factors are detailed below.

4.5.1 Cultural worldviews, values, and beliefs shaping perceptions

"….those days the elders used to come together to perform some sacrifices during the beginning of the season. They would say things like we have seen the rain but have not seen the rain drops. When the rain is about to drop too they would say we have seen the drops, but the amount should increase, but the rain should be free of too much wind but it should rain well till the cessation moment for it to stop. The rain used to fall properly but now the early rains are very windy and destroy people's houses and crops".

(HCS-15-D-Male)

As argued section 1.2.1, the research on local perceptions of climate variability and change to date has tended to focus on understanding what changes are perceived by farmers, with little attention on how these changes are interpreted in particular socio-cultural milieu and the associated meanings attached to such changes within local worldviews, and systems of values and beliefs (Scoville-Simonds, 2018). The researcher therefore in this section, argues that cultural values and beliefs are important in influencing our understanding of climate, which potentially shapes individual and collective priorities, and responses to climate change (Scoville-Simonds, 2018). It is important to have a nuanced understanding of cultural values in shaping CVC if we are to address climate change in a socially just way (Scoville-Simonds, 2018). It is noteworthy that it is not the scope of this section to compare results for the villages of

Doggoh and Tie as the data revealed the same cultural values are shared by the two villages.

Worldviews can be defined as the general social, cultural and political attitudes toward the world that guide individual responses to complex situations, mediated by social relations (Dake, 1991, Dake, 1992). Values can be defined as the commonly held standards of what is unacceptable or acceptable and important or unimportant within a society or culture (Adger et al., 2009).

To understand how cultural values and beliefs shape farmer perceptions of changes in their local climate, the researcher drew data from the village key informant interviews, the focus group discussions, and the household case studies. Throughout the interviews with the participants, three key themes have emerged fundamentally to explain the link between cultural values and beliefs, and changes in the local climate as discussed in the narratives below. These are: a decline in the performance of sacrifices at the *tengan*[44] to the gods of the land, increased in violation of the rules of the gods (specially, people having sex outside of their homes, and the killing of people), and the rains been 'held' by traders.

Example 1: Decline in the performance of traditional sacrifices and rituals

Generally, it was agreed in the interviews that, in the past, the elders in each of the two research villages were very united and would come together to perform sacrifices to the gods of the land at the beginning of every season (VIKI-1-D-M, VIKI-1-T-M, VIKI-2-T-F). Similarly, it was revealed that the elders used to converge at the *tengan* to perform sacrifices to the gods of the land during moments of droughts in order to request for

[44] Throughout the interviews with the village key informants it emerged that *Tengan* (sacred grove) refers to a grove of trees that is meant for the performance of traditional sacrifices (VIKI1-D-M, VIKI-1-T-Male)

normal rainfall. However, the interviews revealed that such sacrifices are no longer performed and that has translated into changes in their local climate[45]. A male participant in the case studies in the village of Doggoh specifically pointed out that when it is about to rain now, the wind supersedes the amount of rainfall because the elders no longer make sacrifices to the gods (*HCS-15-D-Male).*

Box 4. 1 Farmer illustrations of reduction in traditional sacrifices

"Those days, the elders used to go to the mountains top to make a lot of sacrifices when the farming season was getting close. Also, on the aspect of trees, they used to have gong boo – once that was not opened, no woman was permitted to either harvest dawadawa or shea nut fruit seeds until the gong boo was opened. On the aspect of death, when they realised that a lot of people were dying, they put ta-kon in place – meaning when anyone died within the ta-kon season, they should not mourn. When all these were in place, we realised the rain used to fall properly". (HCS-15-T-Male)

"You see, it is because of our behaviour that when it is about to rain, the wind supersedes the rainfall - those days the elders used to come together to perform some sacrifices during the beginning of the season. They would say things like we have seen the rain but have not seen the rain drops. When the rain is about to drop too they would say we have seen the drops, but the intensity should increase, but the rain should be free of too much wind but it should rain well till it cessation moment for it to cease. The rain used to fall properly but now the early rains are very windy and unroof people's houses. Such wind too destroys our crops". (HCS-7-T-Male)

"In the olden days, any time there was drought, the elders used to perform rituals at the
'tengan' to pacify the rains and truly it would rain immediately this ritual was done. Today, this traditional practice has been dropped and it is one reason why it has not been raining" (HCS-5-D-Male).

Source: Household case studies (Doggoh, and Tie, 2016)

The above result of farmers perceiving that the climate has changed because the elders do no longer perform sacrifices to the gods of their land are similarly reported in the literature on cultural values, and farmer perceptions. For example, in a study in the agro-pastoral

[45] See box 4.1 for farmers' illustrations of reduction in the sacrifices at the *Tengan*

communities of Canas province, Cusco, of Peru, Scoville-Simonds (2018) found the perception that the failure of the natives to perform *pagos* (rituals) has led to climatic problems and changes.

Example 2: Violation of the 'rules' of the land

> *"… You see, it is not like the rain does not want to help us but because we have gone against the rules of our land that is why the rain is no longer regular now as compared to that of the past"*
>
> *(HCS-9-T-Male)*

It was also evidently clear through the interviews with respondents that certain behaviours are unacceptable in the lands of Doggoh, and Tie. The themes that emerged in that regard include: (i) sexual engagements outside of home (HCS-9-T-Male) and (ii) the deliberate shedding of human blood (HCS-6-T-Male). In the interviews, the participants generally pointed out that it is against the rules of the land to engage in sexual activity outside of homes. The youth were singled out as the group that largely engages in this sacrilege[46]. Similarly, the results indicated that the shedding of human blood, or someone dying outside home are unacceptable in the culture of the Doggoh, and Tie villages. It was revealed that, once such an incident happened in the past, all the households within the villages would contribute animals and the relevant sacrifices would be performed to the gods to cleanse the land, and the rains would fall normally. However, the data revealed that, such sacrifices are no longer performed during such incidents[47].

[46] See table 4.12 for detailed illustration of the shedding of blood and youngsters having sex outside homes contributing to the changes in the local climate of the village of Doggoh and Tie.
[47] See table 4.12.

Table 4. 12 Farmer illustrations of violations of the rules of the land

Reason	Farmer quotes
Sex outside home	*"You see, we go against the rules of the land, e.g. young guys sleeping with ladies outside. It is hard for us to know those that have committed such sacrilege. You see,it is not like the rain does not want to help us but because we have gone against the rules of our land that is why the rain is longer regular as compared to that of the past". (HCS-9-T-Male)* *"Even at market, some would go home late. At mid night you still hear people talking, doing bad things on the road. How will the rain then come? In past, new couples stayed together for over a week without sex but now even on the road they do before going in and that is bad". (HCS-16-D-Male)* *"There are also some things that the elders say the youth should not involve themselves in but they persist to do them. For instance if people have sex in an open place, all that contributes to the rain not falling properly". (HCS-2-D-Male)*
Shedding of blood	*"Those days, they were some practices that they adhered to. Those days it was prohibited to kill someone. If someone too died outside of home, they used to contribute animals that would be sacrificed to the gods of the land to cleanse the land. But now they kill people around". (HCS-6-T-Male)* "*You see, I do not know whether it is because of the behaviour of our human beings. There are some people that commit murder go against the gods of the land but hide that to themselves. All that contributes to unreliable rainfall these days. (HCS-2-DMale)* *"When people were found dead outside, their blood was taken and contributions were made for the elders of the land to make sacrifices and cleanse the land but now people are found dead outside buried without the performance of these sacrifices and I think the violation of their cultural practices also contribute to the variable nature of the rains". (HCS-14-T-Male)*

Source: Household case studies (Doggoh, and Tie villages, 2016)

Example 3: The rains are 'held' by some people

In the household case studies, it was pointed out that 'some' people have the 'power' to stop the rains from falling. The respondents observed that traders in particular are not happy when it rains as that is not a good ground for their businesses to flourish (HCS-18-D-Male). It is believed that traders have the power to 'hold' the rain so that people cannot get good produce hence would not be able to rely on their farm produce to survive, and therefore the demand for food from market sources would increase which will trickle down to induce the prices of food produce to increase, and more profit for traders [48](see box 4.2).

Box 4. 1 Farmer illustrations of the rains being held by humans

"Some people chase away the rain when it tries to rain at times. This has caused the change in the rain pattern" (HCS-15-T-Male)

"Ok, it is difficult to tell what really accounts for that. I think God and the earth are still in good relation. But I think there are some people who do not want the rain to fall so early but some need it to fall early. Right now if it does not rain well and there is no food, those that sell food stuffs can always sell their produce and get enough money. For instance, for all you know, I have bought food stuffs and have filled my room to the brim, if the rain does not fall, the demand for food will increase and I can increase the prices of my food stuff, sell and make a lot of cash. You see that there are points in time some markets are closed and no trader is allowed to go in there because expected rains do not fall at the appointed time…because the traders pray that the rain should not fall so that they can make a lot of money from their sales. You see that when markets are closed for long, it then begins to rain…it means we humans that have the power to hold on to the rains" (HCS-18D-Male)

Source: Household case studies (Doggoh, and Tie, 2016)

4.5.2 Access to climate information from experts

Sources of climate information

Weber (2010) considers analysis-based factors as all external sources of evidence and expertise that shape beliefs about climate change. In the qualitative interviews, the participants in both the Doggoh, and Tie villages pointed out that they receive climate information from governmental, and non-governmental organisations (NGOs) (VIKI-3-D-M, VIKI-4-T-F). Specifically, Literacy Bridge Ghana (LBG), the Association of Church Based Development

NGOs (ACDEP) in partnership with the Canadian Feed the Children (CFTC), Climate Change, Agriculture and Food Security (CCAFS), and ESOKO Ghana were named as the NGOs that disseminate climate information to farmers (VIKI-3-T-M, VIKI-3-D-M).

---

[48] See box 4.2 for farmers' illustrations of the rains been 'held' by traders

The interviews with the village key informants revealed that ESOKO and CCAFS only work in the village of Doggoh and do not have any interventions in the village of Tie. The Ministry of Food and Agriculture (FAO), and government owned radio stations were cited as the government agencies that disseminate climate information to farmers in both the villages of Doggoh and Tie. This finding suggest that all things being equal, farmers in the village of Doggoh receive more climate information than their counterparts in the village of Tie. This could potentially translate into more farmers in the village of Doggoh adopting new farm inputs and improved varieties of crops as the information from more organisations could shape their cropping decisions.[49]

During the interviews with the village key informants, it was revealed that the above governmental and non-governmental organisations work in partnership. In the village of Doggoh for instance, the data indicated that CCAFS, ESOKO and MoFA work in partnership (VIKI-3-D-M,VIKI-4-D-F). Also, Literacy Bridge Ghana works in partnership with MoFA in the development and recording of relevant agricultural, and health related information on a device known as the 'talking book' (VIKI-3-4-F). A male village key informant narrates that one of the reasons why MOFA collaborates with Literacy Bridge is because of the inadequate staffing nature of MoFA as follows: *"…When they go to the agric people they pick the information about crops and put in these things and then they come and give it to us to listen. The agric people say they are not enough to go to all the areas, so these people also go to the other places"* (VIKI-3-D-M). The expression of the male key informant in the village agrees with the data collected from an official from the Literacy Bridge Ghana. During the interviews, the researcher asked the official about the criteria they used in identifying the needs of

[49] Chapter 5, section 5.3.1, and section 5.3.3 will attempt to find out if indeed exposure to agricultural and climate intervention programmes has a strong influence on farmers' cropping decisions.

farmers and hence running the concerned intervention programmes. The official respondent explained *"we did a baseline study to identify the needs of communities – we identified that communities around the district*[50] *get information maybe once or twice in a year …therefore we partnered with MoFA to develop relevant information for us to record on the 'talking book'*[51] *and then deliver the talking book for the households to use on rotational basis" (*SIKI[52]-1-LBG-M)

Information Dissemination: Who gets more, and why?

Analysis of the interviews showed that climate information is disseminated to farmers in both the Doggoh, and Tie villages in different mediums including phone calls, and texting, meetings with village people, via air waves from radio broadcasts, as well as through the 'talking book'[53]. In a bid to understand access to the climate information, the researcher had to probe during the interviews to understand who receives the information more than the other. Attention was also paid to teasing out the general barriers, and limits to accessing climate information. In terms of accessibility, the analysis revealed that males receive the information more than their female counterparts.

The reasons that emerged include: (i) men being the heads of the families, (ii) women do not see it necessary to sit by radios, and (iii) also because women do not have phones (see box 4.3)[54]. The review in chapter 3 (section 3.3.3) suggests that women are subordinated in North-west Ghana in terms of decisions making on the sale of surplus crops from the family farms as men can decide to consult them not. This potentially translates into women not having enough money to purchase phones hence have less

[50] Note again that the fieldwork took place in 2016 and the Jirapa municipality was then a district hence the reason why the respondent refers to district.
[51] A device in the form of a radio where relevant climate and agricultural information is recorded for farmers (SIKI-1-LBG-M)
[52] Stakeholder individual key informant interview
[53] See table 4.14 for detailed discussion of the sources of climate information for farmers
[54] See box 4.3 for the details of the unequal access to climate information

access to climate information. Similarly, one can deduce that because of unequal power relations between men and women manifested in men being the heads of the families hence controls who has access to the radio and women not having phones have led to unequal access to information. For example, during the household case study interviews, a male participant in the village of Doggoh observed that he listens more to the radio as he is the head of the family. Beyond differentiation in access to climate information on the basis of gender, some participants stated that because they are not part of farmer groups, and because of benefits associated with going for the meetings, the village organisers of the meetings do ‘narrow‘ them and that translates into them been excluded from such meetings (see table 4.17 for details). The unequal access to climate information particularly due to the fact that women do not own radio sets and hence rely on their sons and husbands are similarly reported by Naab and Koranteng (2012) in a study in Ghana, and Jost et al. (2016) in their study that used Ghana, Bangladesh and Uganda as a case study.

Box 4. 2 Farmers' illustrations of differential access to climate information

"The women have no phones..huhu, it is when the radio is opened that they listen. Also, when they call for meetings they attend. Many women do not have phones. If they do not attend the meetings then it is the men that will tell them" (VIKI-3-D-M)

"Because our area is a village, we do not see sitting by a radio to be important. I think it is the men that do listen…it is the men that can get information and spread it" (VIKI-4-T-F)

It is me who goes for the small radio then myself and my children all listen to the messages" (HCS-18-D-M)

"Laughter… I listen to it more as I am the head of the family" (HCS-18-D-Male)

Source: Fieldwork (Qualitative data, Doggoh and Tie, 2016)

Which sources do farmers trust most and why?

In both the villages of Doggoh and Tie, it emerged that farmers have different value for the climate information that they receive from the different sources. Farmers' identified 'the number of times' they get information from each source[55] as the primary driver of trust for the information.

In the village of Doggoh, farmers reported that they trust the climate information from ESOKO Ghana than the other sources because the former calls them regularly to give updates on the state of rainfall in their local climate. With the MoFA, farmers in both Doggoh and Tie opined that only come to their villages once in a while due to limited

[55] See table 4.14 for the details of information farmers get from each source

staffing of the organisation therefore they get less climate information from them hence do not have much trust.

In the village of Tie, farmers reported that they trust the information from the Literacy Bridge Ghana than the radio stations and MoFA. The justification is not different from that of the Doggoh village. Farmers reported that MoFA staff are few and rarely visit their village for intervention programmes[56].

Box 4. 3 Illustration of farmers' trust for climate information from different sources

> *"You see, the Esoko people regularly send us text messages when the agricultural season begins indicating for example, there is 80% chance that it will rain within this week…then when the crops grow, they sent us messages too warning us that it is about to rain and we should not spray our crops with chemicals as the rain will was than away….For Doggoh village here, we trust the climate information from Esoko than the other sources"* (VIKI-4-D-F)
>
> *"In Tie here, many people do not listen to radios, and the Agriculture staff (MoFA) too come once in a while….usually we see an extension officer for long….i think the 'talking book' from the Literacy Bridge is the source we trust most….because they tell us not to burn the bush, that we should not sow crops now in March as the rainfall is no longer as that of the past"* (VIKI-3-T-M)
>
> **Source: Village Key Informant Interviews (Doggoh and Tie villages, 2016)**

Barriers and limits to accessing climate information

The general barriers and limits to the access of climate information were identified as: inadequate staffing of the MOFA, inadequate logistics, some farmers not included in the

[56] See box 4.4 for farmers' illustrations of their trust for information from different sources

climate intervention programmes, as well as farmers' trading off climate information community meetings for other tasks[57].

Table 4. 13 Farmer illustrations of the limits and barriers to accessing climate information

Limit/barrier	Farmer Quotes
Inadequate MoFA staffing	"Agric people, they say the workers are few. So they gave out only one person to care of the whole of Tampoe and here and Duori. So they don't come here regularly. Then it is the NGOs-------eeh the CCASS, Peter who brings him, but his work has finished and he also ended. After all they don't give him fuel. And he won't come again" (VIKI-3-D-Male)
Inadequate logistics	"I don't have a radio set. So those who have the radio, they can hear but if you don't have it, you wouldn't hear. I too do not have a radio set" (VIKI-4-T-Female). "Ok, they do come to give us those small, small radio sets but it is not always much. It can get to two months and you will never see it in your house". (VIKI-4-T- Female). "I do take, let us take it that I took it today and it is up to a week and this is my house in front there before it will move from that place to this place for one week before it then move from this place to the other side. And for another week, it will move from that house to another. So that is how it circulates". (VIKI-4-T- Female). "No, I do not have a radio, if not the small radio I occasionally get from the Literacy Bridge" (HCS-18-D, Male)
Exclusion of some farmers	"I am here alone with my children, I have never been invited for any meeting in the village of Doggoh here. Those that are part of the farming groups have the chance to meet NGOS but I am not part of any of those groups hence how will I get information on climate? None of my children too is part of any of the groups. They have their meetings, share crops for farming. My children were supposed to force and take part in such groups but they refuse to go for such" (HCS-16-D, Female) "Okay, they sometimes ask that they should inform the whole villagers to come for meetings but some of how do not get informed about such meetings. You see, because if you have the chance to be part of such meetings, we all would share the benefits hence they narrow some of us and keep the benefits to themselves". (HCS-16-D, Female) "Well, there are sometimes that we hear they had a meeting with NGOs but some of us never heard about it" (HCS-11-D, Male).
Trade-offs in time management	"Some people have no time. Hehee, to listen, some can't also read the text messages and so can't read anything. Some do not also have phones". (VIKI-3-D- Male)

Source: Fieldwork (Qualitative Data, Doggoh and Tie, 2016)

[57] See table 4.13 for the details

The influence of access to information on farmer perceptions of climate variability and change

During the data collection, the objective went beyond identifying the sources of climate information to farmers, the mode of dissemination, who gets more information than the other and general barriers and limits to accessing climate information, to understanding what specific climate information each of the above sources disseminated to farmers and how that has shaped their perceptions that the climate has changed. Therefore, the next sub-section is dedicated to teasing out the specific climate information from each source and how that contributed to farmers' perception that the climate has changed or is changing.

The key themes that have emerged from the interviews with the respondents include: farmers can plough their farm fields in March but should not sow in the same month as the rainfall pattern has changed (VIKI-3-Male), farmers are advised to raise ridges because of the less rainfall in order to retain the rainfall (VIKI-4-T-Female), farmers are advised to desist from deforestation and bush fires as the pattern of rainfall now has changed (HCS-10-D-Female).[58]

[58] The details are indicated in table 4.14.

Table 4. 14 An illustration of the sources of climate information from different stakeholders

Source	Mode (s) of dissemination	Respondent quotes
ESSOKO	Village meetings Phone calls and texts	"When they came in the beginning, they said the place is changing that is why it's not raining like it used to. The weather is changing and everything is changing, so it no longer rains like before. Then they talked about rainfall- that tress, there are some tress that we are cutting, that is why it is not raining. Therefore, they said we should stop cutting those trees. That is why it is not raining That is what they started telling us in the beginning. From then they said we should not cut down trees, we should not set fires. That's what the Isoko people come to tell us" *(HCS-10-D, Female).*
MoFA/ CCAFS	Village meetings Record information on 'talking book'	*"Agric people tell us that if we have to plough the farm fields in March, we should not sow in the same month that it will not rain well, they tell us if we sow around 4th and 5th month, it would not rain well" (VIKI-8-D, Male)* *"The rainfall is not always enough, so if we farm within three months we would not get anything" (VIKI-8-D, Male)* *"The advice of not ploughing and sowing our crops in April as we did in the past as the crops would not do well. Not matter what, if you grow your crops in May, June, July, no matter what the rain will fall, and they would do well. It is their teaching I have taken. It has helped me as I am able to get some good yield for the food needs of my family-laughter that is the help if I sow and they get bad, it is not the market I will have to buy food – but if I do not have the money and beg for from money from someone today and go back tomorrow, would they give you money again" (HCS-18-T, Male)* *They always explain to us, some of the farming activities. Example, if like raising mouse, but because the rain is not much now, that we should always plough or farm small ridges so that, when it rains small, the water will flow and stay between the ridges so that, the place will not dry fast. When you saw one or two things, and when they geminate, you will see that it will do well for you to get something out of that". (VIKI-4-T, Female).*
Radio stations	Air	*"on the radio, they tell start by educating listeners on how the pattern of rainfall was like in the past and now and that the two patterns are not the same" (HCS-11-D, Male)* *"okay, they tell us that the rainfall pattern is no longer like that of the past and therefore people should not rush to sow their crops as it would not do well" (HCS-8-D, Male)*
Literacy Bridge	Talking book Village meetings	*"They tell us that when it rains once we should only plough the land and should not sow the crops. They said they is a period that the rain would fall properly and then we can now begin to sow our crops. They tell us that no matter what the rain would fall in July". (HCS-18-D, Male)* *"We get small radios. They tell us that the pattern of rainfall now is no longer like that of the past and the reason why when you grow some crops, they do not do well. It rains these days but not as it used to rain in the past. That we should always try to plough our lands early as the rain would not be long before ceasing" (HCS-11-D, Male)* *"Also, they told us that the way the rain is no longer regular as compared to that of the past, if should only apply fertiliser after it rains otherwise we would lose the fertiliser and the fertiliser and the crops without rain will damage the crops" (HCS-18-D, Male)* *"Last season, they told us that the rain will not be much. So that anybody should farm early. That, from the ninth month, it is possible that the rain will stop and actually, the rain did not rain up to that time. But it stopped" (VIKI-4-T- Female).*

4.5.3 Farmer past experiences, and perceptions of climate variability and change

Throughout the interviews with respondents in both the villages of Doggoh and Tie, the results suggested that farmers' past experiences have constructed their perceptions of changes in the local climate. The themes that have emerged include: reduction in the amount of rainfall, changes in the timing of the harvest of some crops, and changes in the return timing of northern farm migrants from the southern belt of Ghana. The narratives on each of these themes are discussed in details below.

Example 1: Changes in the timing of the return of northern migrants from southern Ghana

It was revealed in the interviews that migrant farmers from the north to the southern part of Ghana used to start getting back to the north around either January, February or latest by March to go about their farming activities. However, the respondents stated that the Migrant farmers begin to come back north around May[59].

[59] See box 4.5 for a detailed illustration of the late return of northern migrant farmers from the south

Box 4. 4 Farmer illustrations of the late return of migrant farmers from southern Ghana

"You see, in the past, our young sons that migrated to the southern part of Ghana, after Christmas, those that were the only males in their households had to start getting back home to prepare their farm fields in anticipation for the rainfall – by March, all our sons would have returned from the southern part of Ghana and plunged straight into farming as it would have rained a couple of times" (HCS-3-D-Male)

"That is why I was saying, in the olden days, just starting from eeeeeeeeeeh, we use to go to south for by-day and by then our parents use to be in the house here. But when to go to the south, and just after Good Friday, eeeeeeeeh in two weeks' time, and you know your father is not strong enough to start clearing the farm stocks, then, you have to take the lead to come home. Because, you have to come home to start packing the stock. Ahaaaaaa. After Christmas, it in the second month that Good Friday will also set in. so from the second month to the third month, the raining season is always setting in. so in the olden days, the raining season starts from the third" (HCS-7-D-Male)

"...you see, those days we used to seasonally migrate to the southern part of Ghana, we had to return by January and latest by February and in March it used to start raining for us to plough our farm fields. If one made a mistake and returned after March once you get to your father-in-law and greeted him, he would not respond but instead you are coming to him after the ploughing of farm fields are over" (HCS-13-D-Male)

"You see, it used to start raining by exactly the beginning of March. You see, those days, anyone that migrated to the southern part of Ghana had to be back by March. We used to raise our yam mounds in March then in April, we started ploughing the farm fields for other crops" (HCS-13-T-Male)

"...but now it starts to rain in the sixth month after Christmas and those who migrate to southern Ghana begin to come back in May" (HCS-12-T-Male).

"You see, in the past, anyone that seasonally migrated to the southern part of Ghana, anytime it was time it was March, anyone that wanted to farm that year in the north had to quickly get back home" (HCS-14-T-Male)

Source: Fieldwork (Qualitative Data, Doggoh and Tie, 2016)

Example 2: We used to 'chase' the rains away in the past

> *"Those days it would rain from morning till evening. If you had cattle in the den, you had to take them out in the rain to find some pasture for them to feed otherwise the rain will fall from morning till evening and the cattle would die of hunger or will force their way out*" (HCS-9-T-Male)

The data from the interviews with farmers indicated that the amount of rainfall farmers experienced in the past and now are not the same. The main theme that has run throughout many of the interviews is that, the rain used to fall throughout the entire day from morning till evening in the past. This, according to the interviewees translated into a number of potential hazards. These include: (i) the possibility of households going hungry if they were ill prepared with firewood, and flour for food (HCS-3-T-Female), (ii) farmers feeling so cold due to the heavy downpour and therefore had to carry fire alongside in the mornings on the way to the bush farm fields in order to keep themselves warm (HCS-7-D-Male). Because of the above nature the rainfall in the past, the interviewees revealed that they had to 'chase' the rains away (HCS-9-T-Male). However, the respondents are of the opinion that they only experience windy rainfall now as the wind usually supersedes the rain drops (*HCS-7-T-Female*)[60]. The details of farmer experiences of rainfall in the past and now are illustrated in table 4.15.

[60] The details of farmer experiences of rainfall in the past and now are illustrated in table 4.15.

Table 4. 15 Farmer illustrations of their experiences of rainfall in the past, and now

Longer intensity of rainfall in the past	*" in the past, once the rain started, it would continue to rain for us to plough and sow our crops but now, once it starts to rain, it rains only a little and for the wise ones, they would sow in that state anticipating more rain later- but for the unwise that would expect it to rain heavily, they would be left behind in terms of their cropping decisions….the way it used to rain is no longer like that today" (HCS3-T-Female).* *"Those days, it used to rain throughout the whole day- if you never had firewood in your household, you would go hungry on such rainy days. It used to rain heavily and water will run over around the rivers but these – then the following day, it would get us indoors due to the torrential nature of the downpour – if you did not have beans flour, then you would go hungry- days we do not see such kind or rainfall" (HCS-3-T-Female* *"You see, those days, once it began raining, it would do that continuously till the end of November…then all sorghum and millet in the bush farm fields were all harvested…you see, before going to the bush farm fields those days early in the morning to carry the harvested farm produce, we had to get some fire from wood to warm up ourselves as the whole ground was heavily wet. The days we never had any work, we had to stay at home to get ourselves warm with fire but now, the intensity of the rainfall is no longer like that of the past" (HCS-7-D-Male).*
Rainfall now very windy	*"you see, the time we expect the rain to fall, it would not fall- when the clouds form and the wind begins to blow and rise we expect the rain to fall but it does that without any sign of rainfall. So by the time we begin to sow, if you don't apply fertiliser, the crops would not do well but we did not know all these in the past"* (HCS-3-T-Female) *"Now, once it begins to rain, the wind is usually more than the rain drops….these days, it rains at one section of the same village but the rain drops do not touch other areas—but those days, once it began raining, it would rain heavily and the whole ground would be very wet" (HCS-7-T-Female).* *"The rainfall pattern is too windy than that of the past- it blows a lot of wind with few rain drops" (HCS15-D-Male).*

Source: Qualitative Data (Doggoh and Tie, 2016)

4.5.4 Summary of the factors that shape farmers' perceptions of climate variability and change

Finding 1: Cultural worldviews and values

- Farmers reported that there are changes in their local climate due to: (i) the decline in the performance of sacrifices and rituals to the gods of their land which are meant to induce more rain to fall, (ii) the violation of the 'rules' of land manifested in the promiscuity of the younger generation, and the murdering of people in their land without the necessary accompanied sacrifices to appease the gods of the land, and the rainfall being 'held' by traders so that there will be less food produced hence higher demand for their market produce (Section 4.5.1)

Finding 2: Climate information from experts shaping farmers' perception

- Farmers reported they receive information from government agencies (MoFA and Radio stations in the Upper West region), and non-governmental organisations (CCAFS, Literacy Bridge Ghana, ESOKO Ghana, RESULT Project). It emerged that the two villages receive differential climate information as the village of Tie receives no information from CCAFS and ESOKO Ghana**.** This could translate into the farmers in the village of Doggoh being better informed about the risks associated with climate variability and change. Therefore, regarding cropping decisions, the farmers in the village of Doggoh are more likely to respond to CVC than their counterparts in the village of Tie (section 4.5.2).
- Similarly, it emerged that there are gender differentials concerning access to climate information. Farmers reported that more men receive the climate information from radios and mobile phones than females because men are the heads of the families and more resourced (e.g own radio sets and mobile phones) than the females.

- In the village of Doggoh, farmers reported that they trust the climate information from ESOKO Ghana more than the other sources because the former calls them regularly to give updates on the state of rainfall in their local climate.
- With the MoFA, farmers in both Doggoh and Tie opined that the staff of MoFA only come to their villages once in a while due to limited staffing of the organisation therefore they get less climate information from them hence do not have much trust.
- In the village of Tie, farmers reported that they trust the information from the Literacy Bridge Ghana more than the radio stations and MoFA. The justification is not different from that of the Doggoh village. Farmers reported that MoFA staff are few and rarely visit their village for intervention programmes.
- Farmers reported that the experts that give them climate information make them to understand that the rainfall pattern in the past and now are not the same hence they delay in sowing their crops, raise ridges instead of round mounds to conserve more water when it rains, and they should grow shorter duration of crops[61].

Finding 3: Farmers' past experiences

- Farmers reported there has been changes in the timing of the return of migrant farmers to southern Ghana. It is also reported that the migrant farmers from the villages of Doggoh and Tie used to return latest by March but now they return by May ending to commence their farming activities (Chapter 4, section 4.5.3).
- Similarly, farmers reported that, in the past they had to 'chase' the rain away as it rained heavily from morning until evening and households that did not have dry firewood (food cooking) and food flour risked sleeping hungry. In addition, farmers reported that cattle had

[61] See section 4.5.2

to force their way out of den to find pasture otherwise they go hungry as a free-range system of grazing is practised in the villages of Doggoh and Tie.

4.6 What similarities and differences exist between farmer perceptions of CVC and analysis from meteorological data?

The results in section 4.2 and section 4.3 demonstrate that farmer perceptions disagree with the results of the climate data analysis on rainfall. However, farmer perceptions agree with climate data on temperature being on the increase now as compared to that of the past. The details of the matches and mismatches are summarised in table 4.16.

Table 4. 16 Summary of similarities and differences between farmer perceptions and analysis of climate data

Matches/mismatches	Climate events
Match	• There is an increase in the monthly maximum temperature
Mismatches	• Farmers claim rainfall ceases earlier now than the past but the results from the meteorological data indicate the start of the rainfall is variable showing no statistical trend as in either increasing or decreasing now as compared to that of the past. • Farmers' claim of the rainfall ceasing earlier now as compared to the past disagrees with climate data that reveal variability in the end date of the rainfall. • The climate data indicate variability in the length of the rainy season whereas farmers perceived the length of the season is shorter now as compared to that of the past.

4.7 Discussion and Conclusion

4.7.1 Discussion

This chapter sets out to understand farmers' perception of climate variability and change, how the perception of CVC is socially differentiated, the factors that shape farmers’ perceptions, and how farmer perceptions match or mismatch analysis from meteorological data.

On the aspect of farmers’ memory, farmers reported a shift in the start and cessation of the rainfall from March to June, and from November to October respectively (see section 4.3.1). This finding is similarly reported in other empirical literature in Ghana (see Codjoe and Owusu, 2011, Kusakari et al., 2018), and in Uganda (see Osbahr et al., 2011). Farmers similarly reported a reduction in the amount of rainfall and an increase in the number of warm days and nights. The findings above agree with the findings of other studies in Ghana (see Asante et al., 2017, Codjoe et al., 2011, Kusakari et al., 2018, Yaro 2013). Furthermore, the chapter documented subjectivity in farmers’ memory of CVC that has similarly been reported in other others (see Osbahr et al., 2011, Sing et al., 2018).

Farmers reported memory, personal experiences, climate information from experts and cultural worldviews and values shaping perceptions of climate variability and change. The results on farmers’ memory shaping their perceptions have been found in other studies (see Osbahr et al., 2011, Singh et al., 2018). Similarly, farmers’ past experiences shaping perceptions is also reported by other studies (Singh et al., 2018, Slegers, 2008). The findings on cultural values shaping farmer perceptions of CVC are congruent with the empirical study conducted by Scoville-Simonds (2018) in agro-pastoral communities in the highland Cusco, Peru of South America.

The results demonstrated that perceptions of CVC are socially differentiated. What has clearly emerged in the data is more uneducated farmers in both villages who have perceived that the rainfall started earlier and ceased later in the past, and educated farmers perceiving the rainfall starts later and ceases earlier now. Similarly, more female farmers than male farmers perceived that the rainfall in the past started earlier and ceased later (see section 4.4.2).

Comparing the analysis from the climatic data with farmers' perception, it emerged that the two have largely disagreed. The only exception is agreement on the increase in monthly maximum temperature. The results from the climate data analysis and farmers' perceptions disagreed on onset, end, and length of the season. Whereas the climate data showed variability in all these three climatic events, farmers perceived there is a late onset, earlier cessation and a short length of the season now as compared to that of the past (see section 4.6). The finding of rising temperature reinforces observations that have been reported by other studies in Ghana (e.g. Amadou et al., 2015, Limantol et al., 2016, Yaro, 2013). For example, Amadou et al. (2015) reported a rise in temperature in the Upper East region of northern Ghana. The rise in temperature level could adversely affect agriculture in North-west Ghana as the soil moisture of crops will be affected (Bhatti and Khan, 2012, Limantol et al., 2016) and this potentially can translate into a drop in the yields of crops when temperature exceed the optimal for biological processes (Bhatti and Khan, 2012, Limantol et al., 2016, Ofori-Sarpong, 2001). The matches and mismatches between farmers' perceptions and analysis of climatic data have been explained in diverse ways. For example, it is believed that scientific 'truths' about global change may have turned into myths about environmental change at the local level (see Leach and Mearns, 1996, Osbahr et al., 2011, Roe, 1999). Similarly, Osbahr et al. (2011) reported in their study in Uganda that farmers' perceptions of declining rainfall that contradicts the finding of climatic data could be explained by the impact of increasing temperature experienced by farmers. Additionally, Horsefield (2016) in his study in Zimbabwe explained that the unobservable rate of change in rainfall parameters and the multi-faceted nature of the rainfall in terms of the parameters used to define its quality could explain the mismatches between farmer observations and climatic data. However, Horsefield (2016) believed that for temperature, farmers' perception aligned with the climatic data because temperature possess far less inter-annual variability and also has fewer parameters to assess its change.

4.7.2 Conclusion

The chapter highlighted that that climate variability and change (CVC) are real problems for farmers in Northwest Ghana as the climate data revealed variability and farmers claimed changes in their local climate. Similarly, the chapter highlights that perceptions of CVC is socially differentiated and cultural worldviews and values play a critical role in shaping farmers' perceptions of CVC. To that end, this study has contributed to our understanding of how farmers' perception are socially differentiated and the role of cultural values in shaping farmers' constructions of climate variability and change. In sum, this chapter has demonstrated that farmers' have perceived changes in their local climate.

The question that needs answers is, will farmers focus on maximising yield by selecting crops or crop varieties that are appropriately suited to the prevailing changing climate as the literature suggests and trade-off cultural values and practices as argued in chapter 1 section 1.2.1? Chapter 5 attempts to answer this question.

CHAPTER 5

UNDERSTANDING FARMERS' CROPPING DECISIONS UNDER CLIMATE

VARIABILITY AND CHANGE

5 Understanding Farmers' Cropping Decisions under Climate Variability and Change

5.1 Introduction

This chapter addresses objective two of the thesis: to understand the cropping decisions of smallholder farmers under climate variability and change (CVC). The literature review (see section 2.3.3), indicates a strong connection between farmer perceptions of, and adaptation to CVC. In chapter four, the results (in section 4.3.1 for example) revealed that farmers have perceived changes in climate as manifested in a shift in the start of the rainy season from March to June in both the villages of Doggoh and Tie. Also, the results in chapter four indicated that according to farmers' perceptions, the cessation of the rainfall is now earlier than that of the past with the cessation month of rainfall shifting from November to October (see section 4.3.1). Similarly, in the review (see 2.3.3), it has mainly been documented that under CVC, farmers would focus on maximising yield by selecting crops that are better suited to the prevailing climate. The above implies that, if farmers are to focus on yield maximisation, they will displace crops or varieties that are not appropriately suited to the variable and changing climate. However, as argued in chapter 1 (section 1.2.1), the researcher contends that it is very vital to understand why farmers may not be willing to displace certain crops or crop varieties that are not suited to the prevailing climatic conditions. The justification being that farmers may have other reasons for cultivating crops apart from physiological or economic reasons. Therefore, the displacement of such crops potentially could lead to the trade-off of some cultural values of the people of the Doggoh and Tie villages of north-west Ghana.

Having reviewed several theoretical ideas that explain human behaviour (in section 2.5.2), the researcher employs the Theory of Planned Behaviour (TPB), and the Social Identity Theory (SIT) to understand farmer cropping decisions under climate variability and change (CVC). Specifically, the attitude and perceived behavioural control components of the TPB are used to understand farmer adaptation to CVC via crop selection. Similarly, the social categorisation and social identification elements of the SIT are used to understand why farmers are not adapting to CVC now, or their future intentions not to adapt to CVC via crop selection.

This chapter contributes to the discourse on adaptation to CVC particularly social limits to adaptation. To that end, the chapter draws data from the individual key informant interviews, the semi-structured questionnaire, the focus groups, and the household case studies. This chapter is structured as follows: section 5.2 presents results on the cropping systems of the Doggoh and Tie villages teasing out differences now as compared to that of the past. Next, section 5.3 presents results on farmers' intentions to respond or not respond to climate variability and change via crop selection. Then section 5.4 has the discussion and conclusion of the chapter.

5.2 Understanding cropping systems in Doggoh and Tie villages

Per the definition (s) of adaptation to climate variability and change in section 2.3.1, farmer responses to climate variability and change (CVC) via crop selection is the selection of crops and crop varieties that are suitable to the prevailing climate to reduce the impacts or maximise the opportunities associated with the changing climate. Therefore, it is essential to start the chapter by understanding how the cropping systems in the Doggoh, and Tie villages have changed now, as compared to that of the past[62].

[62] During the interviews, 'past' was used with reference to 25-30 years ago (i.e. from 2016).

Interestingly, studies looking at changing cropping systems have focused mainly on how crop types and varieties have been changed (see, e.g. Adjei-Nsiah and Kermeh, 2012) without considering for example, how the level of importance farmers attach to the different farm fields, and the agricultural cycle of crops have changed now as compared to that of the past. Therefore, in this section, the focus is beyond teasing out changes in crops cultivation to understanding how the value attached to the different farm fields has changed now as compared to that of the past, and how the crop cycle has changed now as compared to that of the past. This is useful as it will give extension officers and policy members for instance a nuanced understanding of the efforts that farmers are putting in place to adjust to the variability, and changes in their local climate. The long-run benefit is for the former to assist farmers effectively and efficiently adapt to maximise the opportunities and reduce the negative impacts associated with climate variability and change.

5.2.1 Current Cropping System

The scope here is to understand the following: (i) identify the main crops that are cultivated in the villages of Doggoh and Tie teasing out any spatial differences, (ii) understand farmer allocation of crops to the different farm fields, and (iii) understand the cycle of cultivation of the crops. To that end, data from the semi-structured questionnaire and the case studies were used to understand changing cropping systems.

(a) Main crops cultivated by farmers

In the semi-structured interviews, the respondents were asked to mention the crops that are currently cultivated by their households. In both villages, maize (w)[63], groundnuts, sorghum, maize (y)[64], beans, bambara groundnuts[65], and yam were the crops named. It emerged from the data all the crops are cultivated for the food needs of the households except groundnuts that is

---

[63] Maize (w) – this refers to maize white colour
[64] Maize (y) – this refers to maize yellow colour
[65] Throughout the thesis b. groundnuts will be used to represent bambara groundnuts

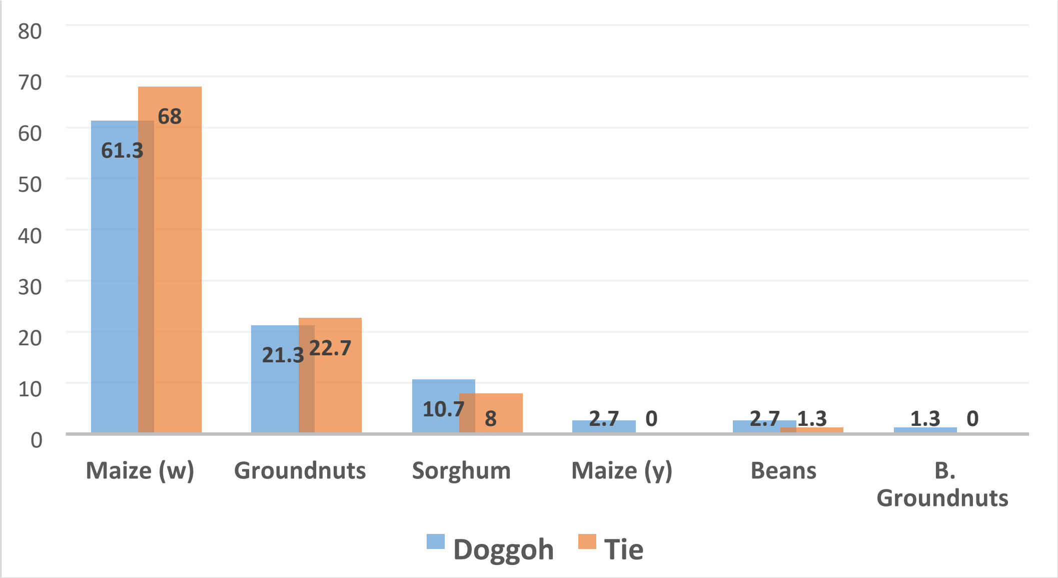
mainly sold. The data reveal that the cash from the sale of groundnuts has a variety of uses including paying for school fees, medical bills, and for funeral activities. A male participant in the village of Doggoh observes the cash value of groundnuts as follows:

"…*as we are go for the funeral, strangers will come. As this funeral came yesterday and I do not have money, I would pick one bag of groundnut and sell. I can use the money to buy drinks for the strangers. It though depends because you can also use such money to buy coffin. Somebody might come to the funeral and fall sick. Such money can take care of that*" (HCS-4-D-Male)

The respondents were asked to mention three crops that are cultivated mainly by their households. This was essential to understand the farmland size allocation for the crops. In that regard, the respondents in the village of Tie cited maize (w), groundnuts, sorghum, maize (y), and beans as the largely cultivated crops. In addition to the above largely cultivated crops in the village of Doggoh, the respondents in the village of Doggoh mentioned bambara groundnuts as among the largely cultivated crops now. This suggests that the villages of Doggoh, Tie grow in the village of Doggoh and not counted in the village of Tie. On the element of magnitude of cultivation, maize (w), groundnuts, and sorghum have been revealed to be the most important crops occupying 93.3% (Doggoh), and 98.7% (Tie) of the total area under cultivation among the main crops that are cultivated in the respective villages.[66]

[66] See figure 5.1

Figure 5. 1 Percentage of households growing the main crops in Doggoh and Tie now (N = 75 in each village)



Source: Semi-structured Questionnaire (Doggoh, and Tie Villages, 2016)

How different are the crops cultivated now, as compared to that of the past?

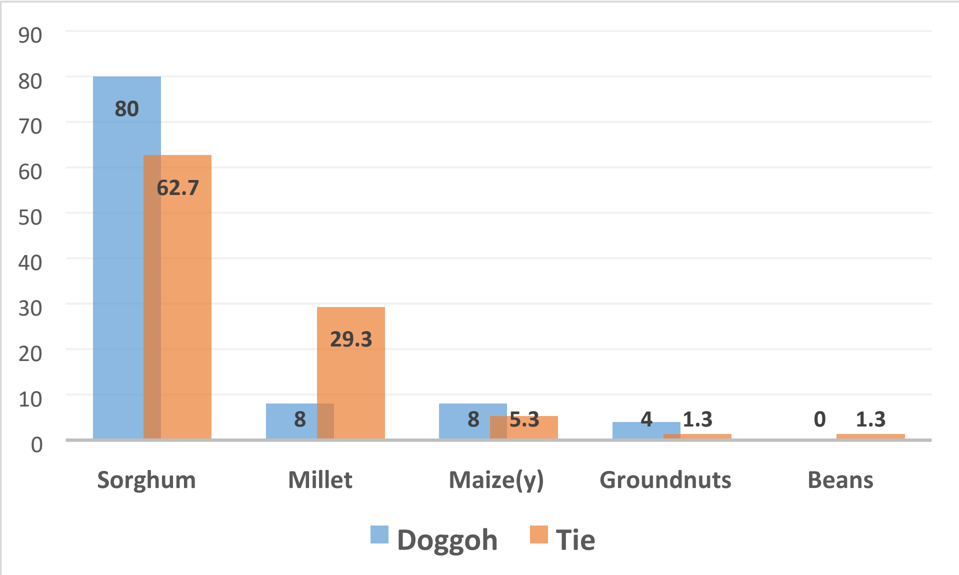
The results from the semi-structured questionnaire data illustrate that the magnitude of cultivation of main crops (i.e. the area under that crop) has changed now as compared to that of the past for both the villages of Doggoh and Tie[67]. For example, the respondents ranked sorghum, followed by millet, and maize (y) as the most important crops in the past. However, the results in figure 5.1 showed that farmers ranked maize (w), followed by groundnuts, and sorghum as the most important crops regarding the magnitude and the number of farmers who cultivate them now in both the villages of Doggoh and Tie. Comparing the results in figure 5.1, and figure 5.2, it is clear that millet has lost its place as among the main crops cultivated in both Doggoh, and Tie villages. Similarly, the results showed that sorghum had lost its position to maize (w) as the highest ranked crop among the main crops.

[67] See figure 5.1 and figure 5.2

It is noteworthy that it is not the scope of this section to understand why sorghum and millet have lost their respective positions as that would be discussed in section 5.3.

The results here imply that cultural foods could be potentially affected if maize (w) is not the main cultural food crop and it turns out that sorghum, and millet in particular are the cultural foods crops[68].

Figure 5. 2 Percentage of households that cultivate the top ranked crops in Doggoh and Tie in the past (N= 75 in each village)



Source: Semi-structured Questionnaire (Doggoh, and Tie Villages, 2016)

(b) Spatial location of crops: understanding why crops are assigned to different farm fields

In this section, the objective is to understand where the different crops discussed in sub-section "a" are located, why crops are assigned to different farm fields, and tease out how the attention farmers attach to the different farm fields has changed now as compared to that of the past. To achieve this, the researcher relied on data from the semi-structured questionnaire (SSQ) the village key informant interviews (VIKI), and focus groups.

---

[68] This is the focus of chapter 6 of this thesis.

The results from the village key informant interview data showed that households in both the Doggoh and Tie villages have similar farm fields for crop cultivation. The participants identified compound farm fields, riverbank farm fields, and bush farm fields (VIKI Interviews, Doggoh, and Tie). Benneh (1988) in a study on small-scale farming systems in Ghana reported similar findings.

The results from the interviews with the research participants revealed that sorghum, maize (y), maize (w) and millet are the crops that are cultivated around the compound farm fields. The main reason that emerged from the semi-structured questionnaire is that the farm fields around the compounds are fertile due to the dumping of refuse (SSQ26-T-Male, SSQ3-D-Female, SSQ16-D-Female, and SSQ29-T-Male). Similarly, it emerged from the data the presence of animal droppings improves the soil fertility (SSQ27-T-Female, SSQ11-D-Male, and SSQ8-T-Female). To the respondents, they cultivate the above crops because these crops need very fertile lands to do well. The data also revealed that the dropping of refuse and animal droppings saves farmers from buying fertiliser (SSQ28-T-Male). However, the results suggested that maize (w) can be cultivated outside the compound farm fields on condition that the farmer applies fertiliser as detailed by a female participant in a focus group discussion in the village of Tie as follows: *"…unless you have fertiliser, maize (w) will not do well in any bush farm field. When the seeds are sown, they germinate nicely but fail to grow, and yield properly. Once the fertiliser is not available, it will not do well"* (Focus Group, Female participant, Tie Village).

Furthermore, the respondents pointed out that groundnuts and bambara groundnuts are not ideally suited to be cultivated around the compound farm fields. It emerged from the data that groundnuts and bambara groundnuts if cultivated in the compound farm fields, they will increase in size and produce less yield as they do not need very fertile land (see table 5.1).

Table 5. 1 Farmer illustrations of the cultivation of crops in the bush farm fields

Crop (s)	Farmer Quotes
Groundnuts	*Because the farmlands around the compounds are very fertile hence these crops will over increase in size and produce little yield (SSQ30-T-Male)* *Such lands are less fertile but these crops do well on such lands (SSQ32-T-Male)*
Bambara groundnuts	*"If you cultivate the Bambara beans around the house, it will not do well. When you farm them around the house, they will only grow well but will not yield. That is why we have to send them the bush. It in the bush that I that I farm my Bambara beans. The nutrients will make them grow well but will not yield, if you farm around the house". (HCS-5-D-Male)*

Source: Fieldwork (Doggoh and Tie villages, 2016)

How has the spatial allocation of crops changed now, as compared to the past?

Analysis of the data from the focus groups, and household case studies in both the Doggoh, and Tie villages suggests that farmers now allocate less attention to the bush, and riverbank farm fields, and more time for the farm fields around the compounds. Five themes have emerged from the analysis of the data to explain why farmers cultivate more of the compound farm fields now as compared to the bush, and riverbank farm fields. These include: (i) the diversification of women's livelihood activities (ii) increasing priority in sending children to school, (iii) changes in climatic conditions, (iv) the influence of modernity, and (v) more labour requirement of the riverbank farm fields. During the analysis, it emerged that the above five factors are intertwined in some sense. For example, the data indicate that women (Focus Group, Female Participant, Doggoh), and children (Focus group, Female Participant, Doggoh) used to go and live in the bush farm fields to take care of the crops.

However, because women now have diverse livelihoods (Focus Group, Female Participant, Tie), and because children are now sent to school (Focus Group, Female participant, Doggoh), that translates into no caretakers for the farms in the bush farm fields therefore households now pay less attention to them[69].

[69] See table 5.2 for a detailed illustration of less importance attached to bush and river bank farm fields

Table 5. 2 Illustrations of farmers' negative evaluation of cultivating bush, and riverbank farm fields

Reason	Farmer quotes
Women's livelihood diversification	"*now you see, after sowing the crops, I may want to brew pito or sell 'koosee'…so if I go to sell 'koosee', who will be there to take care of the bush farms" (Focus Group, Female participant, Tie)* *"You see, a man can ask the wife to go and take care of the crops in the bush farms, but she may also want to do something else… if I go to look after the crops and he cannot help me out in some regard, I would not go to the bush farm… so if the man alone goes to the farm and sows the crops and come home, animals will remove all the seeds" (Focus Group, Female participant, Doggoh)*
Increased priority in sending children to school	*"For now, I do not see people going to chase birds on the farm. For now, not at all. You will not get a child to go to the farm to chase birds. This is because, when the child gets up, he or she is supposed to go to school. We used not to go to school by then. But now, every child that gets up, goes to school" (Focus Group, Female participant, Doggoh)* *"For now, nobody will have a child and ask him to go and look after the crops at the farm. What the child is to take care of is the school. Hahahaha". (Focus Group, Female participant, Doggoh)*
Modernisation	*"…as I am sitting now, do you think if they ask me to go and take care of crops in the bush farmlands, I will say the place is far….i will not go …those days, they used to live there and take care of the crops then after harvesting sorghum millet, our mothers would carry the harvested products on their heads back home but now people no longer carry them on their heads" (Focus Group, Female participant, Tie)*
More labour intensive	*" ..my son, you see, the river bank farm fields require that we raise big mounds for the crops ..so right now, I only farmer home as the younger ones are in school and the bigger sons have migrated to farm in the south…so I see that now the rainfall is no longer regular, why don't I focus on the compound farms that require less labour intensive as I am old and weak" (HCS-15-D-M)*
Irregular pattern of rainfall	*"Also, the current nature of the rainfall too contributed to the attention to bush farms…. You see, it does no longer rain the way it used to rain in the past, so if we cultivate the far away farmlands in the bush and sow sorghum and millet, that they used to grow, they will not do well" (Focus Group, Male participant, Tie)*

Source: Fieldwork (Qualitative data, Doggoh and Tie, 2016).

(c) Agricultural cycle of crops

In sub-sections "a" and "b", the researcher unpacked the crops that are selected in the Doggoh, and Tie villages and the suitable farm fields for each crop respectively.   In this sub-section, the scope is to understand the agricultural calendar of crops. In particular, attention was paid to teasing out how the current crop cycle for the two villages is different from that of the past. It is essential to understand this as it would give us a nuanced understanding of changing cropping systems, which will contribute to the formulation of robust agricultural policies in helping farmers to adapt to the changing climate.

The data from the household case studies were analysed to understand the changes associated with the agricultural cycle for the villages of Doggoh and Tie. The data showed that the two villages have the same crop cycle. The results indicate that the crop cycle for Doggoh and Tie starts with ploughing and sowing of yam in April and May, and ends with the harvesting of crops in November with millet and sorghum being the last in the cycle[70].

[70] See table 5.3 for the crop cycle of the Doggoh and Tie villages

Table 5. 3 Crops cycle in an agricultural season

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Yam												
Sorghum												
Maize (Yellow)												
Maize (White)												
Millet												
Beans												
Groundnuts												
Bambara groundnuts												

KEY

	Ploughing /Sowing
	Staking/Mulching
	Harvest 1/ Earthing-up
	Harvesting/Storage
	Weeding/Uprooting of weeds/Spraying
	Transplanting/earthing up
	Weeding/fertiliser application (round 1)
	Earthingup/fertiliser application (round 2)

Source: Fieldwork (Doggoh and Tie, 2016)

How has the crop cycle changed now, as compared to that of the past?

The results from the data illustrate that the current crop cycle of the villages of Doggoh and Tie is different from that of the past. Farmers noted that they need used to raise yam mounds as soon as sassaba[71] *arrived latest in in early March (HCS-2-D-M). Similarly, it emerged that the cycle of maturation and harvesting of crops have changed*[72]*.*

Table 5. 4 Farmer illustrations of changes in the agricultural calendar

Farming activity	Farmer quotes
Raising of yam mounds	*"Those days, it used to start raining early in March known as Sassaba then people will clear the farm fields for yam raising- then later in March, it would rain again for them to raise the yam mounds" (HCS-2-D-Male)*
Ploughing of farm fields	*"… You see, in the past, the ploughing of all farm fields was always done by the fourth month after Christmas. But now there is no order as to what farming activity comes before the other- we just cultivate all crops anyhow" (HCS-16-D-Male)*
Harvesting of crops	*"…. Those days, in the beginning of April, we had already eaten bean leaves, then by April ending, then we harvested beans (the ones they called tabounaa or so). Then by June, all beans were harvested and stored already then groundnuts started developing yields- then in August, the young ones would gamble with groundnuts around the village square" (HCS-2-T-Male)*

Source: Fieldwork (Doggoh and Tie villages, 2016)

[71] The first rain after Christmas that falls to clear all the remains of the bush burnt during the during season (VIKI-1-D-M, VIKI-1-T-M)

[72] See table 5.4 for farmers' illustration of changes in the agricultural cycle of crops

5.2.2 Labour dynamics and gender roles in the agricultural season

Having presented and discussed results on the crops that are cultivated, their respective spatial locations, and crop cycle in sections 5.2.1, this section presents results on the labour dynamics in the agricultural season, teasing out specific gender roles. The objective of the section is threefold: one, to understand the labour sources households employ in undertaking their agricultural activities; two, to characterise gender roles in terms of what men, and women do in the agricultural season; and three, to tease out what activities men or women are not allowed to partake in, and why?

Labour sources for households' agricultural activities

The results from the field data reveal that households rely on family labour (FL), voluntary labour (VL), Social Obligation Labour (SOL), use of tractors (TR), Voluntary Farming Working Group (VFWG) as well as hired labour (HL) in undertaking the different agricultural activities in the agricultural season[73]. In the context of this study, FL refers to households using solely the labour force of its members. Labour sources like TR, HL, as well as FL sources are straight forward. The results from village individual key informants (VIKI) interviews explain the other sources of labour for household agricultural activities.

For VFWG locally known as *kpetaa*[74], data from VIKI interviews suggest that *kpetaa* helps all the members of the group to go about their agricultural activities on time. Table 5.5 indicates that households employ VFWG in ploughing, weeding, earthing up as well as harvesting of crops.

[73] See table 5.5

[74] *Kpetaa* – a voluntary working group of people mainly of the same age category that work on one another's farm on rotational basis (VIKI-1-D-M, VIKI-1-T-M)

A key informant in Doggoh explains that: "*Kpetaa is about helping one another… like you have your farm and I also have my farm, then another person has his farm too. When it rains you see that going to the farm alone, how long you can till the land ….it is supporting each other. You have to come so that we form as a group signifying agreement and schedule. Let us assume it rains today, one may agree we till your land or mine tomorrow and the other person's land subsequently. Once you go to someone's farm, you help the fellow and eat, and next day you go to another person's farm……that is kpetaa. Then next day you go to another person's farm. That is what you do until you till everyone's farm…"* (VIKI-1-D-M).

Besides households drawing on the labour of its members, going unto VFWG, the VIKIs identified *baalung kouw*[75], and *dee kouw*[76] respectively as forms of VL and SOL in a given agricultural season. However, it is worthy to note that households mainly employ VL during sowing of crops, weeding as well as during harvesting of crops. Similarly, it emerged that SOL is used during ploughing, weeding and earthing-up of crops[77]. A VIKI in the Village of Tie defines baalung kouw as follows: *"--let's assume you and i are friends that move together, then during a given farming season, if you are constrained to go about your farming, you can plead with me to get two, three or more people to come and help you with your farming activities -for example to till a small piece of land or weed some crops --so people do go together to help others in the regard of farming. Apart from your friends you can also plead with friends to go and till the land of your brother's wife who has no one to take care of her*" (VIKI-1-T-M). Unlike the *kpetaa* which is a mutual agreement among friends, results indicate that *dee-kouw* deals with son-in-laws being required and governed by societal expectations to go and help their father-in-laws in their farming activities.

---

[75] Baalung kouw – friends assisting one another in their farm activities (VIKI-1-D-M, VIKI1-T-M)
[76] Dee kouw- a son-in-law organising friends to help the father-in-law with farming activities (VIKI-1-D-M, VIKI-1-T-M)
[77] See table 5.5

VIKI-D-T-M details *dee-kouw* as follows: *"......if you marry someone's daughter and once the farming season sets in and your father in-laws is well to do or is somehow financially stable he can ask you to come and farm his land......sometimes your in-law can come today and ask you to come and till his land in a week's time.....once your in-law makes his request, you need to organize some friends and relations to go and till your in-law's farm. In the event of not getting so many people at the requested time, you have to let you in-law shift the date to probably two or three weeks for you to have enough time to organize the people together.............if your in-law understands issues easily he will wait but if he is the type who does not easily understand matters, and want you to come on his proposed date, if you get only two or three people but you will go and explain to your in-law that your friends had some coming activities that coincide with his proposed date hence the few number that you brought*" (VIKI-1-T-M).

The finding that a son-in-law is customarily required to go and help his father-in-law are similarly reported in the literature on farming systems in northern Ghana. In an attempt to classify farm labour, Benneh (1988) classified a son-in-law going to farm for his father-in-law as a compulsory faming group. Benneh reported that it is a requirement for a son-in-law and from time to time to cultivate his father-in-law's farm with his friends. In the Kaleo area of north-west Ghana, Benneh documents that, it is required that a son-in-law performs farming activities on his father-in-law's farm for at least four different four different occasions for different farming activities. Interestingly, the data from the VIKIs reveal that there are some changes some of the above labour sources that households employ for their agricultural activities. Specifically, it emerged that there is a decline in households employing *dee kouw* in particular.

VIKI-1-D-M explains that "you *see- now it I sonly few people who will invite their son-in-law to come and help them till their farmland. Hmmmm, the rainfall is no longer reliable- when you invite your son-in-law to till your land, you will spend a lot of money in feeding them. You have to prepare food for them in the farm, ten you are required to feed them at home with food and meat, and they brew or buy pito for them to drink at your house before they depart. You see, it is very costly to do that- so if you risk all this and it does not rain, then what is the point...Laughter…so we don't practice that more now" (VIKI-1-D-M).*

How are the roles in agricultural activities socially differentiated?

The results demonstrate that some activities in the agricultural season are: exclusively undertaken by either males or females, both males and females with the dominance of one gender, and males and females playing equal roles[78]. Respondents cited earthing-up of sorghum and millet, the processing of sorghum into *kagyin* [79] and spraying of crops (i.e. maize, and beans) as exclusively male roles. Mulching of yam, transplanting of sorghum, and millet, the drying of farm produce, and winnowing of farm produce (i.e. sorghum, groundnuts, beans, bambara groundnuts and millet) have been identified as exclusively women's roles. In the regard of agricultural roles that males dominate, respondents mentioned ploughing of farm lands (except bambara groundnuts that women also take part in ploughing), staking of yam, and weeding of all crops (apart from bambara groundnuts). The finding of women being in-charge of transplanting sorghum and millet and the mulching of yams agree with other studies in northern Ghana (see Benneh, 1988).

[78] See table 5.5

[79] *Kagyin – a number of pieces of the best yield of sorghum being tight together (VIKI-1-DM, VIKI-1-T-M)*

The data suggest that women cannot engage in some agricultural activities. For example, many respondents claim that women cannot get involved in the sowing of yam. The reasons for the non-engagement of women in the sowing of yams, stems from women not been taught how to do it, and because of the menstrual cycles that they go through. A female household case study participant in the village of Tie opines that *"We have not been taught how to sow yams…it is only the job of men"* (HCS-7-T-Female). Similarly, male participants claim that in north-western Ghana, it is not the job of women to sow yams. A male participant states his view as follows: *"In this part of our world, women are not permitted to sow yams. Men sow yams and the women cover the top of the yam mounds with leaves. You see, just as women do not cook food during menstruation, they are equally not allowed to sow yam…if they do, the yam would get rotten"* (HCS-15-T-Male).

Despite many agreeing that the sowing of yams is the sole responsibility of men, some few respondents argued that women can undertake sowing conditionally. A male participant in the household case study in Doggoh stated his opinion as follows: *"It is not against the tradition of our land for women to sow yams but once you are the man, it is your task to do the sowing of yam. But in your absence, your wife can get some voluntary labour to raise the yam mounds for her, then if she knows her to prepare the seeds, she can do that and sow them and mulch them later" (*HCS-15-D-Male).

Table 5. 5 Sources of labour for households' agricultural activities and gender roles in an agricultural season

Crop	PL	SW	ST	MU	WD	HA1	EU	HA2	SG	BA	TM	WI	SPR	DRY	TP	TH	FA
Yam	FL, VL M	FL, VL M	FL, VL, B-M	FL, VL, W	FL, M	FL, VL, M	FL, VFWG, M	FL, VL, B-M	FL, M								
Sorghum	FL, SOF, VFWG, M	FL, W			FL, SOF, VFWG, M	FL, VFWG, B	FL, SOF VFWG, VL, HL, M		FL, B					FL, W	FL, W	FL, W	
Groundnuts	FL, VFWG, VL, HL, TR, SOF M	HL, VL, FL, W			VFWG, VL, SOF HL, B-M	HL, FL, VL B			FL, B	FL, B	FL, B			FL, W		FL, HL, B	
Maize (Y)	FL, SOF VFWG, VL, M	FL, VL W			FL, SOF, M	FL, B	VFWG, SOF, FL, M		FL, B	FL, B	FL, B	FL, W	FL, M	FL, W		FL, W	FL, B
Maize (W)	VFWG, SOF, FL, HL, TR, VL, M	FL, VL B-W			VFWG, FL, SOF HL, TR, VL, M	FL, VL, B	VFWG, FL, SOF, HL, VL, M		FL- B	FL, B	FL, B	FL, W	FL, M	FL, W		FL, W	FL, B
Beans	VFWG, SOF, FL, HL, VL, M	VFWG, FL, HL, VL, W			VFWG, SOF, FL, HL, VL, M	FL, VL, B			FL, B-W			FL, W	FL, M			FL, W	
B. groundnuts	FL, HL VFWG, B-M	FL, W			FL, HL VFWG, B-W	FL, B-W			FL, W	FL, W	FL, W	FL, W		FL, W		FL, W	
Millet	FL, VFWG, M	FL, W			FL, VFWG, M	FL-B	FL, VFWG, M					FL, VL, VFWG, W		FL, W	FL, W	FL, B-M, VFWG	

KEY

Farming activity

PL-Ploughing, SW- Sowing, ST- Staking, MU- Mulching, WD- Weeding, HA1- Initial harvesting, EU- Earthing up, HA2- Main harvesting, SG- Storage, BA- Bagging, TM- Treatment , WI– Winnowing, SPR- Spraying, DRY- drying, TP- Transportation, TH- Threshing, FA- Fertiliser (manure) application

Farm Labour

FL = Family Labour, **VL**= Voluntary Labour, **VFWG**= Voluntary Farming Working Group, **HL** = Hired Labour, **TR**= Tractor, SOF- Social Obligation Farming

Gender dynamics of labour

M=Men, W= Women, B= Both, B-M = both men and women with the dominance of men, B-W = both men and women with the dominance of women.

Source: Fieldwork (Household case studies, Doggoh and Tie villages, 2016)

The results in table 5.3 above indicated that farmers end their farming activities in November and from December to March no agricultural activity. The question is that, *what do farmers do during the long dry season from November till March?* Therefore, section 5.2.2 is devoted to understanding the livelihood activities of households during the dry season.

5.2.3 Dry season livelihood activities of households

The focus shifts in this section of the chapter to understand the livelihood activities of the villages of Doggoh and Tie during the dry season. It is essential to understand this as the results pointed out that farming ends by November[80]. The data presented here is from the scoping exercises that were carried out to understand the dry season livelihoods of the people of Doggoh and Tie villages. The data were elicited mainly via participant observation. Occasionally, the data collection also involved unstructured informal interactions with dry season gardeners and villagers.

[80] See section 5.2.1 (table 5.3)

(a) Dry season gardening

The scoping exercise revealed that the villages of Doggoh and Tie have the *Charee* and *the Konzokalaa dams* close to them respectively. Therefore, households in the two villages do engage in gardening activities during the dry season. It emerged from the data that tomatoes, pumpkin leaves, and bean leaves are the main vegetables that are cultivated in the *Charee* dam. In addition, the Konzokalaa dam cultivates cabbage, onions, and garden eggs. Through the informal interactions with the gardeners, it emerged that the two dams together with other dams such as the Tizza dam, *Karni* dam supply the vegetable needs of the Jirapa Municipality and beyond. Despite the contributions of these dams to the food and income needs of the households within Doggoh and Tie, the gardeners opined that they have some challenges. For example, it emerged that the siltation of the *Charee* dam confronts gardening activities in the people of Doggoh.

Spatial differentiation of gardening activities

Besides, the differentiation regarding vegetable cultivation between the two dams, data from the participant observation and informal communication with the gardeners revealed other differences (see table 5.6). It emerged from the data that the dam in Charee dries earlier than that of the Konzokalaa dam (see picture 5.1). In picture 5.1, the letters "a" and "c", and "b" and "d" represent the Konzokalaa and Charee dams respectively. A male gardener opines the drying up of the dam and its effects as follows:

"Those days, we used to do gardening until the fourth or fifth month of the year when the farming season will set in for us to stop work for owners of the land to cultivate rice and sometimes maize. Hmmmn, now, we finish around February or March. However, this particular year, we are so scared whether our activities can progress into March as the water level is going down critically."

(Male Gardener, *Charee* dam, 14th February 2016)

The opinion of the above gardener is in line the picture that was taken by the researcher as part of the participant observation exercise. Picture 5.1 shows the water level in the Konzokalaa dam was still high as at 24th of February 2016 whereas that of the Charee dam was critically down as at 22nd February 2016.

Table 5. 6 Illustration of spatial differentiation of gardening activities in Doggoh and Tie

Konzokalaa dam	Charee dam
Water level takes longer time before drying up	Water level dries up so early
Cabbage, bean leaves, pumpkin leaves, tomatoes, onions, and garden eggs are produced	Only pumpkin leaves, bean leaves, and tomatoes are produced
More logistics (e.g. pipes connected to gardens, and generators, water pumping cables)	Few gardeners with generators but many use manual watering cans
Women benefit from the Resilient and Sustainable Livelihoods Transformation to cultivate onions (RESULT Project)	Women do not benefit from RESULT PROJECT

Source: Fieldwork (Scoping, Konzokalaa and Charee dams, 2016

Picture 5. 1 Spatial differentiation of gardening activities for the Konzokalaa and Charee dams

Source: Fieldwork (Scoping exercise, Doggoh and Tie villages, 2016)

The results from the informal interactions with gardeners in the Charee dam indicate that they have displaced the cultivation of cabbage, garden eggs, onions because the dam dries so quickly now. The intermittent nature of the dam translates into many potential consequences on dry season gardening including the displacement of some vegetables. Through interactions with gardeners, a gardener expressed his experience on problems associated with water scarcity in the Charee dam as follows:

"We have stopped cultivating cabbage, lettuce, pepper and garden eggs because they need a constant amount of water to mature well. However, by the time they are about to mature, the dam dries up, and they get spoiled."

(Male Gardener, Charee dam, February 2016)

In the case of the Konzokalaa dam, the water level is quite stable hence dry season gardening takes place longer than that of Charee. They still cultivate Cabbage and onions apart from the mainstream vegetables, i.e. tomatoes, bean leaves, pumpkin leaves and okra. The dam has support from the Canadian Feed the Children in partnership with the Association of Church based NGOs in Ghana.

Transportation and sale of vegetable products

The data from informal interactions and the participant observation suggest that both men and women transport the vegetables from both the Charee and the Konzokalaa dams to the market centres. Men carry them on tri-motorcycles, motorbike or a bicycle depending on the quantity. Women carry them in pans and baskets (see picture 5.2 for details).

Picture 5. 2 Illustration of the transportation of vegetable products

Source: Fieldwork (Scoping exercise, Doggoh and Tie villages, 2016)

Gender differentiation of gardening activities

As per the participant observation, data suggest that dry season gardening activities are primarily carried out by men. Women mainly come in when during the harvesting period of the vegetables. The only exception is the case of the Konzokalaa dam where women are supported by the Resilient and Sustainable Livelihoods Transformation project (RESULT) for the cultivation of onions are indicated in picture 5.3.

Picture 5. 3 Illustration of the Onion gardening by women in the Konzokalaa Dam

Source: Fieldwork (Scoping exercise, Konzokalaa Dam, 2016)

The results in sub-section "a" on dry season gardening revealed that if enhanced, dry season gardening could be useful in improving the income levels of households, food for household, and contribute to reducing the rate of migration of people particularly the youth that drift to the southern part of Ghana. This therefore warrants some policy attention as detailed in section 7.4.1.

The scoping exercise went beyond understanding agricultural related livelihoods of the villages of Doggoh and Tie to understand other non-farm livelihood activities. Therefore, sub-section "b" is devoted to understanding non-farm livelihoods of the villages of Doggoh and Tie.

(b) Non-farm dry season livelihood activities of households

The researcher paid vital attention during the participant observation exercises to tease out non-farm activities that households engage in the dry season. It emerged from the scoping that men engage themselves in small-scale businesses, the laying of bricks, the construction of buildings, and the sale of livestock[81]. Similarly, the data pointed out that women engage in charcoal and firewood sale, the extraction of shea nuts into butter oil, the brewing and sale of pito at market squares and funerals, and the sale of *kosee*[82][83]. The finding on women being engaged in the

---

[81] See picture 5.5

[82] *Kosee – it is a traditional cake that is fried from beans flour (VIKI-8-D-F, VIKI-8-T-F)*

[83] See picture 5.4 for the off-farm dry season livelihoods of women

brewing of *pito,* the sale of firewood and the sale of *kosee* are similarly reported by Banuoku et al. (2017) in a study in the Upper West region of North-west Ghana.

Picture 5. 4 Illustrations of women's livelihood activities during the dry season

Source: Fieldwork (Scoping exercise, 2016)

Picture 5. 5 Illustrations of men's livelihood activities during the dry season

Source: Fieldwork (Scoping exercise, 2016)

5.2.4 Summary

Finding 1: Changing main crops

- The results revealed that maize (w), groundnuts, sorghum, maize (y), beans as the main crops cultivated in the villages of Doggoh and Tie. In addition to the above, bambara groundnuts was mentioned as among the main crops in the village of Doggoh. This finding is similar reported by studies in North-west Ghana (see Banuoku et al., 2017, GSS, 2014, Naab and Koranteng, 2014).
- The results demonstrated that sorghum has lost its position as the largest cultivated crop among the main crops to maize (w) in both the villages of Doggoh and Tie. Similarly, the results showed that millet had lost its place as among the main crops in both the Doggoh and Tie villages (see section 5.2.1).

Finding 2: Changing attention to bush and riverbank farm fields

- The villages of Doggoh and Tie practice compound, riverbank, and bush farm fields. The data indicate that groundnuts and bambara groundnuts are not ideally suited to being cultivated around the compound farm fields as such farm fields are very fertile and groundnuts and bambara groundnuts will only increase in size and produce less yield. The results also demonstrated that households currently attach more importance to the compound farm fields than the bush and riverbank farm fields primarily due to climate variability and change. Other factors that emerged in the data include children being sent to school and women diversifying their livelihoods hence no caretaker of bush farm fields, no labour force for riverbank farm fields, as they are labour intensive (see section 5.2.1). The finding on less attention now being attached to bush and river bank farm fields implies that farmers are more likely to displace or reduce the farm size for the crops that are cultivated on them in attempts to respond to climate variability and change.

Finding 3: Changing Agricultural cycle of crops

- The agricultural cycle of crops is the same for both the villages of Doggoh and Tie. It starts with the raising of yam mounds in April and May and the harvest of crops in November. The agricultural cycle of crops now is not the same as that of the past (see section 5.2.1).

Finding 4: Sources of labour for household agricultural activities

- The results showed that households rely mainly on family labour for their agricultural activities. It emerged from the data that other sources include Voluntary Farming Working Group (VFWG), Voluntary Labour (VL), Social Obligation Labour (SOL) and Hired Labour (HL). It emerged that the earthing-up of sorghum and millet, the processing of sorghum into kagyin, and the spraying of crops are exclusively masculine roles. The mulching of yam, transplanting of sorghum and millet, the drying of farm produce, and winnowing of farm produce are exclusively feminine. The data indicate that men and women complement each other in the other agricultural tasks (see section 5.2.2).

- The data identified dry season gardening as one of the activities of men during the dry season. Men are largely engaged in gardening activities with women being supported in recent times in the village of Tie to engage in onion production by RESULT project. The data revealed that the dam in Doggoh; Charee dries quickly and that warrants policy attention. The data pointed out bricks laying, the sale of livestock, the construction of buildings and migration to southern Ghana as the non-farm livelihoods of men in both the Doggoh and Tie villages. Similarly, it emerged in the data that women engage in pito crewing, the sale of kosee, the extraction of shea butter oil, the sale of charcoal and firewood, and small-scale businesses (see section 5.2.3).

5.3 Understanding Farmers' Responses to Climate Variability and Change

As reviewed in section 2.5.3, the discourse on adaptation is so high on the agenda of academics, governments, and policymakers, with critical attention on limits and barriers to adaptation. Present understanding of the processes of adaptation to climate change suggests that actions occur when risks are known and when resources are available to minimise these risks or reduce vulnerabilities (Hulme et al., 2007). Protagonists of social limits to adaptation (e.g. Adger et al., 2009, Hulme et al., 2007, Jones and Boyd, 2011, Smith et al., 2010) contend that previous analyses have considered adaptation from a narrower standpoint: focusing on ecological, physical, economic or technical processes. This section contributes to the literature on social limits to adaptation via farmers' cropping decisions.

The Theory of Planned Behaviour (TPB) is used in this section to understand farmer adaptation behaviour, and the Social Identity Theory (SIT) guides the presentation of the results on why farmers are not adapting to CVC via crop selection. In subsection 5.3.1, results are presented on the characteristics of the farmers who are responding or not responding to CVC. Then individually, sub-sections 5.3.2, 5.3.3, and 5.3.4 present results on how farmers' attitudes, farmers' perceived behavioural control (PBC), and farmers' social identification shape their cropping decisions under CVC respectively. It is essential to tease out the characteristics of the farmers who are adapting or not adapting to CVC. Understanding adaptation and the social limits to adaptation will equip extension and policymakers direct intervention adaptation programmes appropriately.

5.3.1 Characterising farmer responses to climate variability and change

The results indicate two pathways regarding farmer cropping decisions under climate variability and change for the village of Doggoh: (i) farmers that cultivate the improved variety of groundnut only (i.e. *kyaana)* and farmers that cultivate both *kyaana* and traditional varieties of groundnuts (*dagarasinkaa).* However, for the village of Tie, three pathways emerged: *(i)* farmers that cultivate only *kyaana*, *(ii)* farmers that cultivate only *dagarasinkaa*, and (iii) farmers that cultivate both the *kyaana* and *dagarasinkaa* varieties. Therefore, the focus of this subsection is on understanding those farmers who have changed variety entirely, kept both varieties, and farmers who have not changed the traditional variety of groundnuts. Similarly, it is noteworthy that this section does not in any way explain why farmers are responding or not responding to CVC via crop selection as that is devoted to sections 5.3.2, 5.3.3, and 5.3.4.

To achieve the objective of this section, the researcher draws on data from the semi-structured questionnaire by running cross-tabulations. Individually, a cross-tabulation was run using the variable 'varieties of groundnuts cultivated now' as against the variables 'sex of the head of the household', 'age of the household head', 'the educational status of the head of the household' and 'the wealth status of the household'. The results for the villages of Doggoh and Tie are presented separately, and a comparison is made of the two at the end[84].

---

[84] Table 5.9 has a summary of the results of the spatial differentiation of the cultivation of the traditional variety of groundnuts

Doggoh village: Who cultivates the traditional variety, and who grows the improved variety?

The data from the semi-structured questionnaire reveal that farmers in the village of Doggoh cultivate two varieties of groundnuts: *kyaana*[85] also known as *kpankpaaba*[86] (improved variety) and dagarasinkaa (traditional variety). Results from the cross-tabulation suggest that out of the 75 households surveyed in the village of Doggoh, 71 households cultivate only the improved variety of groundnuts, and 4 households cultivate both the improved and the local varieties of groundnuts[87]. Therefore, the cross-tabulation analysis is focused on the proportion of males out of the total males interviewed that cultivate only the *kyaana* variety, and both the improved and traditional variety of groundnuts. Similarly, the same procedure is carried out for the female farmers that were interviewed.

(a) Sex of respondents

The data indicate that more female-headed households (100.0%) are completely responding to CVC via the cultivation of only the improved varieties of groundnut than the male-headed households (93.3%). Similarly, the data reveal that males head all the households that cultivate the both the kyaana and traditional varieties of groundnuts and no female headed household cultivates both varieties of crops[88].

---

[85] Kyaana – The village key informants explained that it is known as kyaana because it is a strange crop and not that of their ancestors (VIKIs, Doggoh and Tie).

[86] *Kpankpaaba* – The village key informants claimed migrant farmers from their villages got this variety when they visited a place called *kpankpaaba* land in North-east Ghana. To them the migrants realised it was very good in the regard of yield –hence they brought it to their land and with time it got to everyone in the two villages (VIKIs, Doggoh and Tie).

[87] See table 5.7

[88] See table 5.7

(b) Age of respondents

The results indicate that more households within the age bracket; 21-40 (100.0%) and 41-65 (94.9%) are entirely responding to CVC via by selecting the improved variety of groundnuts than those within the age brackets 66-95 (89.5%). This demonstrates that more young farmers and middle-aged farmers are responding to CVC than the older farmers. The results also demonstrate that the younger farmers are adapting to CVC as no farmer within the age bracket 25-40 years grows both the improved and traditional variety of crop. In the regard of partial adaptation to CVC, the data indicates that more older farmers (10.5%) than the farmers within the middle age bracket (5.1%) cultivate both the traditional and improved varieties of groundnuts[89].

(c)Wealth status of respondents

On the parameter of the wealth of the households, the results showed that more poor households (100.0%) are entirely responding to CVC by cultivating the improved variety of groundnuts than those who are rich (96.0%) and semi-rich (88.0%)? The results in section 5.3.2 reveal that the harvesting of the traditional variety of groundnuts requires the hiring of labour to help in the harvest process. The respondents observed that it is difficult in recent times to get voluntary labour for the harvesting of the *dagarasinkaa* variety of groundnuts (see subsection "a" of section 5.3.2). On teasing out among the wealth status of the households, the results reveal that out of the four households that are partially responding to CVC by still both the improved and traditional variety of groundnuts, no poor farmer (i.e. 0.0%) cultivates that. However, more households in the semi-rich (12.0%) and the wealthy households (4.0%) categories cultivate the *two* varieties of groundnuts[90].

---

[89] See table 5.7

[90] See table 5.7

(d) Education of respondents

On the element of level of education attainment of the respondents, more uneducated farmers (96.7%) are responding by entirely cultivating the *kyaana* variety of groundnuts than the educated farmers (86.7%). However, more educated farmers (13.3%), than the uneducated farmers (3.3%) are partially responding by cultivating both the traditional and improved varieties of groundnuts (see table 5.7 for details).

Table 5. 7 Percentage of farmers who are adapting or not adapting to CVC via the selection of groundnuts by age, sex, wealth and education in Doggoh Village (N = 75 in each category)

Variable		Variety of groundnuts	
		Kyaana only n (%)	Kyaana and dagarasinkaa n (%)
Sex	Male	56 (93.3)	4 (6.7)
	Female	15 (100.0)	0 (0.0)
Age	21-40	17 (100.0)	0 (0.0)
	41-65	37 (94.9)	2 (5.1)
	66-95	17 (89.5)	2 (10.5)
Wealth	Poor	25 (100.0)	0 (0.0)
	Semi-rich	24 (88.0)	3 (12.0)
	Rich	24 (96.0)	1 (4.0)
Education	Educated	13 (86.7)	2 (13.3)
	Uneducated	58 (96.7)	2 (3.3)

Source: Fieldwork (semi-structured questionnaire, Doggoh, 2016)

Tie village: ***Who cultivates the traditional variety, and who grows the improved variety?***

All the surveyed female-headed households (100.0%) are responding to CVC by entirely selecting the kyaana variety of groundnuts that is claimed in section 5.3.3 as the variety that is suited to the prevailing climate. However, 86.7% of the male farmers are entirely cultivating the kyaana variety of crop. On the aspect of the farmers not changing the traditional variety of groundnuts, more male farmers (3.8%) and no female farmer (0.0%) cultivates that. Similarly, on the element of partial adaptation, only male farmers (9.6%) and no female farmer cultivates both varieties (table 5.8).

On the aspect of age, results demonstrate that more households within the age bracket 21-40 (94.7%) and 41-65 (94.3%) than the older farmers; 66-90 (81.0%) are responding to CVC by cultivating entirely the kyaana variety. The results suggest that the older farmers are less responding than the younger and the middle-aged farmers. The results also reveal that only the older farmers (9.5%) are not responding to CVC by still cultivating the traditional variety of groundnuts as no farmer within the age bracket 21-40 (0.0%) and 41-65 (0.0%) only cultivates the traditional variety of groundnuts. All the age groups are cultivating both the improved and the traditional varieties of groundnuts. However, more older farmers (9.5%) and middle aged farmers (5.7%) than the young farmers (5.3%) are cultivating both varieties of groundnuts.

The results indicate that no poor household (0.0%) in the village of Tie cultivates the traditional variety of groundnuts[91]. However, the same proportion of rich and semi-rich farmers (4.0%) cultivates the traditional variety of groundnuts. The data also demonstrate that more poor households (100.0%) than the semi-rich (88.0%) and rich (84.0%) households cultivate the *kyaana* variety of groundnuts. On the aspect of the farmers that

[91] The results in section 5.3.3 explain why the poor households are reasoning along such lines.

cultivate both varieties of groundnuts, more rich farmers (12.0%) and semi-rich (8.0%) and no poor farmer (0.0%) cultivates both varieties of groundnuts.

Cross-tabulating the 'varieties of groundnuts that are cultivated now' against the 'educational status of the head of the household', the results show no link between the farmers' educational level and adaptation to CVC via the selection of groundnut varieties. The results indicate that more of the farmers with no level of education (93.3%) cultivate the improved variety of groundnuts than farmers who are educated (90.0%)[92]. However, only educated farmers (3.3%) cultivate the traditional variety of groundnuts and no uneducated farmer cultivates that. On the element of partial adaptation, the same proportion of educated and uneducated farmers (i.e. 6.7%) cultivate both the improved and traditional varieties of groundnuts.

[92] The details of the cross-tabulation are indicated in table 5. 8.

Table 5. 8 Percentage of farmers who are adapting or not adapting to CVC via the selection of groundnuts by age, sex, wealth and education in Tie Village (N = 75 for each category)

Variable		Variety of groundnuts		
		Kyaana only n (%)	Dagarasinkaa only n (%)	Kyaana and Dagarasinkaa n (%)
Sex	Male	45 (86.5)	2 (3.8)	5 (9.6)
	Female	23 (100.0)	0 (0.0)	0 (0.0)
Age	25-40	18 (94.7)	0 (0.0)	1 (5.3)
	41-65	33 (94.3)	0 (0.0)	2 (5.7)
	66-90	17 (81.0)	2 (9.5)	2 (9.5)
Wealth	Poor	25 (100.0)	0 (0.0)	0 (0.0)
	Semi-rich	22 (88.0)	1 (4.0)	2 (8.0)
	Rich	21 (84.0)	1 (4.0)	3 (12.0)
Education	Educated	54 (90.0)	2 (3.3)	4 (6.7)
	Uneducated	14 (93.3)	0 (0.0)	1 (6.7)

Source: Fieldwork (semi-structured questionnaire, Tie, 2016)

Table 5. 9 Spatial differentiation of the cultivation of the varieties of groundnuts

Doggoh	Tie
There is no household that cultivates only the dagarasinkaa variety of groundnuts	There are few households that cultivate only the dagarasinkaa variety of groundnuts
More educated farmers cultivate both the kyaana and dagarasinkaa varieties of groundnuts than the uneducated farmers	The same proportion of educated and uneducated farmers cultivate both kyaana and dagarasinkaa
There are more semi-rich households than rich households that cultivate both the kyaana and the dagarasinkaa varieties of groundnuts	There are more rich households that cultivate the kyaana and dagarasinkaa varieties of groundnuts than semi-rich farmers
There are more rich farmers that entirely grow the kyaana variety than the semi-rich farmers	There are more semi-rich farmers that entirely grow the kyaana variety than the rich farmers

Source: Fieldwork (Semi-structured Questionnaire, Doggoh and Tie villages).

5.3.2 Farmers' attitude, and responses to climate variability and change

The results reveal that farmers' attitudes shape farmers' responses to climate variability and change (CVC) via crop selection. Ajzen (1991) argues that attitude is the degree to which we have a favourable or unfavourable evaluation of the behaviours we perform. In the context of this study, smallholder farmers' attitudes are the negative or positive evaluations of their crop selection decisions under CVC. As indicated in section 2.5.2, the researcher argues that, where farmers positively evaluate the cultivation of a given crop under CVC, they are more likely to select such crops. However, where farmers negatively evaluate the cultivation of a given crop under CVC, there are more likely to displace it.

To that end, subsections "a" and "b" are devoted to understanding farmers' negative and positive attitudinal beliefs respectively shaping farmer cropping decisions under CVC.

(a) Farmers' negative attitudinal belief constructs and cropping decisions

The results from the data reveal: perceived poor yield, perceived difficulty in crop cultivation, and processing of yield, and perceived short duration of the rainfall season as the constructs of farmers' unfavourable evaluation of cultivating crops under CVC. The details of each of the above attitudinal constructs are discussed below.

Perceived poor yield and farmers' intention to displace or reduce the farm size of crops

The results from the household case studies demonstrate that farmers' evaluation of the unsuitability of some crops because they produce poor yield under the prevailing climate, has weakened farmers' intention to grow such crops. Notable among these are sorghum (i.e. the gyibaraa, kaziedanbille, and konye varieties), groundnuts (i.e. *beja*[93] and *dagarasinkaa*[94]).

Example 1 Sorghum: the displacement of the traditional varieties

For sorghum, results indicate the short duration of the current pattern of rainfall, and the displacement of bush farm fields contribute to the displacement of the *konye* and *kaziedanbille* varieties. A dialogue with a case study participant gives the details in box 5.1.

---

[93] Beja- the village key informants claimed beja came after the dagarasinkaa from elsewhere (respondents could not specify exactly where that came from but they said it is not their ancestral crop. After cultivating it for some time, they realised it was not yielding good results hence they displaced it (VIKI-1-D-M, VIKI-1-T-M)

[94] Dagarasinkaa- respondents also referred to the dagarasinkaa as kulmo or sinkaamiew (VIKI1-D-M, VIKI-1-T-M)

Farmers' observations of the displacement of the traditional varieties of sorghum are similarly reported ion the stakeholder interviews. An official from MoFA expresses his views as follows: *"...there is now a variety of sorghum known as 'kapilaa' which matures very fast and is drought resistant- therefore farmers are displacing the gyibaraa and kaziedanbille to the cultivation of that"* (SIKI-1-MoFA-M).

Box 5. 1 Dialogue between researcher and case study participant on the displacement of traditional varieties of sorghum

Researcher: *Ok, tell me about the varieties of sorghum that are cultivated by your household now*

Participant: *"For now, the varieties of sorghum that we used to farm are no more. I will not get them again. For the* ***gyibaraa*** *variety for instance, it takes a long time to mature. There was a time that we farmed but it did not mature. We farmed very late that year. So it did not mature. Because of that, we have changed it to a different brand which they call* ***kundabuo****"*

Researcher: *You said your household used to cultivate* ***konye*** *and* ***kaziedanbille*** *varieties of sorghum but now you no longer cultivate that- what accounts for that?*

Participant: *The rain is no more raining as it used to rain. In those days, around the twentieth day of February that we used to sow* ***kaziedanbille****. Then in March, we would sow the* ***konye*** *that I spoke of. In June, we would sow the* ***gyibaraa*** *which are always around the house. But now, the rain, what time does it normally start? Even in June, sometimes, it does not start. Sometimes, it is always in July. So by that time, when you sow any of the old varieties, they will not have any use. The time for cultivating them has passed. If you cultivate them, you will run at a lost. (HCS-5-D-Male).*

Source: Household Case study (Doggoh village, 2016)

The dialogue suggests that HCS-5-D-Male is reasoning along maximising yield hence, in order to meet that objective, he traded-off the long duration varieties of sorghum (i.e. *kaziedanbille, gyibaraa,* and *konye*).

The above results are similarly reported in the literature (e.g. Isshaku and Maharjan, 2014). It is not surprising at all that the *kaziedanbill*e and *konye* varieties of sorghum (which are bush farm field crops) are been displaced as results in section 5.2.1 on the spatial distribution of crops make us to understand that bush farm fields are no longer attached much importance due to farmers' unfavourable evaluation of cultivating the bush farm fields. This again suggests that climate is not the only variable that contributes to the displacement of the traditional varieties of sorghum.

Example 2 Millet: the displacement and reduction in the farm size for millet cultivation

The data from the focus groups and the household case studies pointed out that changes in the local climate of the villages of Doggoh and Tie has shaped farmers' decisions to either reduce the farm size or displace the cultivation of millet as they reported getting very low yield from it[95]. In an interview with an official at the Literacy Bridge Ghana, it similarly emerged that the available varieties of millet are not appropriately suited to the prevailing changing climate[96].

[95] See box 5.2 for farmers' illustration of the displacement and the reduction in the farmland size for the cultivation of millet

[96] See box 5.3 for a dialogue the researcher had with a stakeholder during an interview

Box 5. 2 Farmers' illustration of millet producing poor yield under the changing climate

"You see, i do not longer cultivate any of the varieties of millet. I have stopped farming millet because you suffer to plough the land, sow, weed and transplant and in the long run get very little yield" (HCS-5-D-M)

" Okay…i just cultivate that in a small quantity because it is my ancestral crop but honestly I usually do not get any yield---if you need millet in this village, only few people give you some" (HC6-T-M)

" We have displaced the cultivation of millet….you see, the millet we have is a very complicated crop….the food tastes nice but if you concentrate on cultivating that, then you always want to get hungry….those that produce it get very little yield" (HCS-3-T-F)

"I stopped cultivating it five years ago- the reason being that by the time it is about to yield, the rainfall ceases then we only get very little yield" (HCS-4-D-M)

Source: Household case studies (Doggoh and Tie villages, 2016)

Box 5. 3 An illustration of the non-availability of improved varieties of millet by a stakeholder

Researcher: "Sir, you earlier indicate your organisation works in partnership with Ministry of Food and Agriculture to recommend improved varieties of crops to farmers. Please which crops within the district will you say are most risk to the impacts of climate variability and change?

SIKI-1-LBG-M: "Okay, in my opinion i think it is millet. Millet, we still do not have any improved variety. Because we sow it around June and around November it becomes terrible when the rainfall ceases- we still have a problem with that" (SIKI-1-LBG-M)

Source: Stakeholder key informant interviews (2016)

Perceived difficulty in harvesting, and processing of crops

The results from the case studies indicate that farmers' evaluation of the difficulty involved in the processing of traditional varieties of groundnuts under CVC, has led to their displacement (see example 1). Similarly, millet has either been displaced by some households or the farm size for its cultivation has been reduced by some households because of the difficulty involved in processing it after harvesting (see example 2).

Example 1 Groundnuts: *the displacement of dagarasinkaa, and beja*

For the traditional varieties of groundnuts: *dagarasinkaa* and *beja*, farmers argued that the ground becomes so hard because of the early cessation of the rainfall, and therefore during harvesting, they have to manually use a hoe to knock the ground to get it softened before these varieties can be uprooted. A female participant indicates why she has displaced the dagarasinkaa variety as follows: *"The harvesting of dagarasinkaa is difficult. When you farm it, the rain stops by the time it gets to the time for harvesting. Hence you cannot uproot it with your hands. And if you do not find someone, me sitting like this I cannot harvest dagarasinkaa unless I beg someone to come and harvest for me. So I chose to cultivate the one that is easy for me to harvest. That is why I no longer cultivate the dagarasinkaa"* (HCS-10-D-Female). A male participant in a focus group discussion in Doggoh reinforced the opinion of HCS-10-D-

Female on the displacement of the dagarasinkaa variety. He states *"You see, the dagarasinkaa whether it rains or not, you still have to use the hoe to harvest or uproot that - but for kyaana, you see now, once it is ready, you need to use your bare hands in uprooting them…so you see the harvest process is easier than that of dagarasinkaa. If you farm dagarasinkaa on a large scale basis and it is time to harvest, whom you will get to come and help you use the hoe to uproot that…as it is challenging to handle that with the hoe* *particularly when the farmland is dried and hard. For one person, you will need like over three weeks to uproot dagarasinkaa"* (Focus group, male participant, Doggoh).

The above quotations suggest that the unfavourable evaluation of their cultivation partly informs the displacement of the *dagarasinkaa* variety of groundnut. In a quest to triangulate responses from respondents through participatory field visits, the researcher came across some households who cultivated *dagarasinkaa* using hoes to knock the ground to soften the ground before they could uproot the groundnuts[97].

Picture 5. 6 Household members knocking ground to soften it to cultivate dagasinkaa

Source: Fieldwork (Doggoh village, 2016)

[97] See picture 5.6

Example 2 Millet*: reduction in the farm size, and displacement*

Drawing on data from the village key informant interviews, household case studies and the participation observation, results of the data suggest that the zie-kpong[98] has been displaced by all households and the farmland size for the zie-leeh[99] has been reduced. Climate variability and change has been noted by all the households as the major driver of the millet cropping decisions. However, the data also suggest the difficulty in the processing of the crop also accounts for its displacement.

In a case study interview in the village of Doggoh, it emerged that *"you see, the processing of millet is very difficult- you need to plead with people to come and help thresh the crop after harvesting it. In that regard, when people come, you need to cook for them and brew pito for them…women need to winnow millet- gain you cannot rely on only family labour do that. It is costly to deal with it hence we just cultivate it little because the food from it taste good"* (HCS9-D-M). Similarly, in an interview with a female case study respondent in the village of Tie, it emerged that the young generation of women complain that the processing of millet as it produces dust and make their skin to itch them. She illustrates *"you see, the young ladies these days are modern girls and don't want to winnow millet, get dirty and scratches around their skin"* (HCS-7-T-F). As a way of triangulating the information with participant observation pictures were picture[100].

---

[98] *Zie-kpong*- Interviews with the village key informants suggest that *zie-kpong* takes longer time to mature

[99] *Zie-lee* – Even though this is a shorter duration variety than the *zie-kpong*, the village key informants indicated it is equally not suitable to the prevailing changing climate

[100] See picture 5.7. Note- the pictures were taken in December by one of the research assistants that lives in the village of Doggoh upon instruction by the researcher. By December 2016, the researcher had returned to the UK (as he arrived on 21st October 2016).

Picture 5. 7 An illustration of the threshing and winnowing of millet in the village of Doggoh

First: Preparing millet for threshing

Second: Threshing of millet

Third: preparing threshed millet for winnowing

Fourth: Stage one of winnowing millet

Fifth: Stage two of winnowing of millet

Sixth: Millet after winnowing

Source: Fieldwork (participant observation, Doggoh)

Perceived short rainfall duration and farmers' intention to displace crops

Example 1 Beans: *the displacement of traditional varieties*

The findings from the village key informant interviews and the household case studies indicate that the traditional varieties of beans have been displaced primarily due to shorter duration of rainfall [101] . However, the data suggest that other factors including the displacement of bush farm and river bank farm fields also account for the displacement of bengbere and wongtelle respectively (VIKIs, Doggoh and Tie villages)[102]. Hereafter, the use of 'hills' or 'hill farms' is the same as bush farm fields as the bush farm fields in the village of Tie are in hilly areas. HCS-

15-T-Male indicates that *"Ok, for the hills, because of the rain pattern, we cannot go and farm on the hill. Because it rains suddenly, we struggle to even farm around the houses, and to talk about going to the hill farm" (*HCS-15-T-Male)[103].

[101] Bengbere, bengpil-kpong, and wongtelle were identified as the traditional varieties of beans (VIKI interviews, Doggoh and Tie, 2016)
[102] Hereafter, the use of the terms 'hills' or 'hill farms' all mean bush farm fields as the bush farm hills are located in the hilly areas of Tie.
[103] See box 5.4 for a detailed illustration of the displacement of the traditional varieties of beans.

Box 5. 4 Dialogue between the researcher and participant indicating a multitude of factors that account for the displacement of traditional varieties of beans

Researcher: If I may also ask, why have you also stopped farming the bengbere, the black beans?
Participant: For the bengbere too, we no longer farm on the hill. We only farm around the houses. So how will you farm the bengbere? And again, it also delays small to mature.
Researcher: So why can you not stop farming around the houses and farm on the hill? Because from your explanation, it means that when it starts to rain, you cannot farm both around the house and on the hill before the rain ceases? So why can you not stop farming around the house and go to farm at the hill side?
Participant: Ok, if you check, if you go and farm at the hill side, you will not get maize to eat. And once you will not get maize to eat and it is maize that we are depending on now. So, if you go to the hill side, by the time you will come down to the house, by then, the time has passed. And again, at first, they farm in groups but now, when you get up, you come to your farm and farm alone. And with one person, you cannot be at two places at the same time. But at first, when we were even ten in a family, but we all farm on our father's land. But now, every young boy farms on his own.
Researcher: Ok, but I think there should be something. Because if you say it is because of the lack of sufficient rainfall and that is why you farm around the houses but not on the hill but why can you not stop farming around the house and farm on the hill? Can you explain further for me to get more understanding?
Participant: Ok, it is also because of the farm animals. When you farm on the hill, as at the time that you will not be round, by the time you will get back to the farm, monkeys might have finished destroying all the crops. You will not get anything there again. So that is why we have stopped farming there. So, for now, if you are to farm in the bush, you must have longer times in the farm till you harvest them. If you do not take care of your crops, the animals will destroy all. So that is why we have seen it to be a problem farming at the hill side. But if you also get someone that can go and take care of the crops, why not, you can go and farm. Ahaaaaa. So, if you do not have a care taker and you farm at the hill and at home and it is you and your wife alone, what will you do?

Source: Household case study (Doggoh, 2016)

A male participant in the village of Tie considers bengpil-kpong as 'dry season beans' as he expressed his opinion as follows: "*When you sow it with other crops, those crops will mature but the bengpil-kpong will still take a longer time to mature and by then, they have released the goats from the ropes and they will destroy them. At the time of harvesting groundnuts, some will then start flowering one by one"* (HCS-15-T-Male). The data demonstrates that households practice a free-range system in the regard of livestock farming hence they tie the goats and sheep with ropes. The livestock are taken out in the morning to tie in reserved uncultivated grassland and then brought home in the evening (Participant observation, Tie village, 2016)[104].

Picture 5. 8 Livestock being regulated during the farming season

Source: Fieldwork (Participant Observation, Tie village, 2016)

[104] Picture 5.8 depicts a woman and her daughter sending goats in a regulated manner to the grassland for grazing.

Example 2 Millet: the displacement, and reduction of the farm size of millet

Drawing on data from the household case studies, and the participant observation, the results indicate that all households have displaced the available varieties of millet (i.e. the *zie-kpong*) and there has been a reduction in the farmland size for the *zie-lee*. All the households have noted climate variability and change as the primary driver of the current millet cropping decisions[105]. Similarly, through participant observation, pictures were taken that depict the poor nature of millet when the rainfall was close to cessation[113].

Box 5. 5 Farmer illustrations of the displacement, and reduction of farm size of millet due to CVC

"when I first got married here, we used to harvest a lot of millet…we used to fill our big silos to the brim…hmmm, but now, if you get it then maybe two pans ….it is all because of the unreliable nature of the rainfall" (HCS-7-T-Female)

" You see, the varieties of millet we have do not always mature before the rainfall ceases- therefore, it does not make any sense for to cultivate that as we will be wasting our time" (HCS-4-T-Male)

"Those days I was young, millet used to do so well… it was one of the crops that we used to allocate more farmland for the cultivation of millet. But now, hmmmm, the rainfall is the problem…only fewer households cultivate it…if you need millet in large quantity in the village of Tie here, trust me you cannot get that " (HCS-15-T-Male)

"…but now, the duration of rainfall is no longer like that of the past hence if you cultivate millet, they will germinate well but when they are close to pollination and tasselling, they need rainfall till when dew begin to fall in November then they can do well" (HCS-4-D-Male)

Source: Fieldwork (Household case studies, Doggoh and Tie villages, 2016)

[105] See box 5.5 that details farmers' illustration of the displacement of millet due to poor rainfall
[113] See picture 5.9

Picture 5. 9 The state of millet as at the last week of September 2016 in Doggoh village

Source: Fieldwork (Participant Observation, Doggoh village, 2016)

(b) Farmers' positive attitudinal belief constructs and cropping decisions

Contrary to the results in sub-section "a" that suggest that farmers' negative evaluation of crop cultivation has led to either the displacement of crops or reduction in the farm size allocated for the cultivation of crops, this section has different results. Results in this sub-section demonstrate that farmers are utilising the opportunities associated with the changing climate via the cultivation of improved varieties of crops that are better suited to the new climate. It emerged from the data that: perceived yield benefits, and perceived economic advantages are the factors shaping farmers' cropping decisions.

Perceived yield benefits and farmers' cropping decisions

Besides the displacement of long duration crops as a way of reducing the impacts associated with climate variability and change, the results demonstrate that farmers are utilising the opportunities associated with the changing climate via the cultivation of improved varieties of crops which are better suited to the new climate. The results similarly revealed that, apart from millet, that respondents claim they do not have any improved variety, data from the research suggest that there are improved varieties for groundnuts, sorghum, beans and maize (both white and yellow colours).

Example 1 Sorghum: switching from traditional to improved varieties

For sorghum, even though it has lost its place as the most cultivated crop to maize (w) and groundnuts as indicated in figure 5.1 for both Doggoh and Tie villages, all households have switched from the traditional varieties to the cultivation of two new varieties known as *kundabuo* and *pookye*[106]. The word kundabuo means "cannot buy a goat" (VIKI-1-D-Male). Several interpretations have been given to the meaning of the names given to the new varieties of sorghum.

A male participant in Tie explains the meaning of *kundabuo* as follows: "*Ok, it means, it matures very fast, and you also eat it very fast, so how can you buy a goat? Hahahah. It finishes very fast. So, you cannot buy a goat. After harvesting, you have started eating it like that. So, it cannot last for long. So that is why they call it kundabuo"* (HCS-15-T-Male). In a focus group discussion with males in Tie, a participant gave a different meaning to *kundabuo* as he opines that "*You see, instead of you getting a goat to go and sell in the market to buy food to eat, God has blessed us with this variety that matures so early hence no need to send any*

[106] See picture 5.10

goat to the market to sell as we rely on that …that is why we call that kundabuo" ***(Male participant, Focus Group, Tie).***

HCS15-D-Male indicates the meaning of *pookye* as "*Ah, the pookye, ah, when you saw it today, the next two days, it ready for harvesting. We just farmed this one just recently and just now it is almost ready for harvesting. So in few days, it will be ready for harvesting. So that is why we call it pookye".*

Picture 5. 10 An illustration of the varieties of sorghum

Source: Fieldwork (Doggoh, 2016)

Example 2: Beans switching from traditional to improved varieties

For beans, it emerged from the data that there are two varieties; *tigboro also known as pogbabawullo*[107], and *oomongdoo*[116] that respondents indicated they are better suited to the prevailing climate. A male household participant in the village of Doggoh notes that the *pogbabawullo* variety of beans produces very good yield hence warrants the farmers (i.e. men) who cultivates it to be prepared in terms of the labour demands (HCS-7-D-Male). Similarly, HCS-7-D-Male details that *"… hahaha, we call it oomongdoo because the woman will sit and when she sees the husband going somewhere, she quickly put it on put*

[107] *Pogbabawullo* – from the interviews, it emerged tigboro is also known as *pogbabawullo* (literally meaning how many wives) or *pogba* pie (10 wives) –(VIKI-3-D-M, VIKI-3-T-M) [116] Oomongdoo- literally means eat with men – (VIKI-4-D-F, VIKI-4-T-F)

it on fire and quickly it will be cooked and she will finish it before the husband comes back" (HCS-7-D-Male). The data from the stakeholder interviews agree with the responses of farmers. The analysis of the data from the interviews with the Literacy Bridge Ghana reveal that *"... we also have new varieties of beans…many farmers even cultivate that twice in a year- when they cultivate it and harvest around August and re-cultivate it"* (VIKI-2-LBG-M).

Perceived economic advantages Example 1: Groundnuts: switching from dagarasinkaa variety to kyaana

Moving beyond the climate as the primary driver of farmers' cropping decisions, it emerged from the data that economic factors also play a role. Specifically, it emerged that the *kyaana* variety of groundnuts is better preferred than the *dagarasinkaa* variety and also fetches a better price than that of the dagarasinkaa. The preference and the higher market value of the kyaana variety are explained mainly by it containing more oil and available in large quantities that quickly meet the market needs of traders[108].

[108] See table 5.10

Table 5. 10 Farmer illustrations of the advantages of kyaana variety of groundnuts over dagarasinkaa variety

Variable	Farmer quotes
Preferred market variety	*"…for the dagasinkaa only a few traders will buy it. But then you that is buying, you will not get a sack full at once –but then kyaana is 'buuro' that's why the buyers of dagarasinkaa are one-one (few). If you take the daga sinkaa into the market, they don't buy; if you buy a little like 10 bowls, if it does not reach 10 bowls you run a loss. Maybe is a bowl and someone buys 1 bowl and doesn't get more to buy what will the person do? That's why*. (HCS-10-D-Female) *"In some instances, one can send the local groundnut to the market but will not get a buyer; you are then compelled to transport it back to the house. Sometimes too, the buyer will offer to buy at cheaper price"* (HCS-5-D-Male)
Higher market value	*It is the kpankpaaba that they will buy first. Because, those of us that are farming the local groundnuts, we are not many. Maybe, someone needs a bag of groundnuts and he will not get the enough local groundnuts to fill the bag early. So if you send the kpankpaaba to the market, it will finish early because, this person is having and this person is also having so he can easily get a bag of groundnuts. But with our own, if kpankpaaba will cost GH₵ 8.00 our own will cost GH₵7.00. if kpankpaaba is costing GH₵7.00 ours will be costing GH₵6.00 in that other (HCS-9-T-Male)*

Source: Qualitative fieldwork data (Doggoh and Tie, 2016)

5.3.3 Farmers' perceived behavioural control, and crop selection decisions

As reviewed in section 2.5.2, Ajzen (1985) proposed the Theory of Planned Behaviour (TPB), having recognised that not all human behaviour comes under full volitional control. To that end, Ajzen suggested the addition of Perceived Behavioural Control (PBC) to the components of the Theory of Reasoned Action (TRA). To the TPB, PBC is our perceived ability or inability to perform a given behaviour. With this study, smallholder farmers' PBC is how they feel about their ability or inability to select crop under CVC. This suggests to a large extent that, farmers' perceived ability will drive their intention to perform the behaviour (i.e. select crops under CVC), and their perceived inability will constrain their intention to perform the behaviour.

However, results from the data suggest that farmers' inability to buy farm inputs (e.g. fertiliser) has influenced them to cultivate crop varieties that have high potentials of improving the soil fertility. Therefore, the scope in this section is to tease out how farmers' perceived ability or inability influences their adaptation to climate variability and change via crop selection.

(A) Perceived inability and farmer cropping decisions under CVC

Inadequate labour and the displacement of crops under CVC

The results from the data indicate that households' inability in terms of inadequate labour has led to the displacement, and the reduction of farm size allocation of some crops under CVC. Notably among them include the *zie-kpong* variety (i.e. traditional and long duration variety of millet) and *zie-lee* (shorter traditional variety of millet) that have been displaced and cultivated in small quantities respectively by households in both Doggoh and Tie villages (see example 1). Similarly, the *wongtelle* variety of beans has also been displaced by households (see example 2).

Example 1: The displacement of millet

"... Now we do not longer cultivate millet in the household in large quantity-those days, we were many in the household but now I am alone. When I farm small, I get tired hence cultivate millet small because it needs longer duration of rainfall to mature well but the rainfall ceases early" (HCS-15-T-Male)

*"Those days, many children were not in school, so it was possible to have them on farms. It is not so today where all children must be in school. The children are only available during weekends and other days when they are not able to attend school. We the adults are not able to do it because of other activities". (*HCS-12-T_Male).

"You see, I could cultivate millet in the farm fields in bush but I am weak and cannot ride bicycle to the far distance places to cultivate that. I used to cultivate it a little around the compound farm fields

but as all crops are harvested and the livestock are now freed to range around, the millet begins to pollinate, and are destroyed by goats and sheep in particular" (HCS-15-D-Male).

Example 2: The displacement of the wongtelle variety of beans

"…you see, I do not longer cultivate the wongtelle variety of beans because I do not have the farmer- my husband is dead. He used to cultivate the farm field around the river bank but now these children do not want to cultivate around the river banks. But wongtelle is a river bank crop" (HCS-16-D-Female).

"When I farm the tabounaa, the bengbere and the pogbabawullo, the strength is not always there again for me to farm the wongtelle. So, I have stopped farming it. When I farm it in a hilly area, they yield but not much. Unless you spray them" (HCS-5-D-Male).

"For now, we don't farm the river bank farms again. For now the riverbank farms, you will not get someone to have the strength to farm. If someone is farming, as I said, if not maize, but you not see someone cultivate the riverbank farms and saw this type of beans. If he is farming, then he is farming maize (w). Ahaaaaaa" (HCS-7-D-Male).

Economic inability, and farmer cultivation of crops

The results suggest that, the traditional variety of groundnuts improves the nutrients of the soil hence even though farmers understand that it produces less yield under CVC, they still cultivate it as an alternative to purchasing fertiliser. A male participant indicates that he practices crop rotation by cultivating maize (w) on the farm fields where dagarasinkaa was cultivated in the last season- and this reduces the burden of applying fertiliser to the maize (w) as follows: "It *means that, the way the dagarasinkaa are, they have fertilizer. If you look at the dagarasinkaa, when I farm here like this, the next season when I farm maize, if you look at this side, can you not see the maize there, last season, I farmed the dagarasinkaa there. It means that because I farmed the dagarasinkaa there, I have not applied fertilizer to maize there as I would have done on the potion I farmed the Kyanna. This is because the dagarasinkaa has manure than the Kyanna. Is the yielding that is not always up to the Kyanna but is because of the manure that I farm for it makes the farm to have dirt for me to farm later in the next season. That is why I cannot stop farming the dagarasinkaa.* (HCS-9-D-Male). The illustration here by respondent 'HCS-9-D-Male' indicates a trade-off of getting better yield to ensuring that the soil fertility is improved via the cultivation of the *dagarasinka*a variety of groundnuts.

(a) Farmers' perceived ability and cropping decisions under CVC

As indicated in chapter two section 2.6, the researcher argues that the agricultural information that farmers get from NGOs contribute to increasing farmers' ability to select crops. In the interviews with stakeholders, it emerged that they provide information on short duration crops to farmers [109] . Similarly, farmers have acknowledged that they receive crop selection information from NGOs and in-deed has displaced certain varieties of crops.

Example 1: Stakeholder provision of improved varieties of crops to farmers

"*We provide early varieties of sorghum and beans developed by the Agricultural Savannah Agricultural Research Institute to farmers- we advise them that the duration of rainfall is shorter now as compared to that of the past. Therefore, they should cultivate the improved varieties of crops*" (SIKI[119]-1-CCAFS-F)

"The gyibaraa variety of sorghum is extinct, the bengbere variety of also extinct…these varieties take a longer time to mature- so we are advising them to go into the improved variety. The farming season now is very short so we advise them to go into the shorter duration varieties" (SIKI-2-CCAFS-M)

" There is this new variety of maize we call 'wongdata' which we provided free-of-charge to farmers last year- those farmers that have cultivated this, others have seen how suitable it is to the climate and people are calling for this variety- next year we doubt if we can even meet the demand for that variety" (SIKI-1-MoFA-M).

" You see, in the village of Doggoh, we have a demonstration field where we cultivate the old varieties and improved varieties of crops together with farmers- then by the end of the agricultural season, they make a decision as to which variety to cultivate" (SIKI-2-CCAFS-M).

Access to information may not necessarily translate into acceptance and usage. Having this in mind, the researcher during the interviews probed the respondents about whether they

[109] Example 1 illustrates the crop selection information that farmers receive from stakeholders
[119] SIKI- Stakeholder Key Informant

accept these information and the usefulness of the information for their agricultural activities. It emerged from the analysis that the crop information are accepted and utilised[110].

Example 2: Farmers' illustrations of the value of crop selection information

"You see, the staff of MoFA tell us not to cultivate the traditional varieties of sorghum and maize. Therefore, we usually go to the office of MoFA and get the improved variety of maize known as obaatanpa. That does well under the prevailing changing climate" (HCS-7-T-F). *"You see, ESOKO and CCAFS people come to have meetings with us and advise us to cultivate the improved varieties of crops" (HCS-3-D-M).*

" *the small radio that they bring for us to use on rotational basis, in that radio, they advise us not to cultivate the bengbere, and wongtelle, and the gyibaraa as those are long duration crops and not suitable. Since they have introduced us to the maize (w), I cultivate that more and less of the maize (y)… and I get a lot of yield these days"* (HCS-4-D-M).

5.3.4 Social identification, and farmers' intention to select crops under CVC

As argued in section 2.5.2, the researcher is of the view that, the identification of farmer households of the villages of Doggoh and Tie with the Dagaaba tribe (i.e. the in-group) of northwest Ghana comes with living along the cultural pathways of the group as suggested by Tajfel and Turner (1979). The data revealed that sorghum and the dagarasinkaa variety of groundnuts unlike the other crops have cultural values. It emerged from the data that sorghum (regardless of the variety) is a ritual crop without which funerals cannot go on either the villages of Doggoh and Tie (VIKI interviews, Doggoh and Tie, 2016).

Continuation of the cultural pathways of the forefathers

Example 1 Groundnuts: Continuation of the farming practices of the forefathers

Even though results in section 5.3.2 suggest that farmers have displaced the dagarasinkaa variety of groundnuts because of the difficulty in involved in harvesting it, findings in this

[110] See example 2

section reveal that because of social identity which comes with the people of Doggoh and Tie being socialised along the farm culture of their forefathers, some farmers still cultivate the local variety of groundnuts as a way of not displacing what has been handed over to them via socialisation from their forefathers. In a case study in Tie village, a participant expressed his view on that as follows: “When you grow up to see your father doing something, you do not have to abandon it. If you grow up to see your father with cattle you cannot chase them away useless a thief comes to steal them, you take care of them. That is why I still cultivate the dagarasinkaa” (HCS-13-T-M). Similarly, in a focus group discussion with male participants, findings point to the same direction. A participant indicated the significance of dagarasinkaa as follows: “Once it is something that has been handed over to us by our fathers if we stop it will affect us, so we have to continue to plant it” (Focus group-D-Male). Further reinforcement of the need to cultivate traditional varieties of crops is detailed in box 5.6

Box 5. 6 Farmer illustrations of the need to cultivate traditional varieties of crops under CVC

"Eeeh…the essence is this. Because it is an old crop that have been passed onto us by our fathers, if you leave it, it will worry you. You must cultivate it. You must cultivate a little of it. If you leave it, it will affect you and that is why we still cultivate it. But now many people don't cultivate it again. You see, this man did not want to cultivate the kyaana but because it has always failed us that is why he cultivates the kyaana and small of the dagarasinkaa" (Focus group-D-Male).

"Okay laughter----- eeih, for me what I consider is that --- because dagarasinkaa is my ancestral crop that is why I still decide to cultivate that on very small-scale basis" (HCS-8-D-Male)

"This is my grandfather's thing that I am still having. For my children, they are farming the kyaana, but I am still holding my grandfather's thing. When I die, if they want, they can throw them away, but I will never throw them away" (HCS-9-T_Male).

"You see, the dagarasinkaa variety is my ancestral crop, and because I want a continuation of the practices, I farm that small to get small". (HCS-15-D-Male)

Source: Household Case Study (Doggoh and Tie villages, 2016)

Cultural food, and farmers' intention not to displace traditional varieties of crops under CVC

Example 1: Better food taste from the traditional variety of groundnuts

Results indicate that social identity manifests itself in the food culture of the people of the Doggoh and Tie villages. Even though results (see table 5.10), suggest many advantages of the improved variety of groundnuts over the traditional one, the preference for soup made from the latter increases farmers intention to cultivate it in small quantity in order not to compromise the taste they derive from the traditional variety. Farmer quotes in support of that opinion are indicated in box 5.7.

Box 5. 7 Farmer illustrations of their preference for soup made from dagarasinkaa

"The reason is that, the local groundnut is sweeter that the kyaana. When you eat the local groundnut, you realize that it is sweeter. So, if have the seeds, I will farm them very early but in a small quantity" (HCS-5-D-Male)

"The dagarasinkaa has so many purposes than the kyaana groundnuts. With the dagarasinkaa, if not because today the kyaana has come to be in abundance, but with almost all the foods that women prepare, they use the dagarasinkaa to prepare them for the food to be good. It is because of all these reasons that make me to farm the dagarasinkaa" (HCS-9-D_Male)

"You see once prepare groundnut soup with either the kyaana and dagarasinkaa variety they both look alike but not the same. The soup made from dagarasinkaa is heavier than that of kyaana. Itis just like sorghum and maize TZ. Sorghum TZ is heavier than maize" (HCS-8-D_Male)

"For the local groundnuts, it has weight. When you are hungry and take some and boil and chop, you will become satisfied but for kpankpaaba, most people self, do not like eating it" (HCS-9-T-Male)

Source: Household case studies (Doggoh and Tie villages, 2016)

Groundnuts is also eaten either raw or roasted or boiled. Findings suggest that *dagarasinkaa* has less oil as compared to that of the kyaana variety hence people prefer to eat more of that as compared to that of the improved variety. Picture 5.11 depicts the researcher enjoying roasted groundnuts with a household during one of his research missions. The above results agree with Noack and Pouw (2015) in their study in Western Kenya where they reported respondents produce maize and get little yield because of value they attach to *ugali (* a traditional food made from maize).

Picture 5. 11 The researcher enjoying roasted groundnuts with a household in the village of Doggoh

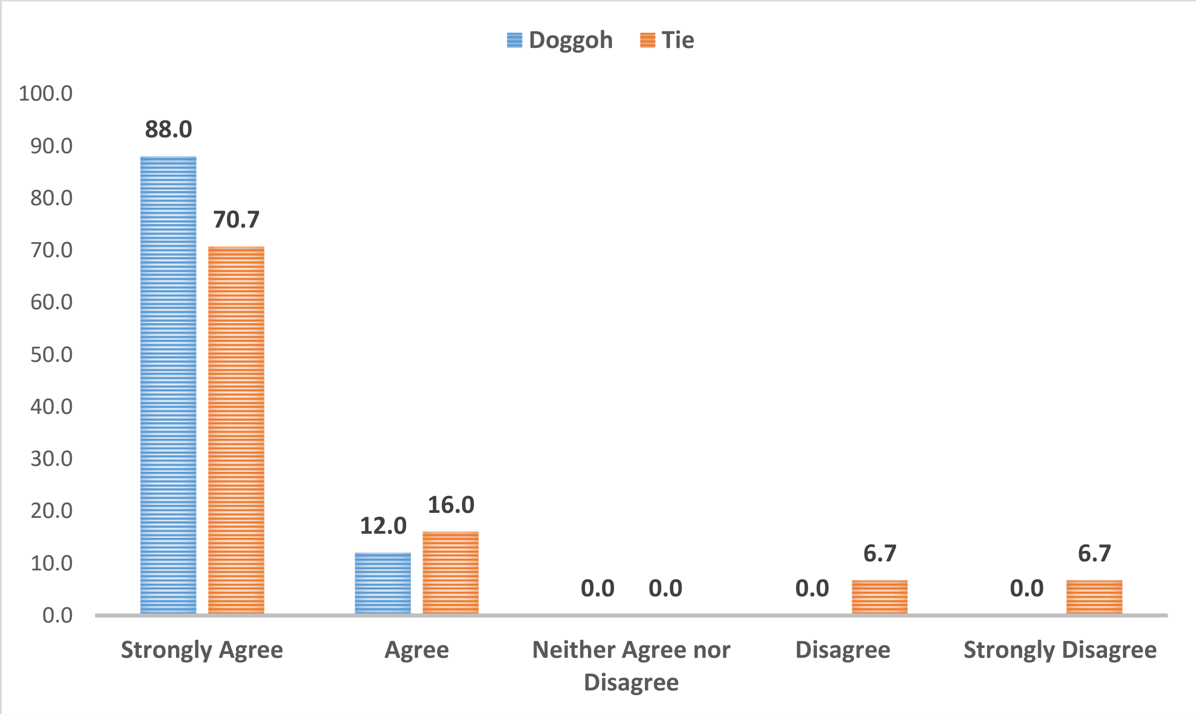
Source: Fieldwork (Participant Observation, Doggoh village, 2016)

P*reserving social events and farmers' cropping decisions*

Example 1 Sorghum: farmers' unwilling to displace sorghum under CVC in the future

Even though results in sub-sections "a" and "b" of section 5.3.2 suggest that farmers have displaced the traditional varieties of sorghum (i.e. *konye*, *kaziedanbille*, and *gyibaraa)* and now cultivate the improved varieties (i.e. *kundabuo*, and *pookye*) respectively in the two research villages, data from the Likert scale questions of the semi-structured questionnaire, the focus groups, and the household case studies suggest that, farmers' future intentions are that they would be unwilling to displace the available varieties of sorghum if they are not suitable to the prevailing climatic conditions. Results from the Likert scale (see figure 5.3 for details) reveal that all (i.e. 100%) and 86.7% respectively for the villages of Doggoh, and Tie have the intentions not to displace the available varieties of sorghum in the future if they are not suitable to the prevailing climate.

Figure 5. 3 Percentage of households' unwillingness to displace sorghum in the future in Doggoh and Tie villages (N=75 in each village)



Source: Fieldwork (Doggoh and Tie villages, 2016)

The above finding is contrary to the findings of Issahaku and Maharjan (2014), Seo and Mendelsohn (2008), and Kurukulasuriya and Mendelsohn (2008) who believe farmers would be rational under climate variability and change (see review in section 2.3.4).

In order to drill down to have a nuanced understanding of the value of sorghum in the sociocultural lives of the people of the Doggoh, and the Tie villages, data were drawn from the village key informants' interviews, the focus groups, as well as the household case studies. Summary of the results suggest that funeral is one of the social activities that bring and unite the people of the Doggoh and Tie villages with the surrounding villages and towns. Results also suggest that sorghum is core in the activities of the funeral ceremonies of the people of the Doggoh and Tie villages, and for that matter, the Dagaaba people at large. Data from the interviews with the village key informants of the Doggoh and Tie villages suggest that sorghum plays multiple significance during funeral celebrations ranging from food to ritual performances. Key significance include the placement of *kagyin* (tight pieces of sorghum as shown in picture 5.10) on the stage where the corpse is placed as to symbolically represent the trade of the deceased when he was a farmer, preparation of *pito* (a locally brewed beverage) to cater for the thirst needs of the sympathisers as well as the bereaved family, *kagyin* for the owner (s) of the xylophones that are played at the funeral ground, *kagyin* for the undertakers (people who bath, stage and bury the corpse – for the performance of rituals to cleanse themselves), and *kagyin* for the in-laws. The summary of the importance of sorghum in the funeral celebrations are shown in table 5. 11.

Picture 5. 12 Tight pieces of sorghum (kagyin)

Source: Fieldwork (Participant Observation, Tie Village, 2016)

Table 5. 11 An illustration of the cultural uses of sorghum

Value of sorghum	Farmer quotes
A 'must' requirement in every funeral	*"Okay, it is 'kagyin' (sorghum) ......when someone dies it is a must that it has to be brought out .....if you do not even have that you still need to go to someone to get that........but as someone dies, kagyin' has to be sent out" (VIKI-1_D-Male).*
Symbolises the trade of the deceased	*"Okay, you see, they say that if you one day die, it is a must that your trade should be exhibited at the funeral ground to signify that was your trade whilst alive on earth. That is why it is a must that when someone dies in my household as a father I need to get kagyin if i do not even have it, it is a must that i get it from somewhere. once you get to someone and ask for no one will deny you as they know it is for funeral celebration ... if people especially the elderly come around and realise there is no crop around the stage of the deceased, they ask questions like 'he did not farm anything or what?' or 'have you finished eating all the food products or what?" (VIKI_2_T-Male).*
Rewards for undertakers and performance of rituals	*"they say the guys who dig the grave and in-charge of burying the corpse, there is usually some 'dirt' associated with their work ...so the first sand that they get in trying to dig the grave is picked and then once they grind the crops meal for them at the funeral they add part of the sand to that perform some rituals in order to cleanse themselves......they say 'bobo' (some illness) can get someone and the fellow begins to lose their hair.....but once rituals are performed they are 'bobo' free". (VIKI_2_T-Male).* *"Whether a dead person is mourned or not, but sorghum still has to be brought out for the undertakers. If you do not have kagyin, the undertakers would not burry your corpse...you must give them kagyin and after the burial, there are some traditional rituals they need to perform to cleanse themselves" (HCS-7-T-Female).*
'Water' for the sympathisers	*"If you observe well you will realize that in every funeral where pito is not available, it is often tough to celebrate such funerals. The attendants become stranded on the funeral ground and try to find their own ways of quenching their thirst. When it's like that many of them leave the funeral ground premature". (HCS-6-D-Male)*

Source: Fieldwork (Qualitative data, Doggoh, and Tie villages, 2016)

5.3.5 Summary

Finding 1: Characterising farmers' responses to CVC

- The results indicated that farmers have adapted to climate variability via their cropping decisions. Specifically, farmers have displaced the traditional varieties of crops, and cultivate the improved varieties of crops. The only exception is households that are still cultivating the traditional variety of groundnuts because of cultural reasons.
- Only male-headed households are cultivating the traditional varieties of groundnuts in both Doggoh and Tie villages (see 5.3.1). Whereas no household cultivates only the traditional variety of groundnuts in the Doggoh village, few households (two) cultivate only the traditional variety of groundnuts. The data revealed that middle-aged and older farmers, and only older farmers respectively for the Doggoh and Tie villages as the ones who are still cultivating the traditional variety of groundnuts.
- The data revealed that no poor household in both the Doggoh and the Tie household cultivates the traditional variety of groundnuts. Whereas more semi-rich farmers than the wealthy farmers cultivate the traditional variety of groundnuts in Doggoh, the same proportion of semi-rich and rich farmers cultivate that in the village of Tie.

Finding 2: Why are farmers adapting to climate variability and change

- Farmers' negative feeling about the cultivation of crops have led to the displacement of crops under climate variability and change. These include farmers' perceived poor yield (for the displacement of traditional varieties of sorghum), perceived difficulty in harvesting and processing (which has led to the displacement of the traditional variety of groundnuts; and the displacement and reduction in the farmland size for millet cultivation), and perceived short duration of rainfall (the displacement of the traditional varieties of beans; and the displacement and the reduction of the farmland size for the cultivation of millet) (see section 5.3.2).

- Farmers' positive feelings about the cultivation of crops have led to the cultivation of improved varieties of crops under climate variability and change. These include perceived yield benefits (this has led farmers to switch from traditional to improved varieties of sorghum, and beans), and perceived economic advantages (has led farmers to switch from traditional to improved variety of groundnuts) (see section 5.3.2).
- Farmers perceived behavioural control has led to the displacement of millet and the displacement of traditional varieties of beans. However, perceived economic inability has led to the cultivation of the traditional variety of groundnuts as of the nitrogen fixation (see section 5.3.3).

Finding 3: Why are farmers not adapting to climate variability and change?

- Social identification has led to the few farmers not adapting to climate variability and change. Specifically, the following emerged from the data. The need to continue the farming ways of the ancestors have led to fewer farmers still cultivating the traditional variety of groundnuts. Similarly, the preference for better food taste from the traditional variety of groundnuts has led to farmers' resistance to adapt by still cultivating the traditional variety of groundnuts even though it fetches less price, produces poor yield and challenging to harvest. `
- The results suggest that farmers in the future would be unwilling to displace sorghum and cultivate other crops if the available varieties of sorghum are not doing well under the prevailing climate.

- The results that emerged from the data include the cultural uses of sorghum during social functions. Specifically, it emerged that sorghum symbolises the trade of farmers during the celebration of funerals in northwest Ghana, sorghum is used for brewing pito which caters for the food needs of people at funerals, it is used for performing rituals to cleanse undertakers, and other functions (as outlined in table 5.9 in section 5.3.4)

5. 4 Discussion and Conclusion

5.4.1 Discussion

This chapter sets out to understand farmers' cropping decisions under climate variability and change (CVC). To that end, the chapter specifically looked at the following: (i) the changing pattern of cropping systems in the villages of Doggoh and Tie, (ii) understand how responses to CVC is socially differentiated, and (iii) understand the factors that shape why farmers are responding or not responding to CVC.

Farmers reported changes in the cropping system of Doggoh and Tie as manifested in households attaching more attention to compound farm fields, and less attention to bush and riverbank farm fields. Farmers identified CVC as the primary driver accounting for the less attention to the bush and riverbank farm fields. In addition to CVC, farmers identified increased diversification of women's livelihood activities, and increased priority in sending children to school- the two factors according to farmers have translated into the availability of less labour force to cater for crops in the bush and riverbank farm fields. Farmers emphasised that the riverbank farm fields in particular come along with the raising of big mounds that require young and energetic labour force (see section 5.2.1). Beyond changes in attention to farm fields, farmers reported that sorghum has lost its place to maize (w) as the largest crop among the main crops in both the Doggoh and Tie villages. Similarly, it emerged from the results that millet has lost its place as among the main crops in both the villages of Doggoh and Tie (see section 5.3.1). These results are similarly reported in Ghana where cocoa has been replaced with maize by farmers in the Wenchi Municipality of the Brong-Ahafo region of Ghana (Adjei-Nsiah, 2012).

Farmers identified male, wealthier and older farmers as the farmers who are not responding to CVC by still cultivating the traditional varieties of groundnuts that produce low yield and of less economic value (see section 5.3.1). The finding here runs contrary to findings of Issahaku and Maharjan (2014) who suggested in their study in Ghana that farmers would allocate less land to crops that produce low yield.

It emerged from the data because of the continuation of the cultural farm ways of the ancestors that is why the older farmers are still cultivating the traditional variety of groundnuts. The wealthier farmers cultivating that could be explained by the labour-intensive nature of the of harvesting the traditional variety of groundnuts where the rich can hire labour in the harvesting process. Similarly, it emerged in section 5.3.2 that farmers are still cultivating the traditional variety of groundnuts because of the better food taste they derive from it as compared to the improved variety that contains much oil. This finding agrees with the findings of Ziervogel and Ericksen (2014) in a study in South Africa.

Farmers reported reasons like perceived poor yield, perceived difficulty in the cultivation and processing of crops, and the shorter duration of rainfall as the ones that have led to the displacement of crops, and crop varieties under CVC. Similarly, it emerged again that because of the logic of getting high yield and economic benefits have led farmers to respond by growing improved varieties of crops.

The results here are similarly reported in the literature on cropping decisions under CVC (Issahaku and Maharjan, 2014, Kurukulasuriya and Mendelsohn, 2008, Seo and Mendelsohn, 2008) - (see section 2.2.1). Farmers also reported that even though they are responding to CVC via selecting improved varieties of sorghum and displacing the traditional varieties that are not better suited to the prevailing changing climate, they would not adapt in the future if the available sorghum varieties are not suitable to the prevailing climate. It emerged that because of the ritual importance of sorghum for farmers social identity as Dagaabas as manifested in symbolising the trade of the deceased during funerals, *pito* for sympathisers during funerals, and *kagyin* for undertakers to perform sacrifices to cleanse themselves (see section 5.3.4).

5.4.2 Conclusion

The results in this chapter have demonstrated that farmers have responded to climate variability and change by cultivating crops and crop varieties that are better suited to the prevailing climate in the villages of Doggoh of Tie of North-west Ghana. The only exception is the fewer male, wealthier and older farmers who still cultivate the traditional variety of groundnuts due to cultural reasons. However, the results here suggest that policymakers and agricultural extension researchers need to consider the cultural uses of crops in the design of improved varieties of seeds for farmers to better adjust to CVC in the future (as detailed in Chapter 7 section 7.4.2). The results have revealed maize (w) as the main crop cultivated now and millet as the main crop that has been displaced by many households in the both the villages of Doggoh and Tie.

In line with the argument in chapter 1 (section 1.2.1), the results here imply that households' food preferences may be impacted if millet and maize (w) are the culturally preferred and not the culturally preferred food crops respectively of the study villages. Therefore, chapter 6 teases out the social aspects of the uses of food and attempts to understand how farmer responses to CVC has impacted on the availability and utilisation of culturally preferred foods. In sum, the argument in chapter 6 is that adaptation to the impacts of CVC could potentially impact on the availability and utilisation of culturally preferred foods.

CHAPTER 6

UNDERSTANDING THE CULTURAL USES OF FOOD, AND THE IMPACTS OF FARMER RESPONSES TO CLIMATE VARIABILITY AND CHANGE ON HOUSEHOLD FOOD PREFERENCES

6 Understanding the Cultural Uses of Food, and the Impacts of Farmer Responses to Climate Variability and Change on Household Food Preferences

6.1 Introduction

The argument that farmers will focus on maximising yield in response to the impacts of Climate Variability and Change (CVC) (see section 1.2.1) has implications for the way that individuals and households may make choices that reflect their cultural food preferences. This chapter addresses objective three of the thesis and focuses on understanding the implications of smallholder cropping decisions under CVC on the food preferences of households.

The results in chapter five demonstrate that overall farming households are responding to CVC by selecting crops and crop varieties that are appropriately suited to the prevailing climate. The only exception is that few male-headed households are retaining low yielding traditional varieties of groundnuts for cultural reasons.

The review in chapter two (section 2.4.2) revealed that the key debates about the development of food preferences have centred on the ideas of cultural idealism, cultural materialism, the availability of food, the sensory characteristics of food, 'mere' exposure to food, and parental feeding practices. This chapter draws on the ideas of cultural idealism to present results on the cultural aspects of the uses of food. Studies on the utilisation dimension of food have paid little attention to cultural acceptability (Treffrey et al., 2014).

Similarly, the ideas of cultural materialism (as reviewed in chapter 2, section 2.4.2) are used to understand the impact of adaptation to CVC via crop selection on the availability, and consumption of culturally appropriate foods. Then the theoretical ideas of food availability and ‘mere’ exposure to food are used to understand how food preferences are constructed by different social groups.

To understand the relative contribution of multiple factors shaping food preferences, the chapter uses data from the village key informant interviews, the semi-structured questionnaire, the focus groups, and the in-depth case studies. Section 6.2 presents results on the cultural dimensions of food. In section 6.3, results are presented on the impact of adaptation to CVC on the availability and consumption of culturally preferred foods, and the factors that differentiate social groups’ constructions of food preferences. Finally, section 6.4 discusses and concludes the results of the chapter.

6.2 The Cultural Dimensions of Food: Tuo-zaafi as a Case Study

As argued in section 1.2.1, studies on the utilisation dimension of food have focused on the nutritional and biological aspects of food with little being understood about the cultural uses of food (Trefrey et al., 2014). Therefore, this section contributes to bridging the gap in the cultural dimensions of food security. To that end, section 6.2.1 is devoted to understanding the staple foods of the people of the Doggoh and Tie villages, and section 6.2.2 discusses the non- biological and nutritional uses of food, using tuo-zaafi as a case study. Section 6.2.3 gives a summary of this section.

6.2.1 Understanding the staple foods of the Doggoh and Tie villages

As a starting point to unpacking the cultural acceptability of food, this chapter starts by presenting results on the different foods that are consumed in the villages of Doggoh, and Tie.

It is necessary to understand this as complete nutrition cannot be found in a single food (Wansink et al., 2003). It is also useful to understand the cultural norms of food, for example how decisions around food consumption are made. In particular, the section tries to unpack the mechanics around food consumption focusing specifically on: (i) the temporal dimension of food consumption such as what food is eaten at what time of the day or night, (ii) the rules and customs governing the consumption of food, for example who gets served first and why, (iii) a sense of who eats with whom, and why, and (iv) then describe what foods are mainly consumed in the villages of Doggoh and Tie. It is important to understand the above in order to holistically have a sense of the food culture of the people of the Doggoh and Tie villages. To achieve the above, the researcher relied on data from the village individual key informants, the semi structured questionnaire, the focus groups, and the household case studies. The discussion on the various sub-sections are detailed below.

The temporal dimension of food

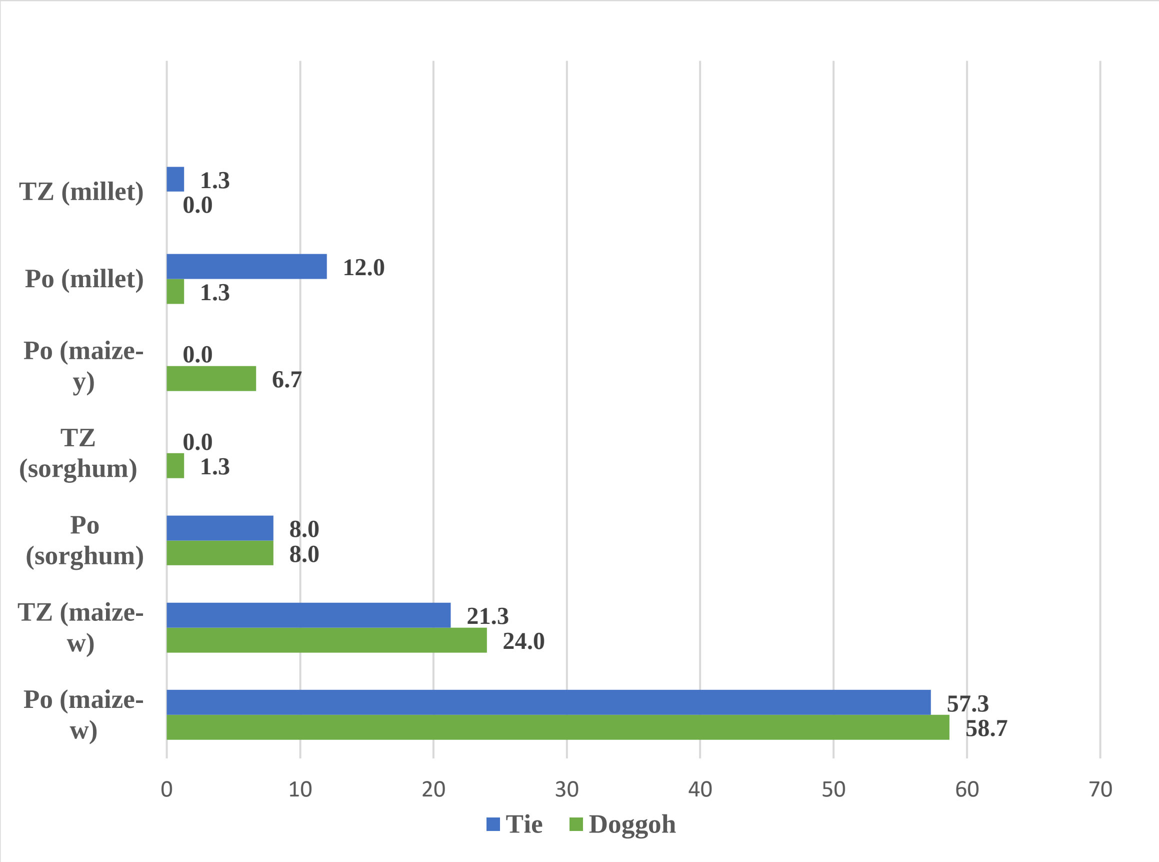
The analysis of the data from the village key informants suggests that the villages of Doggoh and Tie share similar foods. *Tuo-zaafi*[111], *belebelle* (also known as *tunpaane*), *sowolle*, beans with rice, rice only, beans only, bambara groundnuts with rice, banku, *kpoglo* (also known as *parekpobo*), porridge, and *sensere* were named as the foods that are consumed in both the villages of Doggoh, and Tie (VIKI interviews, Doggoh and Tie).

The results in figure 6.1 tell us that, in order of magnitude, Po[112] (Maize-w) is the food that is ranked highest among the foods that are regularly consumed during breakfast in both the villages of Doggoh and Tie. The results also identified TZ (Maize-w), Po (millet), and Po (sorghum) as the other main foods for breakfast in both Doggoh and Tie. However, the results reveal some differences concerning the foods that are consumed for breakfast for the

[111] In this chapter, *tuo-zaafi* is considered same as TZ (Pronounced ("Tee-zed"). The local name of TZ is *saabo* (this may appear in some of the farmers quotes)
[112] Po means porridge throughout the whole of this chapter

two villages. For example, TZ (Sorghum) and Po (Maize-y) are counted as among the primarily consumed foods during breakfast in Doggoh but not in Tie. Also, the respondents in the village of Tie cited TZ (Millet) as among the foods that are consumed for breakfast (see figure 6.1).

Figure 6. 1 Percentage of respondents that reported the foods that are largely consumed for breakfast in Doggoh and Tie Villages (N=75 in each village)

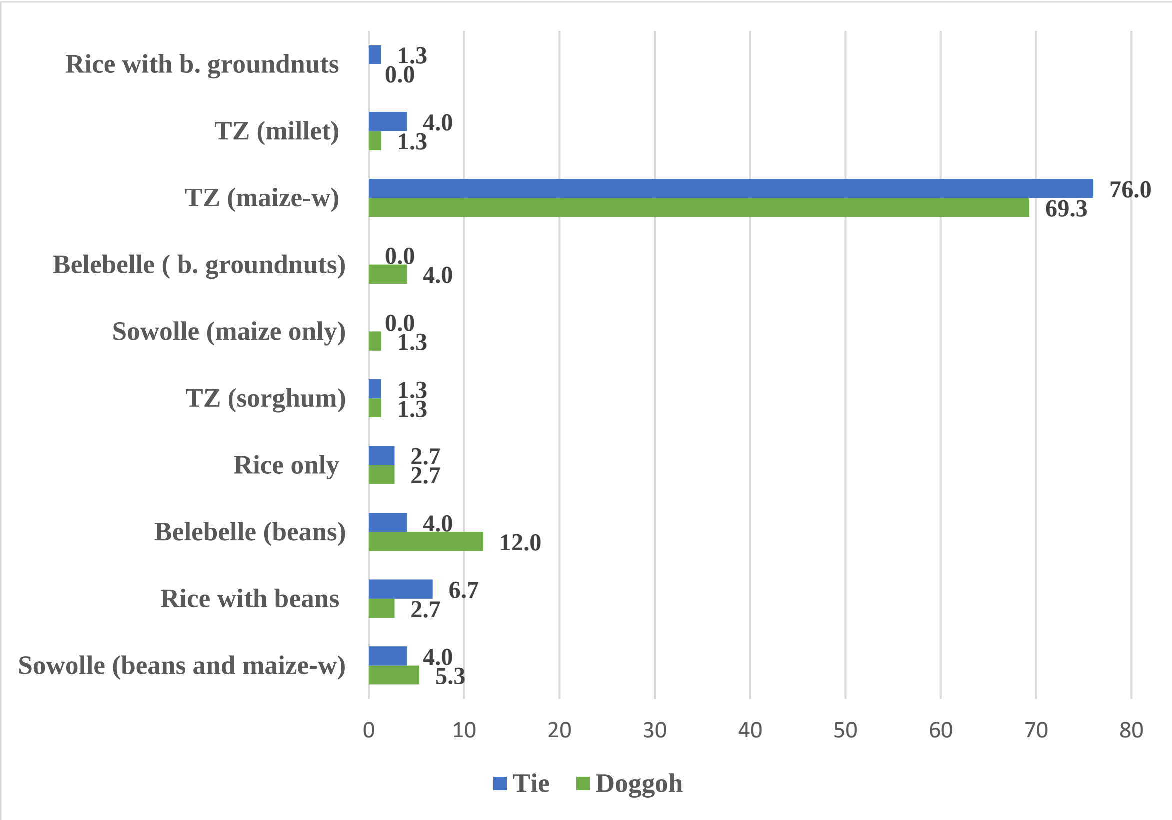


Source: Fieldwork (Semi-structured questionnaire, Doggoh and Tie, 2016)

On the element of the foods that are regularly eaten for lunch, TZ (maize-w) was ranked first in the villages of Doggoh (69.3%) and Tie (76.0%). The results showed that Sowolle (beans and maize-w), rice with beans, belebelle (beans), rice only, TZ (sorghum) and TZ (millet) are the other foods that are primarily consumed by both the villages of Doggoh and Tie. Regarding the differences, the results reveal that it is only the village of Doggoh that consumes sowolle (maize only) and belebelle (b. groundnuts). Similarly, in addition to the above foods, the results reveal that it is only the village of Tie that consumes rice with bambara groundnuts as among the foods that are primarily consumed for lunch (see figure 6.2 for the details).

The consumption of rice in the villages of Doggoh and Tie could be possibly explained by procurement through market sources as the results (see chapter 5 section 5.2.1 for details) showed that rice is not among the crops that are primarily cultivated in the village of Tie.

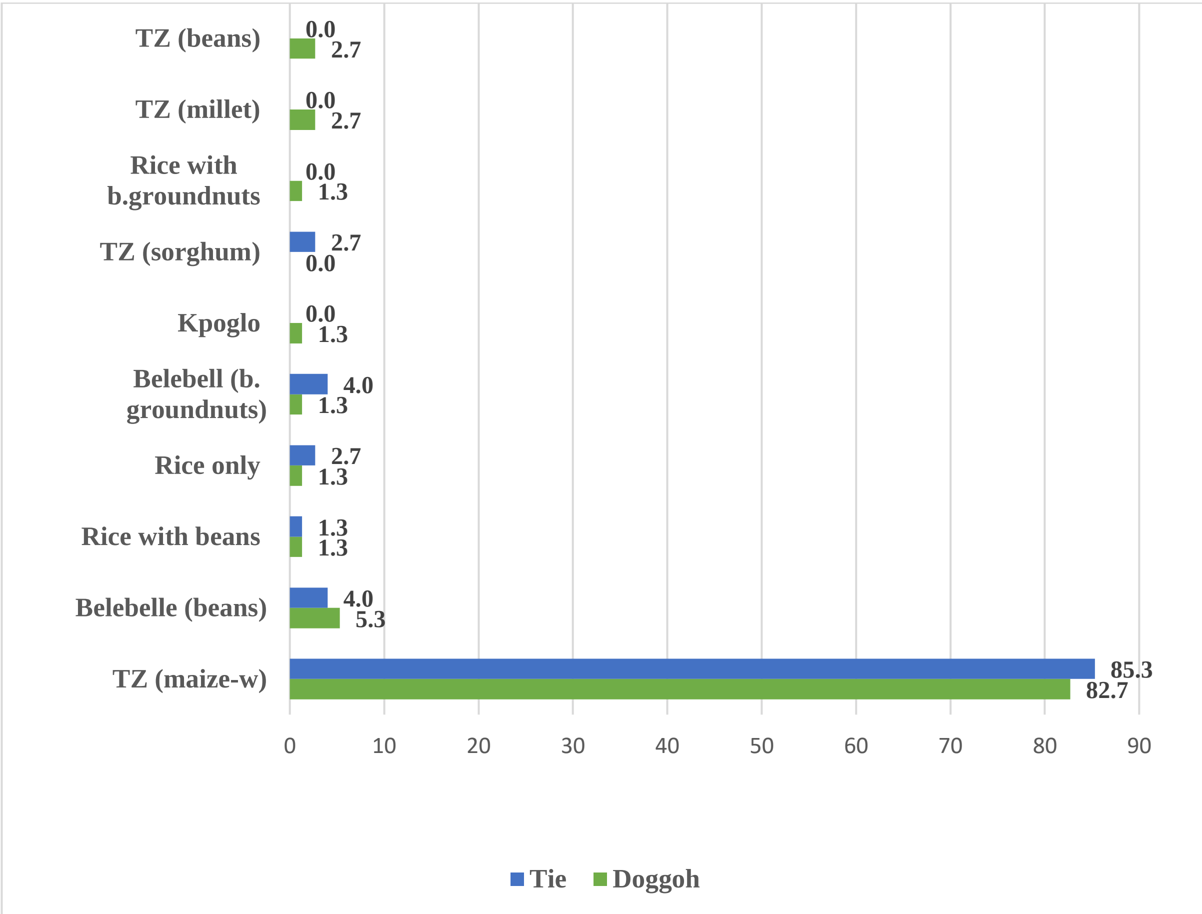
Figure 6. 2 Percentage of respondents that reported the foods that are primarily consumed for lunch in Doggoh and Tie Villages (N=75 in each village)



Source: Fieldwork (Semi-structured questionnaire, Doggoh and Tie, 2016)

The results show that TZ (maize-w) is the food that is ranked first among the primarily consumed foods for supper in both the villages of Doggoh (82.7%) and Tie (85.3%). The results as well indicate that the villages of Doggoh both have *belebelle* (beans), rice with beans, rice only, *belebelle* b. groundnuts as amongst the foods that are primarily eaten for supper. However, there is some differentiation. For example, *kpoglo*, rice with b. groundnuts, TZ (millet) and TZ beans have been cited by only respondents from the village of Doggoh as among the primarily consumed foods for breakfast. Similarly, TZ (sorghum) has been cited as among the primarily consumed foods in the village of Tie (see figure 6.3). *Tuo-zaafi* being ranked first amongst the primarily consumed food during lunch and supper is explained in detail in section 6.2.2.

Figure 6. 3 Percentage of respondents that reported the foods that are largely consumed for supper in Doggoh and Tie Villages (N=75 in each village)



Source: Fieldwork (Semi-structured questionnaire, Doggoh and Tie, 2016)

Having teased out the foods that are eaten for breakfast, lunch and supper in the villages of Doggoh and Tie, it is essential to have a sense of the rituals and mechanics around food consumption. Specifically, it will be vital to understand who is served first when the food is ready. Similarly, it is essential to understand who eats with whom- this will give us a better understanding of the food culture of the people of Doggoh and Tie villages. Therefore, the scope of the next sub-section is to understand the cultural norms of food consumption in the villages of Doggoh and Tie.

The cultural norms around food consumption

"… a man can eat food and leave part for a woman, but a woman cannot …"

(VIKI-8-T-Female)

Fieldhouse (2002: 85) opine that food is distributed according to complex rules and customs within households. The data from the focus group discussions with women in both the villages of Doggoh and Tie revealed that there are norms regarding the serving of foods and eating arrangements. It emerged from the data that once the food is ready, it is the head of the household, men, and children who are served first, then women are served afterwards. A participant in the focus group discussion with women in the village of Tie explains the order of serving meals as follows *"when you finish cooking, and if the family head and kids are there, they are served first, before you serve yourself. So if you finish cooking, generally men are served first, followed by children and then the women"* (Female participant, Focus Group, Tie). The results here are similarly reported in the literature on food serving. Fieldhouse (2002:115) reports that women only eat after men and children are served first when food is ready in the nomadic Gadulia Lohars of Northern India. The results above suggest the subordination of women to men when it comes to eating meals.

Similarly, it was reported that there is social differentiation regarding the eating arrangements of meals according to age and gender. A female participant in one of the focus groups discussions in the village of Doggoh explains: *"we do not eat together. Men eat alone, children eat alone as well, and then the women eat together"* (Female Participant, Focus Group, Doggoh). The following were the reasons cited to buttress why men and women do not eat together: (i) men have many tasks to accomplish hence rarely stay at home, therefore eating together suggests that the women can eat all the food leaving the men to go hungry, and (ii) women menstruate, and it is culturally unacceptable to eat with men during such periods.

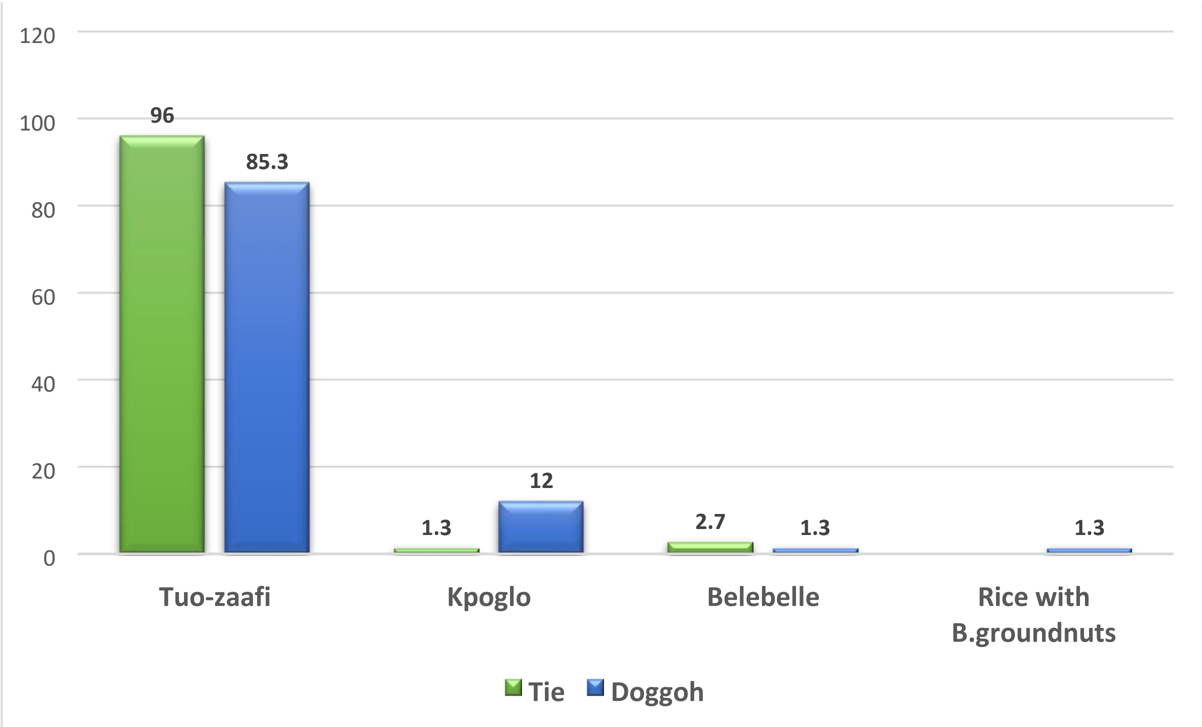
A female participant in the focus group discussion in the village of Tie details why women do not eat with men as follows: *"Maybe if we put everything in one bowl and men are out or not around, can you eat part of the food and keep part for the men? Absolutely no! That is why we put them separately. A man can eat food and leave part for a woman, but a woman cannot do that. Also, we women have many issues; maybe you are in your menses and the food is cooked, you cannot eat with a man or eat part and leave him part".* (Female participant, Focus Group, Tie).

The magnitude of consumption of food: which food plate dominates the other?

In the previous sub-sections, the various foods eaten in the villages of Doggoh, and Tie were looked at, differentiated by meal times (i.e. breakfast, lunch, and supper). In this section, the focus is turned to understanding the 'weight' (as in the food that is regularly eaten by households) of the various foods over others. This is important to have a sense of the value of the different foods. To accomplish that, the researcher relied on data from the semi-structured questionnaire for the data analysis. The results suggest *tuo-zaafi*, *kpoglo*, *belebelle* and rice with bambara groundnuts as the widely patronised foods in the village of Doggoh. Similarly, *tuo-zaafi*, *kpoglo*, and *belebelle* are named as the widely patronised foods in the village of Tie. Respondents in both villages agreed that *tuo-zaafi* is the widely patronised food in the two villages.

However, regarding the second largest patronised food in the two research villages, there exist some difference- whereas respondents in Doggoh opined *kpoglo*, their counterparts in Tie opined *belebelle*. The details are indicated in figure 6.4 (see also table 6.1 for the description of the preparation of the main staples).

Figure 6. 4 Percentage of respondents by top ranked foods in Doggoh and Tie villages (N=75 in each village)



Source: Fieldwork (Semi-structured questionnaire, Tie and Doggoh, 2016).

Table 6. 1 A description of the preparation of the main staples of the people of Doggoh and Tie villages

Staple food		Preparation
TZ	Maize TZ	"You will soak the maize for about two or three days and you will then send it to the grinding mill to grind and dry for them to dry and do the final grinding. When you bring it home, you will clean the place and fetch water. After fetching the water, you then bath and wash you cooking utensils and put the cooking pot on fire. You put some sour water into the cooking pot and when it starts to boil, you will fetch some down and start to stir your TZ the way you want it to be. After that, you prepare some soup for the family to eat. I think that is how we do it" (Women's Focus Group-Doggoh)
	Bambara beans TZ	Ok, if it is the Bambara beans TZ that you want to prepare, you will fetch your Bambara beans and send it to the grinding mill to grind. After that, you will come and clean the place, wash all you dishes, take you bath and pound your soup ingredients. You prepare a good soup, put it down, and then take the pot that you will like to use to prepare the TZ and put it on fire. You put some water into it and when it starts to boil, you will mash some of the flour and pour it into the hot water and start stirring until it becomes solid. You continue to stir until it is well cooked and you serve it into bowls and cover so that it does not easily become cold. After that, you serve the soup for the family to eat. I think that is how we also prepare the Bambara beans TZ (Women's Focus Group, Tie Village). You will coarse grind them, winnow it and grind it again into flour. At home, boil water, add pepper and salt and wait until it is boiling. You will fetch some of the water down, pour the flour inside and start stirring until it cooks to your desire, then you add oil and eat directly"(Women's Focus Group-Doggoh).
Kpoglo		You see my son, you will need fried maize, fried groundnuts, and fried bambara beans and beans flour to prepare kpoglo- you will have to send the fried groundnuts, b. groundnuts and maize to the corn mill to grind them together as flour- you can add the beans flour small or not at all…the beans flour makes it more starchy…once you have all these, you mix with water and add some salt to it- then you have to set your fire and get you cooking pot placed on and add water …if you're just preparing small quantity for family consumption, you can start shaping them into the form of a small ball and put inside the hot water…however, if you're preparing in large quantity let us say for farmers, then you have to mould them ready before the water begins to boil so you can put all of inside….usually, it cooks for like 25-30 minutes…when you talk one of the moulded balls on fire and it does not get separated, and is hard, you know it is ready…you can eat that with stew or you dry them on top of the zinc and then eat later with water" (Women's Focus Group, Doggoh Village)
Belebelle		"To prepare belebelle, you will need to have either beans or b. groundnuts flour, have some leaves or paper, or soft polythene bag, and you need to have saltpetre. With the beans or b.groundnuts flour, you need to follow the same procedure, as you will do to get the beans flour for TZ. Once all these are there, you will need to put the pot on fire and cover it so the vapour does not escape. Then you need to mix the beans or b.groundnuts flour with water, and the saltpetre, and then you stir the combination for like 10 minutes…. With your leaves or paper or polythene bag pieces, you then get reasonable amount of the mixture into the leaves and cover each portion then it is placed in the boiling water…you do that until all the mixture has been covered and out on the hot spot with water…. Within 30-1 hr, it gets cooked and then you can prepare stew to eat with it…once it is cooked, you need to remove either the leaves or paper in cold water, and by the time the stew is ready, you begin to serve it" (Women's Focus Group, Tie Village)

Source: Fieldwork (Women's Focus Group Discussions, Doggoh and Tie villages, 2016)

In section 6.2.1, the results showed that *tuo-zaafi* (TZ) is the food that is widely patronised in the villages of Doggoh and Tie. However, the section gave us little information justifying *tuo-zaafi* as the main staple food of the people of Doggoh and Tie villages. Therefore, section 6.2.2 is devoted to teasing out the cultural uses of food using *tuo-zaafi* as a case study.

6.2.2 The value of *tuo-zaafi* beyond nutritional and biological benefits

The results in section 6.2.1 showed that tuo-zaafi (TZ) is a food that is regularly patronised in both the villages of Doggoh, and Tie. This section now explores the various forms of TZ that exist in the villages of Doggoh, and Tie by teasing out the similarities and differences that exist among the various forms of TZ. Then in the latter part of this section, the focus is tailored to understanding the social uses of TZ.

What forms of tuo-zaafi exist? Are there any similarities and differences among the different forms of TZ?

The results from the village key informant interviews, and the focus groups discussions with women find that TZ consists of sorghum, maize (y), maize (w), millet, rice, beans and bambara groundnuts hence in both the villages of Doggoh and Tie, there is sorghum TZ, maize(y) TZ, beans TZ, millet TZ, rice TZ, and bambara groundnuts TZ. Results from the village female key informant interviews for example suggest that, regardless of the above forms of TZ, water is needed in their preparation. Again, except for rice TZ, flour is needed for the preparation of the other forms of TZ (VIKI-8-T-Female, VIKI-8-D-Female).

However, the results from the data suggest that the above forms of TZ can be differentiated on the parameters of: (no) addition of food seasoning leaves to the preparation, (no) production of porridge, (no) preservation in *ko-rou*[113], (no) production of *saakoouw*[114] and ideal time for preparation (see table 6.1 for the summary of the groupings).

Interviews with the village key informants in both the villages of Doggoh and Tie reveal that *ko-rou* is a local mechanism of preserving TZ in a pot made either from clay or from a metal. Similarly, the data from the village key informants indicate that *saakoouw* is mashed TZ with water added to it for drinking (VIKI-8-T-Female, VIKI-8-D-Female).

On the element of addition or no addition of food seasoning leaves, village female key informants in both the villages of Doggoh and Tie grouped sorghum TZ, millet TZ, maize(y) TZ, and maize(w) TZ as the forms of TZ that require the addition of *be-ree*[115] or *po-rou*[126] to the water before they are prepared. However, rice TZ, beans TZ and bambara groundnuts TZ do not need the addition of the seasoning leaves before preparation. A participant in the focus group discussion with women in the village of Doggoh explains the essence of *be-ree* and *porou* as follows: *"If you use a very good sour water to prepare TZ and store it, it can last for three days and still be good. But if the sour water is not enough, just the next two days, it will start to go bad"* (Female Participant, Focus group, Doggoh). Interviews with the female village key informants revealed that millet TZ, sorghum TZ, maize (w) TZ, maize (y) TZ can produce porridge whereas beans TZ and bambara groundnuts TZ cannot produce porridge (VIKI-8-TFemale, VIKI-8-D-Female).

On the aspect of food preservation, the data from the key informant interviews, the focus groups with women, and the household case studies showed that households in the villages

---

[113] A local mechanism for the preservation of TZ (VIKI interviews, Doggoh and Tie villages- see picture 6.1 for details)

[114] Mashed TZ and water added to it for drinking (VIKI interviews, Doggoh and Tie villages)

[115] Seasoning leaves for the preservation of TZ (VIKI-8-D-F, VIKI-8-T-F) [126] Seasoning leaves for the preservation of TZ (VIKI-8-D-F, VIKI-8-T-F)

of Doggoh and Tie have a local mechanism of preserving the TZ they prepare in *ko-rou* (see picture 6.1). A female village key informant in Tie justifies the usage of *ko-rou* as follows: *"…you see, once you store TZ in the ko-rou, you can go about your daily activities the next day and will only need to cook some soup to eat it that instead of spending a lot of time in preparing another TZ"* (HCS-7-T-Female).

Therefore, on the basis of (no) preservation in *ko-rou*, results suggest millet TZ, sorghum TZ, maize (y) TZ and maize (w) are preserved in *ko-rou*. Unlike millet TZ, maize TZ, or sorghum TZ, the data suggest that rice TZ, Bambara groundnuts TZ, and beans TZ cannot be preserved in *ko-rou* and are consumed immediately as pointed out by a female respondent as follows: *"the whole portion of TZ made from either beans, rice, or bambara groundnuts is consumed the same day- if you keep it for some hours, it will look dry"* (Female participant, focus group, Tie).

Picture 6. 1 An illustration of a woman preserving tuo-zaafi in ko-rou in Doggoh village

Source: Fieldwork (Participant observation, Doggoh Village, 2016)

The results suggest that different forms of TZ can be prepared at any time. However, the data show that millet TZ, maize TZ, and sorghum TZ are ideally prepared in the evening as they can be stored in *ko-rou* for use during the subsequent days.

In the interviews, it emerged that TZ becomes complete when it is either eaten with soup or shea butter oil and pepper (VIKI-8-T-Female, VIKI-8-D-Female). On this criterion, results suggest that sorghum TZ, millet TZ, maize(y) TZ, rice TZ, and maize (w) TZ cannot be eaten with shea butter oil and grinded pepper whereas beans TZ, and bambara groundnuts TZ are eaten with both soup, and shea butter oil and grinded pepper but they are largely consumed with the latter. The results above, as summarised in table 6.2, imply that more of the TZ made from maize (w), maize (y) and sorghum would be eaten than the TZ from b. groundnuts and beans due to the preservation mechanisms of the former.

Table 6. 2 An illustration of the differences that exist among the various forms of tuo-zaafi

Criterion	Forms (s) of tuo-zaafi
Use of flour for preparation	All forms of TZ except rice
Local preservative leaves required for preparation	Millet TZ, sorghum TZ, and maize TZ
Porridge as by-product	Millet TZ, sorghum TZ, and maize TZ
Preserved in *ko-rou*	Millet TZ, sorghum TZ, and maize TZ
Eaten with shea butter oil and grinded pepper	Beans TZ and Bambara groundnuts TZ
Eaten with soup	Sorghum TZ, maize TZ, beans TZ (occasionally), rice TZ, and Bambara groundnuts (occasionally)

Source: Fieldwork (Doggoh and Tie villages, 2016)

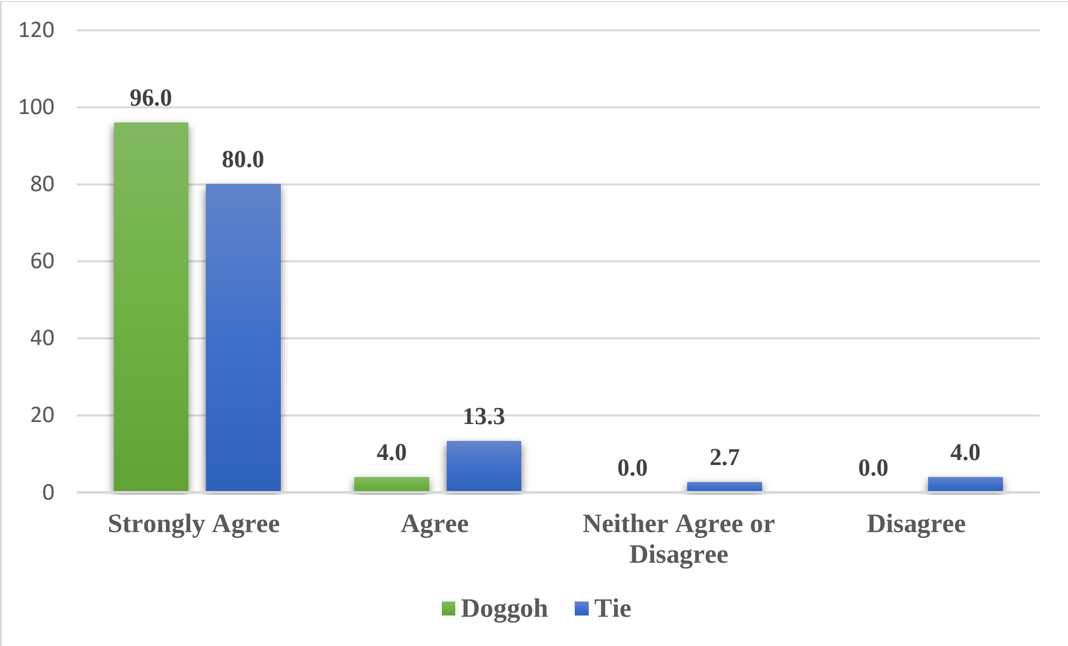
No tuo-zaafi, no food in the villages of Doggoh, and Tie

"… Tuo-zaafi is a 'big food'. We eat and warn the children never to finish all the tuo-zaafi in the ko-rou" (HCS-7-T-Female)

Moving beyond looking at food as primarily a vessel of nutrition as nutrition interventions have always seen as a core objective (Scrinis, 2013), this section teases the cultural value of *tuo-zaafi*. In this sub-section, the researcher draws on the ideas of cultural idealism (see chapter 2, section 2.4.2). As a starting point, the Likert scale data obtained from the semi-structured questionnaire were analysed to understand respondents' attitude towards tuo-zaafi. The results (see figure 6.5) indicate that the majority of the surveyed respondents in both Doggoh (96.0 %) and Tie (80.0%) strongly agreed that without TZ, there was no food in their households. The results here are a reinforcement of the results in the earlier part of this section that revealed TZ as the primarily patronised food in both the villages of Doggoh and Tie. Similar findings are documented in the discourse on cultural aspects of food. For example, in a study in western Kenya, Noack and Pouw (2015) reported that about 60% of the surveyed respondents in their study opined that without ugali (a traditional staple food), they do not eat food at all.

The results, however, demonstrate differences between the two villages. For example, whereas the respondents in the village of Doggoh either strongly agreed or agreed, in the village of Tie, some respondents neither agreed or disagreed (2.7%) and disagreed (4.0%) that without TZ, there was food.

Figure 6. 5 Percentage of respondents by 'no tuo-zaafi no food' (N =75 in each village)



Source: Fieldwork (Semi-structured questionnaire, Tie and Doggoh, 2016).

Having described the attitude of households toward tuo-zaafi (TZ), the next step is to present results explaining the cultural value of TZ. This was achieved by triangulating data from the village key informants, the focus groups, and the household case studies.

During the data analysis, the following themes emerged to explain the 'supremacy' of tuo-zaafi over other foods: continuation of the foodways of the forefathers, a tool to welcome visitors by host households, tuo-zaafi as medicine, easy to prepare, a tool to replenish body fluids, longer 'expiration' date, tuo-zaafi as a 'time saver', and ritual uses of *tuo-zaafi* for undertakers. The details of each of the factors are discussed below.

(a) Continuation of the food ways of the ancestors

The foods we eat are largely shaped by our ‘roots’ (as in our ethnic origin, particularly the family). However, as we grow and get integrated into the wider society, other factors come to influence what we eat including media influence and travel to other geographic settings. In the interviews with the village key informants, it was revealed that tuo-zaafi is the food the people of the Doggoh, and Tie villages have known since childhood (VIKI-7-D-Male, VIKI-7-TMale).

This implies that socialisation particularly primary socialisation plays a critical role in shaping the food habits of the people of the Doggoh and Tie villages. To Fieldhouse (2002:13), the law of primacy means that whatever habit is learnt earliest is more likely to persist in later life and to be most resistible to change. A female participant in a focus group discussion at the village of Doggoh explained: *"you see, it is the food that we have regularly been eating since childhood hence we are used to that tradition"* (Female participant, Focus Group, Doggoh). This value is also evident in the following statement by a male participant in one of the case study interviews in Tie: *"you cannot stop eating it. Since you are a son of the Dagaaba land, you are used to it and can never stop eating tuo-zaafi"* (HCS-4-T-Male). The aforementioned findings demonstrate no rational reason (e.g. nutritional or biological reasons) for the consumption of *TZ.* It is evident from the results that by virtue of the fact that HCS-4-T-M is born a *Dagao*[116] he accepts the pattern of consumption of different foods in the village of Tie.

(b) A tool to welcome visitors to households

On the aspect of acquisition of food habits via socialisation, one may be tempted to ask: is *tuo-zaafi* the only food that the households have inherited from their ancestors? The answer is an emphatic no, as the data revealed that other foods are also inherited. Hence, moving

[116] A Dagao is anyone that is a member of the *Dagaaba* ethnic group (VIKI-5-D-M, VIKI-5T-M)

away from the transmission of food habits from the older generation to the younger ones, the results suggest that TZ is a tool that nourishes social relations (Corr, 2002).The data from interviews with the village key informants, and the household case studies indicate that it is a societal expectation for a visitor to be offered *saakoouw*, and fed with TZ by the host households (see table 6.3). Accordingly, *saakoouw* is particularly offered to guests that travel from far distances to the host household (HCS-10-T-Female), and it is impolite to offer the guest only water (VIKI-7-T-Male).

In addition, the data revealed that the host households are even required to prepare tuo-zaafi for guests if they have already prepared a different dish (VIKI-7-T-Male, VIKI-7-D-Male) - see table 6.2 for details. Therefore because of the above value of *tuo-zaafi*, a female village informant in the village of Tie illustrated the cautions they put in place to ensure that TZ is readily available at all times: *"TZ is a big food, we eat and warn the children never to finish all the TZ in the ko-rou"* (HCS-7-T-Female). The findings here are similarly reported in the literature. For example, Fieldhouse (2002: 84) reports that "among the Kikuyu tribe of Kenya, there is a basic assumption that every time you visit a home, the host will feed you". Similarly, Fieldhouse (p.84) tells us "when a special guest arrives in a Zarian home, it is important for the host to kill something or serve 'meat with blood'". Just as findings in this study reveal that it is a shame not to feed a visitor, the literature suggests that it is impolite not to feed a guest in the culture of Kenya (Fieldhouse, 2002:85). Again, the results here demonstrate that if it is being rational (e.g. on the basis of nutritional value), households in the villages of Doggoh and Tie could possibly serve guests with rice, eggs and vegetables that one can say are more nutritious than TZ. However, the offering of TZ to guests by the host households is a reflection of the cultural code of the Dagaaba people that represents, symbolises, and expresses their unique worldviews as the cultural idealists believe (Torpoco, 1997).

Table 6. 3 Households' illustrations of the value of TZ in nourishing social relations

'Water for guests'	*"TZ is a 'big food'. When guests come, you cannot just fetch only water from a pan for them if there is no TZ...TZ is a big food" (VIKI-8-T-Female)* *" ...Once they visit, you have to mash TZ , add water to that and give it to them to drink...once they come from long distance for instance, the water quenches their thirst" (HCS-10-T-Female)*
Cultural food for visitors	*" If a given household receives a visitor and has no TZ preserved in the ko-rou or in a bowl, it is considered a disgrace" (HCS-7-T-Female)* *" If a visitor comes to my house no matter food has been prepared, I will still ask my wife to prepare TZ for the visitor" (VIKI-7-T-Male)*

Source: Fieldwork (Qualitative data, Doggoh and Tie villages, 2016)

(c) *Tuo-zaafi* as a core requirement for the ritual activities of undertakers

Through the interviews with the village key informants, it emerged that *tuo-zaafi* plays a central role in the lives of undertakers and the initiation of children against certain illnesses through the performance of the *boo-kpeo*[117] ritual during funerals. The details are illustrated in box 6.1. The finding here is in line with Fieldhouse (2002: 100) believe that many rituals, both pagan and religious involve food. Fieldhouse (2002: 100) considers a ritual as a repetitive act carried out in a codified manner. He cites turmeric in the case of the Hindus, wine for Christians and citron for the Jews in the performance of rituals.

[117] A ritual in which children are put in the grave with the dead prior to burial to fortify them against certain illnesses (VIKI-5-D-Male, VIKI-5-T-Male)

Box 6. 1 A dialogue between the researcher and a village key informant on the ritual uses of TZ

Researcher: *My father, you said TZ has some role in the funeral activities of your village. Can you please tell me more about it?*

VIKI-5-T-Male: *okay, clearing throat... you see, the crops that are placed besides the dead during funeral celebrations are very important for performing sacrifices to cleanse the undertakers and also for people especially children that would go through 'boo- kpeo' to 'fortify' them and reduce the risk of them getting some traditional illnesses.*

Researcher: *Father, can you please explain further what you mean by 'boo-kpeo'. You mean they will bury the kids with the dead or what?*

VIKI-5-T-Male: *Hahaha, you see, what the undertakers do is that they take children who have not been through such a practice and put them together with the dead in the grave....then some of the undertakers outside would cover the round grave with a big stone. Then after the necessary exercise, the children would be brought out ...many of the children will cry a lot as they think they are going to be buried...but it is very vital to undergo that exercise.*

Researcher: Tell me a little about the importance of such a practice.

VIKI-5-T-Male: *You see, if you enter a car and there is a accident and blood split on the ground and you cross that, we believe that you get some illness such as your legs will become big and you will die. But if you go through such an initiative, you can cross the blood and would be free...nothing can happen to you. You see, we all have gone through that initiative.*

Researcher: *You said kagyin and other crops would be used for preparing some food after the burial...can you tell more about which crops are used father?*

VIKI-5-T-Male: *Okay, the key crops are sorghum and groundnuts. The sorghum is used in preparing TZ and the groundnuts for the soup. All the children that go through the practice have to eat that food after certain sacrifices are performed to the gods by the undertakers. This cleanses the undertakers of any 'dirt' associated with the burial of the dead. It also prevents the children that have gone through the initiative from acquiring some diseases.*

Source : Village Key informant interview (Tie village, 2016)

(d) Tuo-zaafi is medicine

Besides the factors outlined in “a” and “b”, the results from the data suggest that tuo-zaafi is a ‘supreme’ food because of its medicinal value. The medicinal value of tuo-zaafi is evident in its potency to deal with diseases (e.g. fever, and diarrhoea), assist in improving people’s blood levels, as well as the ideal food for nursing mothers (see table 6.4 for detailed information). As discussed earlier in this section (see table 6.1), the TZ made from millet, sorghum and maize have porridge as a by-product. Results from the qualitative interviews suggest tuo-zaafi as the first food call point when a household member falls sick. Sorghum TZ has particularly been identified as very nutritious hence is recommended by medical doctors. The results here are similarly reported by Kumar (1988:26) in which he spoke about rice broth being used for curing dysentery, and those suffering from consumption or asthma were advised to take rice prepared in specific ways.

Table 6. 4 Respondents’ illustrations of the medicinal value of tuo-zaafi

Remedy for fever	*“…if you are attacked by fever and you eat sorghum TZ it cleanses all the dirt in your system” (HCS-5-D-Male).*
Increases blood level	“Ok, the tuo-zaafi they say it gives you blood and gives you a good skin – in terms of beauty” (HCS-4-T-Male)
Doctor’s recommendation	*“The sorghum has power. When you go to hospital, the doctors sometimes ask you to go home and be eating sorghum. It increases you blood level and other things in your system” (Female Participant, Focus Group, Doggoh).*
Warm the human system	*“For the TZ, it is an olden day thing. Even, as you are sitting now, if you fall sick it is porridge that they will make for you to take. You cannot take “sowolle”. That’s why we eat it every day. That is our tradition. All the other food are luxury”* (HCS-18-D-Male)
Remedy for diarrhoea	*“Sorghum tuo-zaafi is heavier than that of millet....it is heavy because once someone runs diarrhoea and you use sorghum to prepare porridge for the person concerned, the diarrhoea will cease …” .(Female participant, Focus Group, Tie)*

Source: Fieldwork (Qualitative data, Doggoh and Tie villages, 2016)

(e) *Easy to prepare*

The respondents are of the view that unlike the other foods discussed in section 6.2, the preparation of *tuo-zaafi is* easy. The data further suggest that the ease of preparation of *tuozaafi* helps households to deal with 'emergency' food situations. Among the unannounced situations that warrant food that have emerged from the data is someone coming to help them in their farm fields without prior notice (Village key informants, Doggoh, and Tie, 2016). In box 6.2, HCS-11-T-Female nicely illustrates the easy preparation of *tuo-zaafi* as compared to that of *sowolle.* In the preparation of the latter, women will need to go pluck vegetable leaves, and get that boiled, and then boil the beans too before the food would be ready for consumption.

Box 6. 2 Households' illustrations of the ease of preparation of tuo-zaafi

"You see, preparing it is easy too…preparing TZ is very easy for us"

(Female participant, Focus group, Doggoh)

"You see, if a visitor comes to your house and you do not have TZ in ko-rou and gives the visitor only water, you should be disgraced. You see, you cannot cook beans food for the visitor as it would take longer time to get ready but TZ would be ready very fast"

(Female participant, Focus group, Doggoh)

"Well, it is because of the work, as we are standing like this, if you stay here and say they should go and pluck the vegetable leaves today and boil, that t they should prepare the sowolle, how will they get it"

(HCS-11-T-Female)

"… but if there is flour, like now they have carried out the maize home, she will Take that flour and prepare the TZ, prepare the soup and add it and come back"

(HCS-9-D-Male)

Source: Fieldwork (Qualitative data, Doggoh and Tie villages, 2016)

(f) *Tuo-zaafi* replenishes the body's fluid

The results in section chapter 5 section 5.2.5 illustrated that households in the villages of Doggoh, and Tie draw labour from both within and outside their households to undertake farming activities. The results in this sub-section reveal that *saakoouw* is a required during farming activities, and during the consumption of certain foods. VIKI-8-D-Female explains the role of TZ during the farming activities as follows *"you see, when we have farm labourers, we need to give them water to drink- we cannot just give them any water but mashed TZ combined with water. This helps to get them hydrated- so during farming, we the women are required to organise saakoouw and place close to the farm labourers".* Similarly, it emerged from the data that when households are eating *sowolle*, *saakoouw* is needed to be taken intermittently for the food to adjust well in the stomach as respondents opined that *sowolle* takes a longer time to digest (VIKI-8-D-Female, VIKI-8-T-Female).

(g) *Tuo-zaafi* takes a longer time to 'expire' than other foods

The results suggest that, because *tuo-zaafi* (specifically either millet, maize, and sorghum form) is prepared with local preservatives, and stored in *ko -rou (*see table 6.1), that makes it last longer before 'expiring' as compared to other foods. Therefore households (see "g") opine that it saves them a lot of time. In a focus group discussion with women on food preparation and preferences, one of the participants expressed her view as follows: *"...But for the Sowolle, once you prepare it today, within the next day, you may be able to eat that in the morning but once it delays for a while, it will get go bad that is why they prefer to prepare the TZ"* (Female participant, Focus Group, Doggoh). The results are similarly reported in the literature (e.g. Forde, et al., 2017, McCrikerd, et al., 2012).

6.2.3 Summary

Finding 1: The Villages of Doggoh and Tie share similar foods

- Farmers reported *tuo-zaafi, belebelle, sowolle, beans with rice, rice only,* bambara groundnuts with rice, *kpoglo,* porridge and *sensere* as the main foods.
- Farmers reported that a good day comprises of three meals: breakfast, lunch and supper. Varieties of dishes are eaten during these periods. Farmers from the two villages reported porridge (maize-w) and *tuo-zaafi* (maize-w) as the foods that are mainly eaten for breakfast and supper respectively.
- Similarly, the respondents in both Doggoh and Tie reported TZ (maize-w) as the food that is mainly eaten during lunch (Chapter 6, section 6.2).

Finding 2: The head of the household, men and children are first served, and women are served last

- Farmers reported that men and children are served first when the food is ready. Farmers reported that it is the custom of the village of Doggoh and Tie to serve the head of the family when the food is ready, then children and women are the last to be served.
- Similarly, farmers reported that eating arrangement is according to age where the men eat with men, children with children and women with women. Farmers explained that because women menstruate, they do not eat with men, and because men hardly stay at home, the women eat separately and reserve the men's food for them.

Finding 3: No *tuo-zaafi,* no food in the villages of Doggoh and Tie

- Farmers reported *tuo-zaafi* as the main staple of the people of the Doggoh and Tie villages. It emerged that *Tuo-zaafi* has different forms and is differentiated on the parameters of: (i) the use of flour for preparation, (ii) local preservative leaves for preparation, (iii) porridge as a by-product, (iv) preservation in korou, and (v) eaten with shea butter or oil; or eaten with soup.

- It similarly emerged that without *tuo-zaafi*, there is no food in the villages of Doggoh and

  Tie. Farmers reported that *tuo-zaafi* has uses beyond biological and nutritional functions. Farmers reported that following as the cultural aspects of eating *tuo-zaafi*: (i) continuation of the food ways of the ancestors, (ii) a tool to welcome visitors by host households, (iii) *tuo*-zaafi as medicine, and (iv) *tuo-zaafi* being used for performing rituals by undertakers.
- The results (see section 6.2.2) here on the role of no tuo-zaafi can be likened to Sahlins claims that human valuations of the edibility and inedibility of meat are qualitative and not in any way justification of biological, ecological or economic advantage (Torpoco, 1997, Sahlins, 1978).
- The symbolic value of TZ in nourishing social relations as manifested in host households using it as a tool to welcome guests into their homes reflects Fiddes claim that a society's attitudes toward food is a reflection of its worldviews (Torpoco, 1997).

6.3 Household Food Preferences under Climate Variability and Change: T*uo-zaafi* as a Case Study

The review in chapter 2 (section 2.4.2) suggests that food availability is a necessary condition for the development of food preferences. As argued in chapter one (see section 1.2.1), farmer responses to climate variability and change impacts via crop selection could potentially lead to the trade-off of culturally preferred foods. The justification being that the crops that may do well under the prevailing changing climate hence more quantities of that being available may not necessarily be the culturally preferred food crops of households.

In chapter 5, the results indicated that farmers have responded to the changing prevailing local climate by cultivating more of maize (w) and less of sorghum and millet (see section 5.2.1). This has translated into more of maize (w), and less of sorghum and millet available to households in the villages of Doggoh and Tie. To that end, the following questions are worth reflecting on (i) is maize (w) the cultural food crop for tuo-zaafi in the villages of Doggoh and Tie?, and (ii) does availability necessarily translate into the preference for food? In an attempt to answer the above questions, the study draws on the theoretical ideas of cultural materialism, the sensory properties of food, food availability, and 'mere' exposure theory (as reviewed in chapter two section 2.4.2) to guide the presentation of the results. To that end, section 6.3.1 discusses the changing nature of tuo-zaafi consumption. Then section 6.3.2 is devoted to understanding the changing nature of the preferences for tuo-zaafi. In sections 6.3.3 and 6.3.4, results are presented on how the preference for tuo-zaafi is socially differentiated, and the factors that shape the preference for tuo-zaafi respectively.

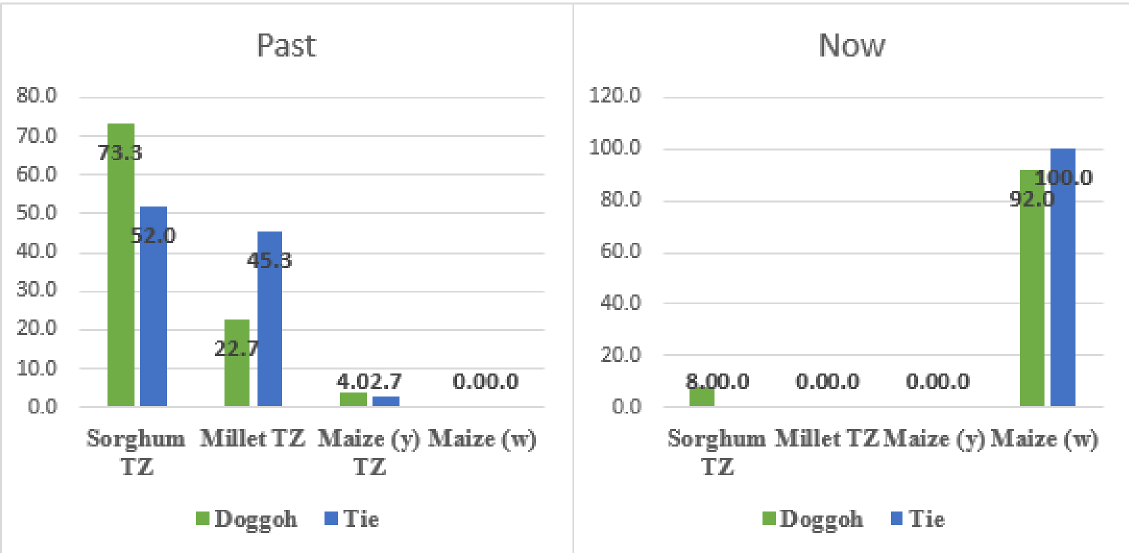
6.3.1 The changing nature of tuo-zaafi consumption

This section, focusing solely on *tuo-zaafi*, seeks to tease out how the consumption pattern of TZ has changed now as compared to that of the past. This is important to understand how the cropping decisions in chapter 5 have impacted that because Rozin (2015) argues that food choice is highly constrained by availability and cost, both of which are primarily determined by culture and the local climate.

In the context of this section, 'pattern of consumption' is used to refer to changes in the primarily consumed form of TZ now, as compared to that of the past. To reach that objective, data from the semi-structured questionnaire were analysed. Results indicate that sorghum TZ, millet TZ, maize(y) TZ were the varieties of TZ that were primarily consumed in the past in both the Doggoh and Tie villages (see figure 6.6). The statistics from the data (see figure 6.6) indicate that the primarily consumed forms of TZ in the past for the village of Doggoh were: sorghum TZ (73.3%), millet TZ (22.7%) and maize (y) TZ (4.0%), and now are: maize (w) (92.0%) and sorghum (8.0 %). For the village of Tie, surveyed respondents cited: sorghum TZ (52.0%), millet TZ (45.3 %) and maize (y) (2.7%) as the primarily consumed forms of TZ in the past, and maize (w) (100.0%) as the primarily consumed form of TZ now.

It is not surprising to see that millet TZ and maize (y) TZ are not listed among the regular forms of TZ eaten in both the villages of Doggoh and Tie now, as the results in chapter five (see section 5.2.1) indicate that households have displaced these crops as among the primarily cultivated crops hence we expect that farmers would not have that to regularly consume. In the case of the sorghum, results suggest that about 8% of the surveyed households in the village of Doggoh consume sorghum TZ as the regular form of TZ. The data suggest that the decisions of households in the village of Tie to eat maize (w) regularly than the TZ made from sorghum could be due to the less value of maize (w) in the performance of ritual functions as depicted in table 6.5. The results here, particularly on millet TZ, are worth reflecting on- what if millet TZ is the culturally preferred food?

Figure 6. 6 Percentage distribution of varieties of TZ regularly eaten in the past, and now in Doggoh and Tie villages (N = 75 in each village)



Source: Fieldwork (Semi-structured Questionnaire, Doggoh and Tie, 2016)

To have a nuanced understanding of the tuo-zaafi choice decisions of households, data from the village key informant interviews, the focus groups, and the household case studies were drawn on. On the patronage of maize (w), the results reveal that it is widely consumed now because there is more available and because it is of less significance regarding the ritual activities of the villages of Doggoh and Tie (see table 6.5 for details). For sorghum, the results demonstrate that households trade-off the tuo-zaafi from sorghum, and therefore eat less of it in order to use the available sorghum for their ritual activities. For millet tuo-zaafi, the results in chapter five (section 5.2.1) demonstrate that it is a crop that has been displaced by households because the available varieties are not suited to the prevailing climate (see table 6.6 for detailed information).

Table 6. 5 An illustration of the reasons why maize (w) tuo-zaafi is widely consumed by households

Reason	Farmer quotes
Largely cultivated crop	*"….But now, it is agric maize that we all cultivate a lot now. It is very important food crop now" (Female participant, focus group, Doggoh village)* *"…you see, everyone cultivates that ….many people focus on maize (w) …some cultivate it alone others intercrop that with sorghum"* (HCS-7_T-Female) *"Now it is white mazie TZ that we regularly eat and love to eat..we do not longer know how to eat sorghum TZ, for millet, we do not longer cultivate it that much as we did in the past hence we do not longer think about millet TZ..so it is maize TZ that we eat widely now"* (Female participant, Focus Group, Doggoh)
Less ritual uses	"*but we do not get them the way we used to get them....it is maize that produces better yields than sorghum and millet.....so once we get just a few and because of the role in our cultural practices we cannot take all and wouldn't have any...if we say because they give us better our preferred tuo-zaafi and eat that we would have some traditional practices that cannot be attended to so it is now a must for us to eat more of maize tuo-zaafi because if the maize is finished but we can still use the millet and sorghum to perform our cultural practices"* (VIKI-T-5-Male)

Source: Fieldwork (Qualitative data, Doggoh and Tie villages, 2016)

Table 6. 6 Illustration of the reasons why millet and sorghum forms of tuo-zaafi are not widely eaten

Reason	Farmer quotes
More ritual uses	"…For Sorghum, we do not longer cultivate that much. It is because of the traditional rituals performance that make us cultivate that a little. If you get like 10 *Kagyin,* that would cater for funeral rites, that would be used for brewing pito" (HCS-18-D-Male) "…you see, we cultivate sorghum because of its paramount role in our traditional practices…you see, we put sorghum for the performance of our traditional practices, then when you run short of white maize, you can now go for *kagyin*, thrush it and prepare TZ" (Female participant, focus group, Doggoh) "You see, for the sorghum now, we reserve that for *hunger season*. Also, if we hurridly eat that and there is something that has to be addressed traditionally, we would not be able to handle such matters. " (HCS-18-D-Male)
Less available quantity	"No that is not it…laughter. I said we love that they should prepare ift for us to eat but because it is no longer available in large quantity" (HCS-7-T_Female)
Difficulty in processing	"Also, if you ask the women to thresh it, they would complain that there is maize, so when would they thresh sorghum, winnow it and go for grinding " (HCS-18-D-Male)

Source: Fieldwork (Qualitative data, Doggoh and Tie villages, 2016)

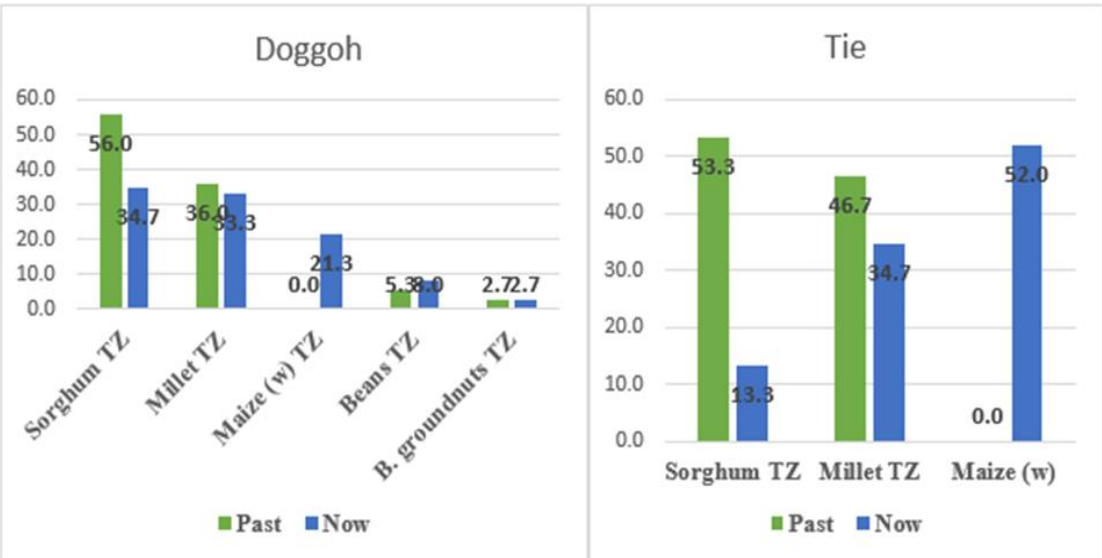
6.3.2 The changing nature of preferences for *tuo-zaafi*

In section 6.3.2, the researcher discussed how the consumption pattern of *tuo*-zaafi has changed now as compared to that of the past. In this section, the researcher attempts to answer the question: *does the consumption pattern of tuo-zaafi tally with the preferences for tuo-zaafi*?

The data showed that both the villages of Doggoh and Tie preferred sorghum and millet forms of TZ in the past. In addition to the above forms of TZ, the data revealed that the village of Doggoh also preferred beans and bambara groundnuts forms of TZ in the past (see figure 6.7). This finding suggests that preferences was driven by availability of food (among other factors) as sorghum and millet were the largely cultivated crops in the past in both Doggoh and Tie villages (see section 5.2.1). However, in terms of household food preference now, the data revealed that the main preferred form of TZ is maize (w) TZ for the village of Tie, and sorghum TZ for the village of Doggoh. Other preferred forms of TZ are millet TZ and sorghum TZ for Tie, and maize TZ, millet TZ, beans TZ, and b.groundnuts TZ for the village of Doggoh.

The preferences of households in the village of Tie for the TZ made from maize (w) could be explained by the cultural materialists' views of food preferences as a construction of man's adaptation to earthly problems. The finding of the consumption pattern of *tuo-zaafi* tallying with the preference for *tuo-zaafi* disagrees with Fieldhouse's assertion that preferences may differ from actual consumption (Fieldhouse, 1996: 194). However, that agrees with the finding of the village of Doggoh where the consumption pattern of TZ (maize-w) differs from the preferences for TZ (Sorghum). The differences in actual consumption and preferences for tuo-zaafi calls for policy interventions to incorporate the local food preferences into due consideration in the design of resistant varieties of crops in adaptation measures.

Figure 6. 7 Percentage of Preferred form of TZ in Doggoh and Tie villages (N= 75 in each village)



Source: Fieldwork (Semi-structured Questionnaire, Doggoh and Tie, 2016)

Even though the respondents in the village of Tie during the semi-structured data collection stage indicated they prefer maize (w), it emerged in the household case studies and focus group discussions that is not a 'true' preference but a 'forced' preference (see box 6.3 for farmers' illustrations of the 'forced' preference for maize (w) TZ).

Box 6. 3 Farmers' illustrations of 'forced' preferences for maize (w) TZ in the village of Tie

"We are forced to eat maize TZ. It is millet TZ that we used to love and eat. But these days the millet do not do well when we farm them. That's why we are now consuming maize TZ" (HCS-15-T-Male)

"For 'zie 'we want that to eat but we do not have that much those days we used to have that much……..those days we used to have that a lot.... some people elsewhere get it more to eat but Doggoh here we do not get it that much" (VIKI-7-T-Male).

"...Maize is not the form of TZ that we prefer but because of its availability we have no other option than to resort to that" (HCS-7-T-Female).

Sources: Fieldwork (Qualitative data, Tie village, 2016)

6.3.3 How are the preferences for tuo-zaafi spatially and socially differentiated?

In this section, the focus is to understand two main things: one, how the preference for the different forms of tuo-zaafi are spatially and socially differentiated, and two, to tease out the factors that influence the preference for the different forms of tuo-zaafi.

(a) Spatial and social differentiation of the preference for tuo-zaafi

In this sub-section, the scope is to understand how the preference for *tuo-zaafi* is spatially differentiated, and how different social groups in each of the two research villages differentiate their preference for tuo-zaafi.

'Food availability' explaining spatial differentiation of food preference

Here, the scope is to understand whether there is differentiation in terms of the preference for TZ between the villages of Doggoh and Tie. In figure 6.7 the results show that whereas the majority (34.70%) of the respondents in the village of Doggoh observed sorghum TZ as the form of TZ that is preferred now, their counterparts (52.0%) in Tie opined maize TZ as the form of the TZ that is preferred now. Furthermore, the results in figure 6.7 point out that in addition to the sorghum, millet, and maize (w) forms of TZ that were mentioned as the preferred forms of TZ now in Tie, beans TZ, and bambara groundnuts TZ were also named as among the preferred forms of TZ in the village of Doggoh now.

The absence of bambara groundnuts TZ as among the forms of TZ that are now preferred by the village of Tie could be explained by the fact that bambara groundnuts is not allocated much farm field for cultivation (as indicated by figure 5.1 of section 5.2.1 in chapter five), which translates into less quantity of that food crop available. Similarly, the results in chapter five (see figure 5.1 in section 5.2.1 of chapter five) showed that beans are ranked as the least cultivated of the main crops in the village of Tie. This could potentially translate into less quantity of beans being available. Besides availability, the results in section 6.2.1 revealed that beans have many uses including preparing: beans only, beans with rice, sowolle, and *sensere*. This also means that households could trade-off the *tuozaafi* from beans to prepare any of these dishes.

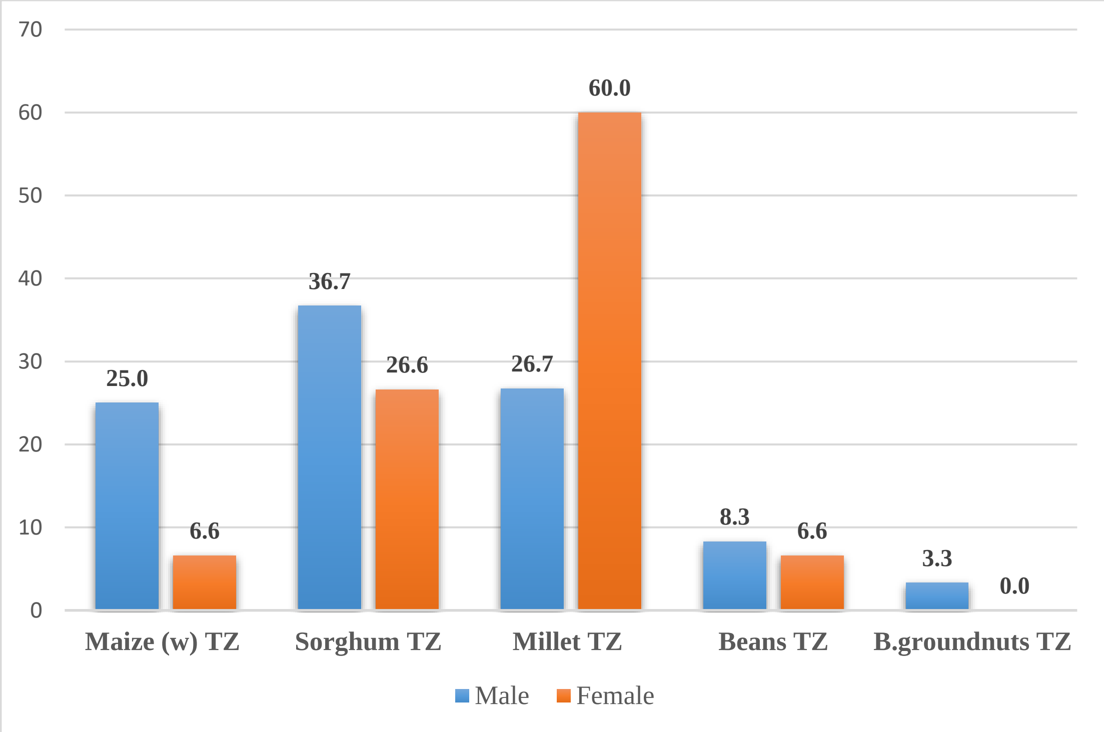
Intra-spatial differentiation of the preference for tuo-zaafi

Having teased out the inter-spatial differentiation of preference for *tuo-zaafi* (TZ) above, the focus here is to understand how the different social groups in the villages of Doggoh, and Tie perceive their preferences for the different forms of TZ. To achieve that, the results are presented separately for the villages of Doggoh and Tie.

Doggoh Village

The results in figure 6.8 indicate that out of the 60 male headed households that were interviewed (Appendix I), the majority preferred sorghum TZ (36.7%) and millet TZ (26.7%) followed by maize (w) TZ (25.0%). Also, looking through the cross-tabulation results for the 15 females interviewed in the semi-structured questionnaire, it emerged that the majority of the females preferred millet TZ (60.0%), sorghum TZ (26.6%) and then maize TZ (6.6%). In that regard, it can be concluded that men now prefer the TZ prepared from sorghum, and women that made from millet. Similarly, it can be concluded that maize (w) being the form of TZ that is regularly eaten (as indicated in figure 6.6 of section 6.3.1) in the village of Doggoh does not necessarily mean that is what is preferred by the households as they could be 'forced' to eat more of it due to its availability in large quantity.

Figure 6. 8 Percentage of respondents' preference now for the different forms of TZ by sex in Doggoh Village (Males = 60, Females = 15)

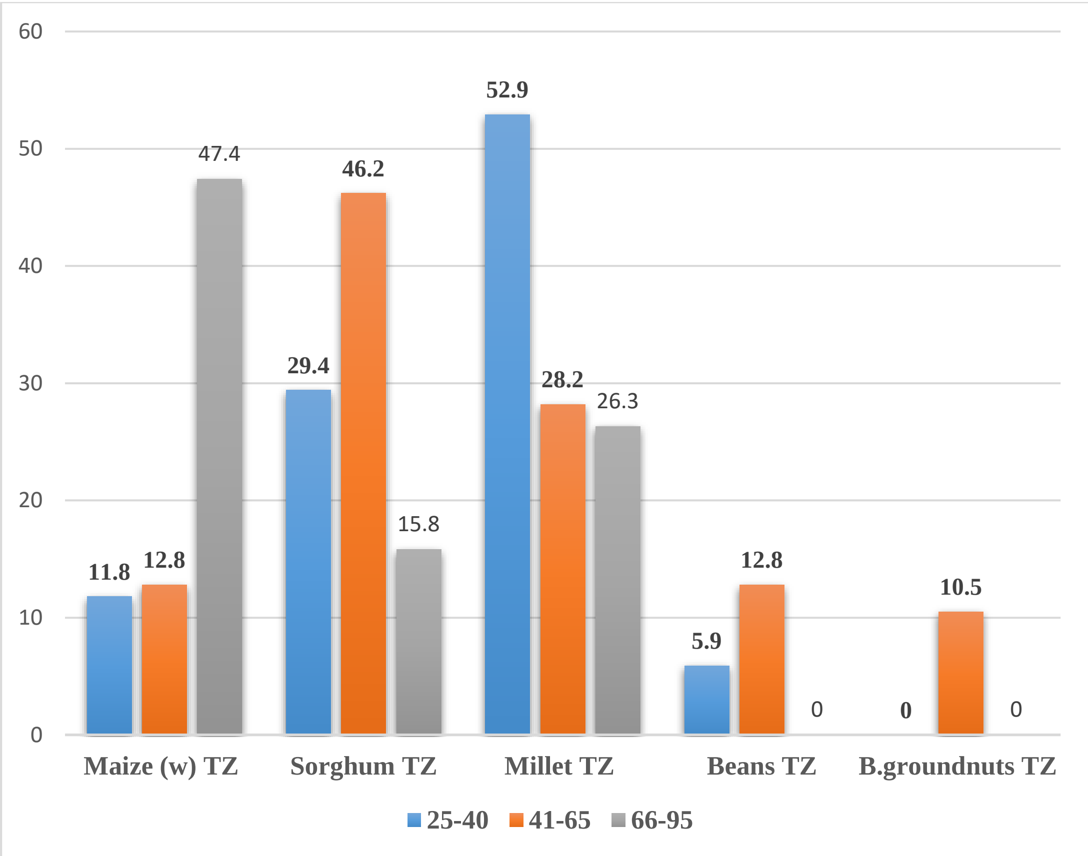


Source: Semi-structured Questionnaire (Doggoh Village, 2016)

The key messages from figure 6.9 include: (i) younger population (i.e. 25-40) prefer more of the millet TZ (52.9%), than sorghum (29.4%), and maize (w) TZ (11.8%), (ii) the middle-aged population (41-65 years) prefer more of sorghum TZ (46.2%), millet TZ (28.2%), and maize (w) TZ (12.8%). However, the elderly population (i.e. 66-95 years) prefer more of maize (w) TZ (47.4%), than millet (26.3%), and sorghum (15.8%).

Even though the quantitative data suggests that millet TZ is what the young population prefer to eat, the results in chapter five (see figure 5.9 in section 5.3.2 of chapter five) indicates that millet is not counted as among the largely cultivated crops now in both the villages of Doggoh, and Tie. That result does not suggest that it is not cultivated at all in the two villages as data from the participant observation (see picture 5.3 of section 5.3.1) indicate that millet is cultivated but on small scale basis in the village of Doggoh. Therefore, that potentially could translate into less availability of millet as households rely on their own production for their food needs (Naab and Koranteng, 2012). This implies that the right to millet *tuo-zaafi* is compromised as a result of the impacts of climate variability and change.

Figure 6. 9 Percentage of respondents' preference now for the different forms of TZ by age in Doggoh Village (25-40=17, 41-65 =39, 66-95 = 19)



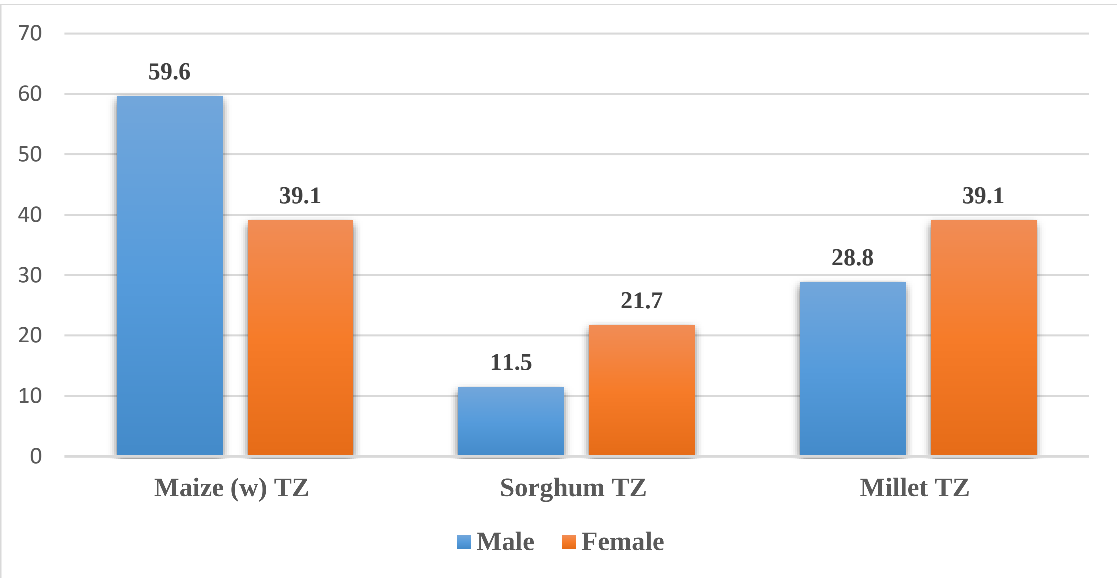
Source : Semi-structured Questionnaire (Doggoh Village, 2016)

Tie Village

In figure 6.7, the results indicate that the majority (52.0%) of the respondents in the village of Tie opined maize (w) tuo-zaafi as the form of the TZ that is preferred now. However, this was a generalised opinion for households that are made up of different social groups. Therefore, in a quest to differentiate the preference for TZ, a cross-tabulation was carried out using the variable *'what form of TZ does your household prefer to eat now'* by *'sex'* and *'age'*. Here, the interest was to look at perception of the majority of the different social groups. For example, the analysis (see appendix I) indicate that 23 female households were interviewed in the village of Tie. Therefore, it was necessary to understand what form of TZ is preferred now by the majority of the sampled female respondents in the village of Tie.

The results (see figure 6. 10) reveal that the majority of the males (59.6%) surveyed cited maize (w) TZ as the form of TZ that they prefer now. However, for the females interviewed, there was a tie as the same proportion of female respondents stated maize (w) TZ (39.1%), and millet TZ (39.1%) as the form of TZ that is preferred now (see 6.10).

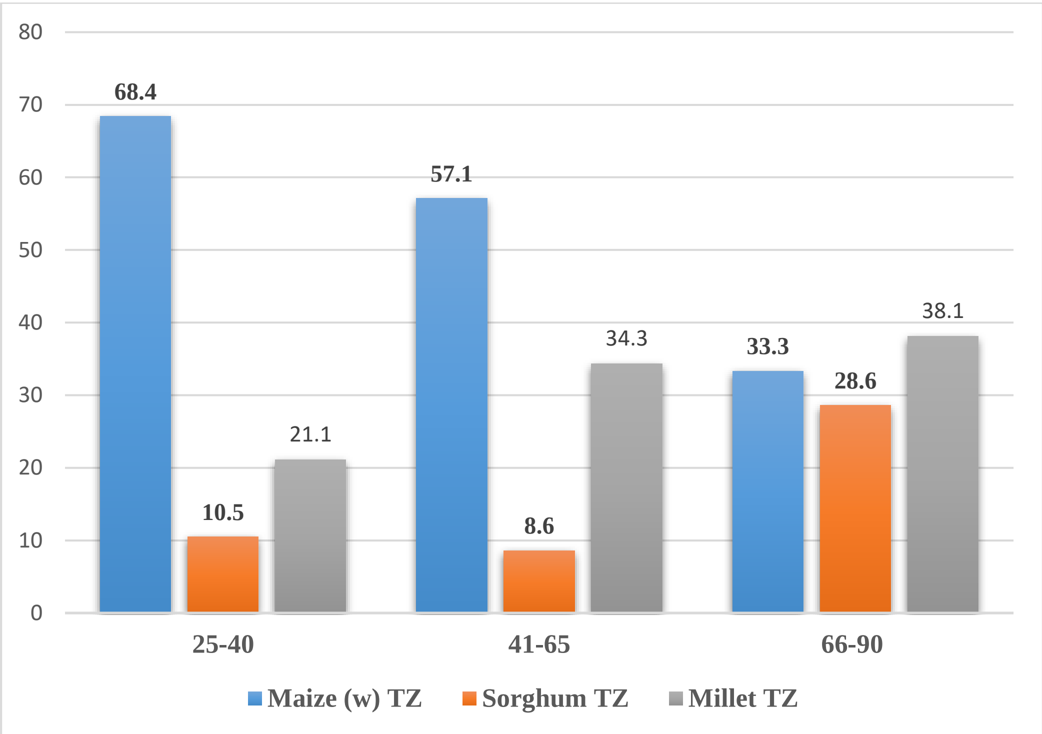
Figure 6. 10 Percentage of respondents' preference now for the different forms of TZ by sex in Tie Village (Males = 52, Females = 23)



Source: Semi-structured Questionnaire (Tie Village, 2016)

Similarly, for the different age groups interviewed, the majority of the younger population (i.e. 25-40 years) (68.4%), and the middle-aged population (i.e. 41-65 years) (57.1%) stated maize (w) TZ as the form of TZ they prefer to eat now. However, the majority (38.1%) of the older generation (i.e. 66-90 years) mentioned millet TZ as the form of TZ they prefer to eat now (see figure 6.11). The differentiation in preference here could be explained by the 'mere exposure theory' which states that repeated exposure to a particular food for a longer period could lead to reduction in neophobia for the food, and increased preference for the food. In the context of this study, the results earlier discussed (see figure 5.1 of section 5.2.1 of chapter five) showed that maize (w) was neither cultivated in the village of Doggoh, and Tie in the past. This translates into the non-availability of the maize (w) food. Similarly, the results in section 5.2.1 indicate that millet and sorghum were among the major crops cultivated in both the villages of Doggoh and Tie thereby exposing the older generation more to that than the maize (w) which is a recent food crop.

Figure 6. 11 Percentage of respondents' preference now for the different forms of TZ by age in Tie Village (25-40 = 19, 41-65= 35, 66-90 = 21)



Source: Semi-structured Questionnaire (Tie Village, 2016)

In generalising the results from the study to the entire villages of Doggoh, and Tie based on the opinions of the majority of the surveyed social groups, the results (see table 6.7) show that younger population and women prefer the *tuo-zaafi* made from millet, the middle aged, and men prefer *tuo-zaafi* from sorghum, and the older generation prefer *tuo-zaafi* from maize (w) in the context of the Doggoh village. However, for the village of Tie, the results show that the older generation prefer the *tuo-zaafi* from millet, and then women, the younger generation and middle aged prefer *tuo-zaafi* made from maize (w).

Table 6. 7 Summary of the preference of tuo-zaafi by social groups

Village	Preferred form of tuo-zaafi by social groups		
	Millet TZ	Maize (w)	Sorghum TZ
Doggoh	- Young generation - Women	- Old generation	- Middle-aged generation - Men
Tie	- Old generation - Women	- Men - Women - Young generation - Middle-aged generation	

Source: Fieldwork (Semi-structured Questionnaire, Doggoh and Tie Village)

It is necessary to understand why different social groups have different preferences for the various forms of *tuo-zaafi*. Therefore, the next section is devoted to understanding the factors that shape the preference for the various forms of TZ.

6.3.4 Understanding the factors that shape the differential preference for tuo-zaafi

Here, the researcher draws on the sensory availability of food, the 'mere' exposure theory to food and the availability of food to understand how the preferences for the different forms of TZ is constructed by different social groups. To that end, the focus is limited to understanding differentiation among the younger and older generation.

(a) Sensory characteristics of food

The results from the qualitative data suggest that the sensory characteristics of the various forms of tuo-zaafi either influence the preference or aversion for them. The sensory properties of the food that have emerged from the data are: taste, texture, and colour. It emerged from the data that colour and taste strongly shape the younger and the older generations' sensory appeal for food respectively. The details of each are discussed below.

Colour

On the aspect of the colour of the different forms of TZ, the results indicate children have preference for the TZ made from maize (w) and millet, and aversion for the TZ made form sorghum. It emerged that the preference for the TZ made from maize (w), and the aversion for the TZ from sorghum by children are respectively shaped by the white colour and dark colours respectively[118].

[118] See example 1 for farmers' illustrations of children's preference for the TZ made from maize (w) and millet, and example 2 for the illustration of children's aversion for the TZ from sorghum.

Example 1: Preference for TZ from maize (w) and Millet

" my son, you see, when we prepare the sorghum saabo, the children eat a little but when we prepare the prepare the saabo from maize (w), they eat and clean the bowl- they say they like it because the colour is white and looks nice" (HCS-3-T-F)

"The children like the millet TZ because it looks bright but that of the of the sorghum looks dark- they complain the colour does not look attractive" (HCS-10-D-F)

After the case study interviews with participants, the researcher had to as part of the participant observation exercise move around the villages of Doggoh, and Tie to have a sense of the foods they prepare. This was necessary to triangulate the results from the focus groups and the household case studies. In that end, pictures of the different forms of TZ were taken[119].

[119] See picture 6.2 which depicts the different colours of the TZ made from maize (w) and sorghum

Picture 6. 2 An illustration comparing sorghum and maize (w) TZ

Sorghum TZ

Maize (w) TZ

Source: Fieldwork (Participant Observation, Doggoh Village)

Example 2: Children aversion for TZ made from sorghum

"You see, they would say sorghum TZ is dark hence they would touch it and leave it and you have to take it away. they eat a little and leave the remainder…yesterday for instance, I prepared yuuvaaree soup and my grandchildren said the soup is not good hence they refused to eat…when you prepare yuuvaaree soup they would either eat it a little or refuse to eat at all but when you use tomatoes to do light soup they concentrate so much in eating. You see modern Ghana children" (HCS-7-T-Female).

The above quotation from HCS-7-T-Female suggests that children conditionally eat more of the TZ made from sorghum provided the soup is made nicely with tomatoes and meat that enhances the taste. This therefore suggests that parental feeding practices regarding tailoring the soups of the TZ made from Sorghum could influence children to develop preference for that form of TZ.

Taste

The literature reveals that basic tastes are being influenced by the following sensory factors: sweet, sour, bitter, salty and umami, and these are claimed to constitute the vast array of flavours in our foods (Garcia-Bailo et al., 2009, Mette Vabo, 2014). In this study, the key message that has emerged from the data analysis is that, the TZ from millet and maize (w) are preferred by children because of the sweet taste associated with them[120]. Similarly, the results showed that the older people prefer the TZ made from sorghum due to its medicinal value[121]. In terms of comparing the magnitude of the sweetness of the taste of the two, it emerged that the tuo-zaafi from millet tastes better than that of the maize (w), and if the two are given to children to choose, they will prefer the former.

In the case study interviews, a female participant in the village of Doggoh explains *"you see, if we have millet in our household, and prepare TZ from that, and that of maize (w) the children would prefer the TZ made from millet to that of the maize TZ because it tastes sweeter than that of maize (w)"* (HCS-10-D-Female). This quotation from HCS-10-D-Female illustrating children's preference for the millet TZ when less of it is available to few households is a reinforcement of adaptation to climate variability and change impacting on the food preferences of people.

Example 1: Children's preference for TZ made from maize (w) and millet

"The main reason is that, once you eat maize TZ and the soup finishes, you can mask the TZ alone and drink that but if you mask the sorghum TZ, it becomes sour hence they do not rely on it that much". (HCS-13-D-Male)

[120] See examples 1 for respondents' illustrations children's preference for the TZ from maize (w) and millet

[121] See example 2

"Everyone likes the millet; it is sweet and appetizing. Children do not have to add sugar to it when they mash it because of its sweetness". (HCS-7-T-Female)

The preference for the TZ from maize (w), and millet by children could be explained by the genetic predisposition to like sweet tastes (Rozin and Vollmecke, 1986). However, in the literature, it is pointed out that this is readily modified by experience with food (Sullivan and Birch, 1990), and deteriorates as one ages (Boesveldt et al., 2018). This suggests that, as the younger generation develop into adults and grow old, they could potentially develop preference for sorghum TZ that they claim tastes bitter.

Example 3: Elders preference for sorghum TZ

Contrary to the result that children have aversion for the TZ made from sorghum, the data point out that the older generation have preference for it as the bitter taste from the porridge as indicated by VIKI-8-T-Female is medicinal. It is documented that the keenness of taste and smell deteriorates with ageing (Boesveldt et al., 2018). Therefore, this could explain the preference of the older generation for sorghum TZ which tastes bitter. A female key informant explains the preference of sorghum TZ by the elderly generation as follows: *"Sorghum tuo-zaafi is 'heavier' than that of millet....it is heavy because once someone runs diarrhoea and you use sorghum to prepare porridge for the person concerned, the diarrhoea will cease"* (VIKI-8-T-Female).

Texture

Food texture has been documented as one of the characteristics that influence the preference for food as there are beliefs surrounding the potential satiating power of food (Boesveldt et al., 2018, Brunstrom, 2014). It is believed that foods that are perceived to be thicker are expected to be more filling and hunger solving than versions without these properties (Forde et al., 2017, McCrickerd et al., 2017). In one of the household case studies in the village of Tie, a female participant explained the preference for sorghum TZ, and aversion for maize (w) TZ due to the texture composition as indicated below:

Example 1: Elders preference for *tuo-zaafi* from sorghum, and aversion for TZ from maize (w)

"We the older generation prefer the TZ made from sorghum as the one from maize (w) digests quickly and you easily get hungry after consuming the latter but with the TZ from sorghum, you eat and roam for long before it digests hence we prefer that to maize (w) TZ. (HCS-11-T-Female).

"…as I am seated like this, I eat more of the TZ from maize-w because I have more of that in my household. But I prefer the TZ from sorghum because when you eat a small bowl of sorghum saabo, it is like eating three bowls of maize (w)... so if we are farming, we ask they use the sorghum to prepare TZ for us as that takes longer time in digesting. As for the maize (w) TZ, when you eat it within some minutes you will 'pee' and become hungry…eating maize (w) is like drinking pito" (HCS-5-D-Male)

(b) 'Mere'exposure explaining the preference for different Tuo-zaafi

It has documented that repeated exposure to a given food serves two main purposes: one, it reduces the neophobic reaction to the food (Birch, 1999), and two, it increases the preference for that food (Rozin, 2015). However, it is suggested that repeated consumption of food over a short period of time can lead to boredom and reduced pleasure known as sensory specific satiety (Rozin, 2015). In this research, repeated exposure to the food can be translated into the availability of food crops in the villages of Doggoh, and Tie as the discussion previously (see section chapter 3 section 3.3.2) reveals that the population of these villages rely largely on what they produce to meet the food needs of their households. To that end, a female participant explains that she prefers the TZ made from sorghum as that is what she has been exposed more to as follows: *"It is Sorghum TZ that I will take because that is the crop my husband was farming and that was the TZ we used to eat a lot" (HCS-7-T-Female). The f*indings also suggest that children's preference for maize (w) is influenced partly by they been more exposed to that than 'olden days' crops such as millet and sorghum.

A male participant in a household case study expresses the preference of children in his household for maize (w) TZ as against sorghum as follows: *"okay, now the children are used to the maize (W) TZ-if you cook maize TZ and sorghum TZ, the children would choice the maize (w) TZ and leave the sorghum TZ" (HCS-13-D-Male).*

"If you give children TZ from maize (w), sorghum and millet, they will leave the TZ made from sorghum but we as adults who are used to it so will patronise it, but the children will go for the maize (w) TZ because of the white bright colour". (HCS-13-T-M).

(c) Food availability shaping preferences for tuo-zaafi

The results in both sub-sections "a" and "b" reveal that the availability of food shapes the preferences for food. Specifically, in sub-section "b", it was demonstrated that even though children prefer both the preference for TZ made from maize (w) and millet, if given the two, they will choose the latter over the former. This suggests that the abundant availability of maize (w) food has influenced children's preference for it. The results here implies that preferences for food should be looked at beyond 'mere' availability of food. Similarly, the results also call for policy attention to take critical account of the food preferences of households and individuals in the design of crop adaptation policies to holistically address the cultural foods needs of people.

6.3.5 Summary

Finding 1: Changing pattern of consumption of the main form of tuo-zaafi

- Farmers reported sorghum TZ, millet TZ, and maize (y) TZ as the main forms of *tuo-zaafi* that households patronised in both the Doggoh and Tie villages. Similarly, respondents pointed out maize (w) TZ and sorghum TZ; and maize (w) respectively as main forms of *tuo-zaafi* for the Doggoh and Tie villages.
- Farmers reported that because they have adapted to climate variability and change via selecting crops and crop varieties that are better suited to the prevailing changing local

climate, this has translated into less availability of sorghum and millet as cultural food crops.

- Therefore, it is reported that maize (w) is the main form of TZ now in both the Doggoh and Tie villages. In addition to that, famers in the village of Doggoh reported sorghum TZ as a main form of tuo-*zaafi*.
- Farmers reported two main reasons explaining why maize (w) TZ is the main form of TZ in both the Doggoh and Tie villages: (i) maize (w) now being the main crop cultivated in both villages hence more of it is available, and (ii) because maize (w) has less ritual uses hence it is mainly meant for food consumption (see table 6.4).
- Farmers similarly reported that millet and sorghum no longer occupy 'key' positions as the main forms of TZ in both the Doggoh and Tie villages. For example, farmers reported that the case of millet is due to the availability of less quantity due to climate variability and change. In the context of Sorghum, farmers explained that because of its ritual uses, that is why less of it is mainly consumed as a cultural food.

Finding 2: Consumption of food not the same as preference for food

- Farmers in the village of Doggoh reported that even though maize (w) and sorghum TZ are the form of TZ that are mainly consumed, the former occupies 3rd place as the form of TZ that is preferred now after sorghum and millet forms of TZ. For the village of Tie, farmers reported that maize (w) TZ, millet TZ, and sorghum TZ are the forms of TZ that are preferred in an order of ranking.

- For the village of Tie, even though maize (w) has been cited as the main preferred TZ, which corresponds with the consumption pattern of the main forms of TZ, farmers argued that they are 'forced' to prefer that because of its availability. This implies that households' preference for maize (w) TZ is explained by their adaptation to the earth as argued by the cultural materialists.

Finding 3: Social differentiation of the preference for *tuo-zaafi*

- Farmers reported in the village of Doggoh that males prefer sorghum TZ and females prefer millet TZ. On the aspect of age, farmers indicated that the younger generation prefer millet TZ, the middle age prefer sorghum and the older generation maize (w). Women and children's preference for millet TZ as a cultural food is compromised, as less millet is now available primarily due to the impacts of climate variability and change (section 5.3.2 of chapter 5).
- Farmers in the village of Tie reported that men preferred the maize form of TZ. However, an equal proportion of women preferred millet and maize (w) forms of TZ. In terms of age the young generation and the middle-aged preferred TZ from maize (w) and the older generation preferred millet TZ (section 6.3.3).

Finding 4: Understanding the factors that explain the differential preference for *tuo-zaafi* *Sensory characteristics of tuo-zaafi*

- Farmers reported sweet taste and white colour as the sensory characteristics that shape women and children's preference for millet and maize forms of TZ. However, famers indicated that the bitter taste and dark colour of sorghum TZ explains children's aversion for it.
- Farmers reported the satiating potential of sorghum (i.e. texture) explaining the preference for it by the middle –aged, and the aversion for maize (m) TZ as it has less satiating potential.

'Mere' exposure to food

- Farmers explained the older generation prefer the sorghum and millet TZ because those are the forms of TZ they have been exposed more to.

- Similarly, farmers revealed that children's preference for maize (w) TZ is because that is the TZ crop that is available in abundance and that is what is regularly prepared, and they are exposed more to that form of TZ.

6.4 Discussion and conclusion

6.4.1 Discussion

This chapter sets out to understand the cultural aspects of the uses of food, and the impact of adaptation to climate variability and change on the availability and consumption of culturally preferred foods. This chapter contributes to knowledge on the cultural uses of food as previous studies on the utilisation dimension of food has largely focused on the biological and nutritional aspects of the uses of food (Treffrey et al., 2014). Similarly, studies looking at the development of preferences for food assume that food is always available and people can choose one over the other but this chapter challenged that this is not always the case for the poor in rain-fed areas that depend mainly on their household production to cater for their culturally appropriate foods as climate variability and change primarily shapes what is available to them.

This chapter explored the different foods that are consumed in the villages of Doggoh and Tie. Even though the results revealed that many foods are consumed in the two villages (see section 6.2.1), it emerged from the data that without *tuo-zaafi* there is no food in the villages of Doggoh and Tie (see section 6.2.2). This finding is similarly illustrated by other empirical studies in Africa. For example, Noack and Pouw (2015) in a study in western Kenya report that without eating *ugali* there was no other food. Also, there are similar findings on the use of food as a tool to welcome guests by host households. Fieldhouse (2002: 84) illustrates how it is a requirement for host households in Zarian homes to serve meat with blood for special guests.

The results on the changing nature of the main forms of tuo-zaafi (section 6.3.1) with maize (w) TZ replacing sorghum TZ as the main TZ for both the Doggoh and Tie villages, and the changing nature of the preferences of tuo-zaafi with maize (w) replacing sorghum in the village of Tie (see section 6.3.2) agree with Torpoco's believe that food habits are somehow partly adaptive as they evolve in response to ever-changing conditions (Torpoco, 1997). Interestingly, even though households in the village of Tie considers millet and sorghum TZ as the forms they prefer and maize (w) TZ as a 'forced' preference, the results suggest the subordination of cultural factors imposed by climatic factors in shaping preferences. Also. One can also conclude that households in the village of Doggoh preferences for the sorghum and millet forms of TZ are a reflection of Sahlins argument that human food habits are a reflection of cultural reason and not adaptive rationality (Sahlins, 1978, Torpoco, 1997).

Similarly, the choice of maize (w) TZ as the preferred TZ now by the village of Tie could be explained by Marvin Harris's argument that all human social life is a construct of the responses to the practical problems of earthly existence (Harris, 1987, Torpoco, 1997). In the context of the younger generation's preference for *tuo-zaafi* from maize (w) and the older generation's preference for millet and sorghum have implications for the food identity of the two villages, as what happens after the older generation is no more.

- The results (see section 6.2.2) here on the role of no tuo-zaafi can be likened to Sahlins claims that human valuations of the edibility and inedibility of meat are qualitative and not in any way justification of biological, ecological or economic advantage (Torpoco, 1997, Sahlins 1976)
- The symbolic value of TZ in nourishing social relations as manifested in host households using it as a tool to welcome guests into their homes reflects Fiddes claim that a society's attitudes toward food is a reflection of its worldviews (Torpoco, 1997).

6.4.2 Conclusion

This chapter has highlighted that food is not just consumed for nutritional and biological benefits but food is also used as a tool to nurture social relations (Corr, 2002) and food is also used for ritual purposes. Similarly, the study has demonstrated that farmers' adaptation to climate variability and change has translated into the less availability and therefore less consumption of culturally preferred foods. These calls for policy regarding the design of food and nutrition interventions should take into due account the cultural aspects of the uses of food of indigenous people.

CHAPTER SEVEN

CONCLUSIONS

7 CONCLUSIONS

7.1 Introduction

This study set out to understand smallholder farmers' cropping decisions under climate variability and change (CVC), and the dynamics between the resulting crop selection and impact on the availability of culturally preferred foods for households in northern Ghana. A case study from the Upper West region of northern Ghana was used to explore these dynamics, and 150 households, 16 village individual key informant interviews, 6 focus group discussions, 7 stakeholder key informant interviews, and 34 household case studies from the villages of Doggoh and Tie participated (chapter 3 section 3.3.5).

The study challenged the assumption that farmers' recognition of CVC impacts on their crop viability will routinely translate into significantly adapted crop selection strategies that reflects extension advice and economically yield maximisation outcomes. The study argued in Chapters 1 (section 1.2.1) and 2 (section 2.3.3) that farmers have multiple motives for selecting crop varieties and thus there will be trade-offs in the adaptation choices that farmers make when managing CVC impacts. In particular, shifting to more resilient crop varieties or changing crop type could compromise cultural values or practices. While it is vital to understand how farmers' perception of CVC shape crop selection and how these are socially differentiated, it is the everyday trade-offs that households make when adapting their agricultural practices to the impacts of CVC and the role of cultural preferences on these decisions that remains important to understand better. This is because revealing the specific role of culture on pathways to food security in farming areas that are affected by

CVC allows more effective policy and practice strategies to support adaptation while being sensitive to cultural identity and food preferences.

To explore the role of culture, the study drew on conceptual ideas of memory, experience, affect-based factors, and cultural worldviews (chapter 2, section 2.6) to make sense of the way that farmers' perceived CVC and judged this information together with other cultural considerations. The Theory of Planned Behaviour (TPB) and Social Identity Theory (SIT) (chapter 2, section 2.6; and chapter 5, sections 5.3.2, 5.3.3, and 5.3.4) were useful to explain why some farmers are adapting their crop selections to CVC and others are not. The cultural aspects of the uses of food, and food preferences were explained through ideas from cultural idealism and cultural materialism, together with understandings of the role of food availability, sensory properties of food, and 'mere' exposure theory (chapter 6, sections 6.2.2, and 6.3.3). To reveal a nuanced understanding of these issues, a social constructivist research approach was adopted for the study (chapter 3, section 3.2).

The study was organised around three objectives: (i) to understand farmer perceptions of CVC, how different farmer groups perceive CVC, and how cultural worldviews and values contribute to farmers' perceptions of climate variability and change; (ii) to understand which farmers are adapting or not adapting to CVC, and the associated factors explaining why this is the case; and (iii) to understand the cultural aspects of food, how farmer cropping decisions have impacted on preferred household foods, and what factors shape preference for tuo-zaafi by different social groups. The main findings for each of these themes are detailed below.

7.2 Main Findings

7.2.1 Understanding farmers' perceptions of climate change and variability

The first objective was to understand farmers' perception of climate variability and change, how farmer perceptions are socially differentiated, how farmer perceptions match or mismatch analysis of climatic data, and the factors that shape farmers' constructions of changes in their local climate. These issues were explored in Chapter 4.

How do farmers perceive changes in their local climate?

The sampled farmers from Doggoh and Tie villages perceived and reported a shift in the onset of the rainy season from March to June, and for cessation from November to October (section 4.3.1). Therefore, farmers perceive a shorter growing season for their crops, which will have implications for the way in which local people construct the perception of the importance of climate risk within their livelihood.

The sampled respondents from Doggoh and Tie villages also perceived and reported an increase in the number of warm days and nights each year and a decrease in the number of cold days and nights (section 4.3.2). Again, this reveals awareness of temperature increases for the location and this will influence decision-making.

How are farmers' perceptions spatially and socially differentiated?

- Spatially, the main difference in perceptions was of flood conditions now as compared to that of the past. Respondents in Tie village felt that there are more floods now, while respondents in Doggoh village felt that there are fewer floods now in the village of Doggoh.
- The results demonstrated that perceptions of CVC are socially differentiated. What has clearly emerged in the data is more uneducated farmers in both villages perceived that the rainfall started earlier and ceased later in the past, and educated farmers perceiving the

rainfall starts later and ceases earlier now. Similarly, more female farmers than male farmers perceived that the rainfall in the past started earlier and ceased later (see section 4.4.3).

What are the matches and mismatches of farmers' perception and analysis from climate data?

Comparing the analysis from the climatic data with farmers' perception, it emerged that the two have largely disagreed. The only exception is agreement on increased in maximum temperature. The results from the climate data analysis and farmers' perceptions disagreed on onset, end, and length of the season. Whereas the climate data showed variability in the above climatic events, farmers perceived there is a late onset, earlier cessation and a short length of the season now as compared to that of the past (see section 4.6). The finding of rising temperature reinforces observations that have been reported by other studies in Ghana (e.g. Amadou et al., 2015, Limantol et al., 2016, and Yaro, 2013). For example, Amadou et al. (2015) reported a rise in temperature in the Upper East region of northern Ghana. The rise in temperature level could adversely affect agriculture in North-west Ghana as the soil moisture of crops will be affected (Bhatti and Khana, 2012, Limantol et al., 2016) and this potentially can translate into a drop in the yields of crops when temperature exceed the optimal for biological processes (Bhatti and Khana, 2012, Limantol et al., 2016, Ofori-Sarpong, 2001).

What shapes farmers' perceptions of climate variability and change?

It is important to contextualise the factors that drive farmers' perceptions of climate variability and change because it will enable policy makers to comprehensively understand the matches and mismatches hence support farmers with robust climate information to equip them to adapt better to climate variability and change impacts. The results revealed that perception is shaped by the cultural values of the societies of Doggoh, and Tie, farmers' personal experiences, climate information from experts, and farmers' memory of the climatic events in the past and now (chapter 4, section 4.5). A summary of the main observations are discussed below:

- ***Cultural worldviews and values:*** Respondents in both Doggoh and Tie felt that cultural values contributed to the changes in the climate conditions. Specifically, it emerged that non-offering of sacrifices to the gods of the land, the killing of people without accompanied ritual performances to appease the gods, traders 'holding' the rains for their businesses to flourish, and promiscuous behaviour by young people contribute to the associated changes in the rainfall pattern (Chapter 4, section 4.5.1).
- ***Farmers' personal experiences:*** Farmers argued that in the past, it used to rain torrentially from morning until evening. This type of rainfall pattern led to: (i) some households going hungry because they did not get dry firewood or had not grinded flour at home to cater for their food needs; (ii) extra labour demands from harvesting crops in the bush farms but needing to take firewood in help warm up their body because of the extreme cold associated with the intense rainfall; and (iii) cattle escaping from their enclosures to look for pasture because they remain fenced for long periods (iv) some respondents resorted to playing the drums on top of the roof of their houses to request from the gods that the rains cease, (v) family members that migrated to the southern part of Ghana started returning by December for them to begin to prepare the farmlands in readiness for the rains (section 4.5.3, chapter 4).

- ***Sources of information (analysis based factors) about the seasonal weather:*** Farmers receive climate information from the government through government-owned radio stations, the Ministry of Food and Agriculture extension officers, and the Ghana Meteorological Agency. Non-governmental organisations are also important and included project officers from the Climate Change, Agriculture, and Food Security- CCAFS initiative, Literacy Bridge Ghana; RESULT Project; and ESOKO Ghana). The results (section 4.5.2) revealed that the Doggoh village receives climate information from ESOKO, and CCAFS in addition to the information it gets from the other organisation, but the Tie village does not. Men receive more climate information from radios, and mobile phones than women do (section 4.5.2). This is important because it helps increase understanding about differential access to climate information (hence give direction as to which crop to target in terms of climate information intentions) and influences how different people perceive CVC. Farmers report that external stakeholders advise them that because the climate has changed they should not sow their crops in May or April, they should plough ridges instead of round mounds to conserve water once the little rainfall comes and plant fast-growing crop varieties. This is important because it reduces the risks associated with managing climate variability and change impacts.

7.2.2 The pattern and process of farmer crop selection and adaptation to climate variability

Objective two sought to understand which farmers are adapting or not adapting to the impacts of CVC and how this was based on their perceptions (as in 7.2.1 and Chapter 5). It is critical to explore whether farmers are addressing their perceptions of climate risk and the advice from external stakeholders to select crop types or varieties that are better suited to the changing climatic conditions (Issahaku and Maharjan, 2014, Kurukulasuriya, 2008) or the extent to which other motives beyond the economic, biological, and nutritional benefits for the cultivation of crops are perceived as more important (section 1.2.1). Therefore, the study explored the process of trading-off some cultural elements of their life (e.g. ritual uses of crops, and culturally preferred foods) if the crops that enable them to achieve such activities are not the ones that do well under the prevailing climate.

How has cropping changed now, as compared to that of the past?

Section 5.2 of Chapter 5 identified what crops were cultivated in the past compared to today and found that sorghum was no longer the staple crop in both villages and had been replaced by maize (w). Similarly, the cultivation of millet has reduced significantly as a traditional crop in both villages. Farmers in both villages have had to focus their attention away from farm fields in the bush and along the river banks (see Chapter 5, section 5.2.1) due to increase in the diversification of women's livelihood activities and increasing importance attached to sending children to school which have both reduced family labour, and the irregular rains and flooding risk. It emerged in the data that the river bank farm fields deal with raising bigger mounds that demand a lot of young and energetic labour (see chapter 5- 5.2.1).

Who is adapting their cropping in response to the impacts of climate variability and change?

- The process of cropping adjustment is differentiated by location and gender. Whereas no household in the Doggoh cultivates only the traditional variety of groundnuts, few households (2 households) in the village of Tie cultivate the traditional variety of groundnuts. By gender differentiation, only men cultivate the traditional variety of groundnuts called *dagarasinkaa* because of cultural reasons, and women cultivate only the improved variety of groundnuts (see section 5.3.1 of chapter 5).
- Cropping selection was also differentiated by age with middle-aged (41-65 years) and older farmers (66-95 years) still cultivating traditional varieties of groundnuts, although these produce a low yield under the prevailing climate. To that end, a potential implication is that the cultural identity of the Dagaaba people of North-west Ghana would be affected as the older generation will no longer be there and the cultivation of the traditional variety of groundnuts, for example, will go into extinction.
- Wealthier farmers are the ones who are cultivating the traditional varieties of crops. Farmers reported that the processing of dagarasinkaa is labour intensive hence those that

cultivate it needs abled young men to assist in the harvesting process (see Chapter 5, section 5.3.2). Therefore, wealthier farmers with the economic knowhow can hire labour to assist in the harvest process.

What factors explain why farmers are adapting, or not adapting, their crop type and variety to locally-perceived impacts of climate variability and change?

- Farmers' attitudes influence their adaptation to climate variability and change in two ways. First, farmers' negative attitudinal beliefs (manifested as perceived poor yield, perceived difficulty in crop cultivation and processing of yield, and perceived shorter duration of rainfall) have led to the displacement of traditional (i.e. late yielding and low yielding) varieties of sorghum, beans and millet (see section 5.3.2, chapter 5). Second, farmers' positive attitudinal beliefs (as manifested perceived yield benefits, perceived economic benefits) have translated into farmers cultivating improved varieties of groundnuts, sorghum and beans (see section 5.3.2, chapter 5). This is important because others (Issahaku and Maharjan, 2014, Kurukulasuriya and Mendelsohn, 2007, Seo and Mendelsohn, 2008, Wineman and Crawford, 2014) have found that under climate variability and change, farmers will select crops and crop varieties that are better suited to the prevailing climate in terms of yield maximisation.

- Perceived Behavioural Control (PBC) (section 5.3.3, chapter 5), which in this study manifested in the form of inadequate labour has led to the specific displacement of the wongtelle variety of beans, and a reduction in the cultivated area for millet (section 5.3.3, chapter 5).

  This is interesting because the processing of millet, for example, has been pointed out by farmers to be difficult as it is labour intensive and young women do not want to get involved in winnowing because of the dust associated with it.

- Importance of social identification. The data revealed that farmers are not adapting to climate variability and change as farmers still cultivate the traditional varieties of groundnuts because of some cultural norm of the in-group membership (in the context of this study identification as Dagaabas). The analysis themes that are emerged include better taste from the traditional variety of groundnuts (respondents claimed because it contains less oil), and the continuation of the farming ways of the forefathers. Also, because of the cultural uses of sorghum in the lives of the Dagaaba tribe manifested in the form of symbolic significance during the funerals via portraying the trade of farmers while they were alive, the preparation of *pito* (a local beverage for funerals and other social functions and ritual purposes for undertakers who bury the deceased (see section 5.3.4, chapter 5).

7.2.3 The cultural aspects of food, and the impact of adaptation to climate variability and change on culturally preferred foods

The third objective was to understand the cultural uses of food beyond nutritional and biological benefits. The focus was also to understand how adaptation to the impacts of CVC via crop selection has affected local access to culturally preferred foods, and the factors that influence the preference for a staple food called tuo-zaafi in particular by different social groups. This was important for two reasons (see section 1.2.1, chapter 1). First, the cultural acceptability dimension of food has been given less attention as studies on the utilisation dimension of food has been on the biological and nutritional aspects (Trefrey, 2014). Second, studies on the factors that shape the preference for foods have assumed that food will be available and then consumers can willingly choose one over the other (see table 2.2 of section 2.4.2, chapter 2).

However, as argued in section 1.2.1, this is not always the case, particularly for family farmers that rely on their production to meet the food needs of the households and live in rain-fed areas. Similarly, for the poor, food can always be available elsewhere in the market, but low capital means they cannot access the food for economic reasons.

Understanding the cultural dimensions of food: tuo-zaafi as a case study

- Farmers reported tuo-zaafi as the main staple of the people of the Doggoh and Tie villages. It emerged that Tuo-zaafi has different forms (sorghum, millet, maize-w, beans, bambara beans, and rice), and is differentiated on the parameters of: (i) the use of flour for preparation, (ii) local preservative leaves for preparation, (iii) porridge as a by-product, (iv) preservation in korou, and (v) eaten with shea butter or oil; or eaten with soup (Chapter 6, section 6.2.2).
- It similarly emerged that without tuo-zaafi, there is no food in the villages of Doggoh and Tie. Farmers reported that tuo-zaafi has uses beyond biological and nutritional functions. Farmers reported that following as the cultural aspects of eating tuo-zaafi: (i) continuation of the food ways of the ancestors, (ii) a tool to welcome visitors by host households, (iii) tuo-zaafi as medicine, and (iv) tuo-zaafi being used for performing rituals by undertakers (Chapter 6, section 6.2.2).

Changes in consumption pattern of, and preferences for tuo-zaafi

- Farmers reported sorghum TZ, millet TZ, and maize (y) TZ as the primary forms of tuo-zaafi that households patronised in both the Doggoh and Tie villages in the past. Similarly, respondents pointed out maize (w) TZ and sorghum TZ; and maize (w) respectively as primary forms of tuo-zaafi for the Doggoh and Tie villages now (chapter 6, section 6.3).
- Farmers reported that because they have adapted to climate variability and change via selecting crops and crop varieties that are better suited to the prevailing local climate that has translated into less availability of sorghum and millet as cultural food crops.

- Therefore, farmers reported that maize (w) is the primary form of TZ now in both the Doggoh and Tie villages. In addition to that, farmers in the village of Doggoh reported sorghum TZ as a primary form of tuo-zaafi (section 6.3.1, chapter 6).
- Farmers reported two main reasons explaining why maize (w) TZ is the primary form of TZ in both the Doggoh and Tie villages: (i) maize (w) now being the main crop cultivated in both villages hence more of it is available, and (ii) because maize (w) has less ritual uses hence it is mainly meant for food consumption (see table 6.5, section 6.3.1, chapter 6).
- Farmers similarly reported that millet and sorghum do not longer occupy ‘key’ positions as the primary forms of TZ in both the Doggoh and Tie villages. For example, farmers reported that the case of millet is due to the availability of less quantity of millet due to climate variability and change. In the context of Sorghum, farmers explained that because of the ritual uses, that is why less of it is mainly consumed as a cultural food (table 6.6 of section 6.3.1, chapter 6).

Consumption of food not the same as preference for food

- Farmers in the village of Doggoh reported that even though maize (w) and sorghum TZ are the forms of TZ that are mainly consumed, maize (w) TZ comes third as the preferred form of TZ now after sorghum and millet forms of TZ. For the village of Tie, farmers reported that maize (w) TZ, millet TZ, and sorghum TZ as the forms of TZ that are preferred in an order of ranking (Chapter 6, section 6.3.2).
- For the village of Tie, even though maize (w) has been cited as the main preferred TZ, which corresponds with the consumption pattern of the main forms of TZ (see sections 6.3.1 and 6.3.2, chapter 6), farmers argued that they are ‘forced’ to prefer that because of its availability. This implies that households’ preference for maize (w) TZ is explained by their adaptation to the earth as argued by the cultural materialists.

Social differentiation of the preferences for Tuo-zaafi

- Farmers reported in the village of Doggoh that males prefer sorghum TZ and females prefer millet TZ. On the aspect of age, farmers indicated that the younger generation prefers millet TZ, the middle age prefer sorghum and the older generation maize (w). Women and children's preference for millet TZ as a cultural food is compromised, as less millet is available now primarily due to the impacts of climate variability and change (see section 5.3.2, chapter 5).
- Farmers in the village of Tie reported that men preferred the maize form of TZ. However, an equal proportion of women preferred millet and maize (w) forms of TZ. Regarding age, the young generation and the middle-aged preferred TZ from maize (w) and the older generation preferred millet TZ (section 6.3.3, chapter 6).

Understanding the factors that explain the differential preference for tuo-zaafi

- Farmers reported sweet taste and white colour as the sensory characteristics that shape women and children's preference for millet and maize forms of TZ. However, farmers indicated that the bitter taste and dark of sorghum TZ explains children's aversion for it (Chapter 6, section 6.3.4).
- Farmers reported the satiating potential of sorghum (i.e. texture) explaining the preference for it by the middle-aged, and the aversion for maize (m) TZ as it has less satiating potential (Chapter 6, section 6.3.4).
- Farmers explained the older generation prefer the sorghum and millet TZ because those are the forms of TZ they have been exposed more to (Chapter 6, section 6.3.4).
- Similarly, farmers revealed that children's preference for maize (w) TZ is because that is the TZ crop that is available in abundance and that is what is regularly prepared, and they are exposed more to that.

7.3 Implications of the findings on conceptualising the role of culture within understandings of crop adaptations to CVC

- The findings have implications for conceptualising the process of crop adaptation to deliver food security and growth in dryland areas experiencing CVC. They highlight how vital it is to recognise culture within this process as the results highlight the role of cultural values in shaping farmers' perceptions of changes in rainfall (see chapter 4, section 4.5.1).
- While previous studies (e.g see section 2.2.2 in Chapter 2) looking at farmer perceptions of climate variability and change have considered farmer perceptions alone, or in comparison with analysis from meteorological data, this research has gone ahead to tease out how farmer groups socially differentiate perceptions of CVC. In addition, this study has gone beyond understanding how farmer perceptions are shaped by farmers' memory, experiences, and climate information from experts to understanding how cultural worldviews and values shape farmers perceptions of the changes in their local climate.
- Theoretically, the results of this study have demonstrated that the Theory of Planned Behaviour (TPB) is a useful framework for explaining farmers' adaptation to CVC via crop selection. For example, farmers' negative and positive attitudinal feelings have led them to respond to CVC by respectively displacing, and cultivating crops and crops and crop varieties that are not suitable, and suitable to the prevailing climate (section 7.2.2). The study similarly showed the usefulness of the perceived behavioural component of the TPB as manifested in less labour has led farmers to the displacement of the crops and perceived behavioural control in the form of access to climate and crop selection information have led to the cultivation of improved varieties of crops (see section 7.2.2).
- The research also highlights that a sense of social identity in the context of the Dagaaba tribe constitutes a major influence on the crop choices made with respect to climate change adaptation. The research has demonstrated the importance of in-group perceptions in a behavioural context. The decisions for example not to displace dagarasinkaa (i.e. the

traditional variety of groundnuts) under CVC now, and farmers' future intentions not displace sorghum if it does not do well under the prevailing climate are all signs of the potency of membership of groups and the norms shaping behaviours. This highlights the importance of social identity when planning adaptation policies. The sense of identity with a given group and the assimilation of the norms of the group constitute a major barrier to climate change adaptation.

- The study builds on previous research on limits to climate variability and change (CVC) adaptation particularly the social limits to CVC adaptation (Adger et al., 2009, Hulme et al., 2007, Jones and Boyd, 2011). The results in chapter 5 section 5.3.4, revealed that farmers are not responding to CVC now via the selection of the traditional variety of groundnuts because of cultural reasons and not because they are limited economically, or technologically. Therefore, the study highlights the need to include the social aspects of limits to climate change adaptation in contemporary debates on adaptation to climate variability and change.
- Similarly, the study contributes to research on the institutional limits to CVC adaptation. The results demonstrate that the village of Doggoh, for instance, is not able to do dry season gardening for an extended period because the water in the Charee dam dries up quickly due to siltation. The farmers in the village of Doggoh engaging in dry season gardening for a long time could be a way of reducing the negative impacts associated with CVC as the rainy season in the area ceases earlier now than the past (see chapter 5, section 5.2.3).

7.4 Implication for policy and practice

The empirical findings presented in this research provide insights that can be useful to policymakers and outreach professionals to better support farmers through their interventions to adapt to climate variability and change and have access to their culturally preferred foods.

7.4.1 Objective 1

- The disagreement between farmers' perception of CVC and analysis of climatic data in which the former believes there is late onset, cessation and shorter duration of the length of the rainfall season now as compared to that of the past and the latter indicating variability in the start, end, and length of the rainy season (see chapter 4, section 4.6) calls for a participatory approach like the Participatory Integrated Climate Services for Agriculture (PICSA). With PICSA and the necessary stakeholders (e.g. farmers. Extension officers) working in a participatory manner, there will information to equip farmers to better understand the current state of their local climate and adapt accordingly. This will help reduce negative impacts and maximise benefits associated with CVC.
- The results (see section 4.4 of chapter 4) showed that farmers in the villages of Doggoh, and Tie receive climate information from few stakeholders (i.e. the Ministry of Food and Agriculture, Literacy Bridge Ghana, and from radio stations). In addition to these, the results indicate that the village of Doggoh gets climate information from ESOKO Ghana, and Climate Change, Agriculture and Food Security (CCAFS). This study suggests that the government should strengthen the human resource base of the Ministry of Food and Agriculture (MoFA) at the local levels to ensure that farmers get the services that they require. Similarly, the village of Tie needs extra interventions from non-governmental organisations into agriculture and climate services programmes as the results suggest the village of Doggoh receives more information than that of Tie.

- The most striking finding perhaps is inadequate access to climate and agricultural information from stakeholders particularly from the Ministry of Food and Agriculture (MoFA). This is manifested in the form of unequal spatial access to climate and agricultural information where the village of Doggoh receives more climate and agricultural information than the Tie village, and men receiving more climate and agricultural information via phones and radios than women in both villages (see box 4.3 of section 4.4). The inadequate staffing, for example, points to the need for the government of Ghana to strengthen the human resource base of the Ministry of Food and Agriculture (MoFA) at the local levels to ensure that farmers get the services that are required for their agricultural activities.

- The fewer non-governmental organisation (NGO) intervention programmes in the Tie village calls for more interventions from non-governmental organisations (NGOs) particularly those that are into agriculture, climate information dissemination and food security. Although the Literacy Bridge Ghana supports farmers with agricultural information via the ‘talking book’, the findings from this study reveal that men receive more climate information than women from radio and mobile phones. This finding, therefore, calls for the need to mainstream intervention programmes by resourcing women with the necessary technologies such as mobile phones. In sum, in the provision of farmer assistance programmes in the regard of climate information, the findings from this study suggests the “segmented approach” to farmer outreach suggested by Arbuckle et al. (2013). This approach takes into account differences in farmers’ beliefs about climate change. In the context of this study, whereas the entire village of Tie needs more climate information from stakeholders, the focus on women in accessing climate should be on assisting them with livelihoods that they can generate some cash to procure phones in order to access climate information.

7.4.2 Objective 2

The results presented here is a vital starting ground in the development of a robust understanding of north-west Ghana farmers’ willingness to or not to adjust their cropping systems in response to changes in their local climate.

- It is evident from the findings of this study that attempts to address climate adaptation sustainably will require policymakers and agricultural researchers to take into account the cultural uses of crops in the development of cropping adaptation policies say the development of improved and high yielding varieties of crops. In section 5.3.4 of chapter 5, the results revealed that crops play a major role in the cultural lives of the people of Doggoh and Tie particularly sorghum.

- Even though farmers have adapted to climate change with the cultivation of sorghum because of the availability of improved varieties. The results (see chapter 5 section 5.3.4) indicated that in the future farmers may not displace sorghum if the available varieties are not suitable to the prevailing climate. The key themes that have emerged to support why farmers may not displace sorghum include (i) the symbolic role of sorghum (i.e. *kagyin*) as the major crop that portrays of the farming trade of the deceased during funerals, (ii) the use of sorghum for the preparation of pito (a local alcoholic beverage), (iii) the significance of sorghum in the ritual activities of undertakers as they need to cleanse themselves (see chapter 5 section 5.3.4 table 5.11). Therefore, policy makers and planners need to holistically understand the socio-cultural lives of the communities in a way to develop adaptation measures that would fruitfully meet the needs of the people concerned. Once the social lives of people are not considered, adaptation measures may not yield maximum results as communities (for example the villages of Doggoh and Tie) may continue to cultivate varieties of sorghum that are not suitable to the prevailing climate if stakeholders do not develop varieties that are suitable to the prevailing climate.
- The results showed that farming within the villages of Doggoh and Tie last for 6 months spanning from June to October with the dry season running for 7 months (see figure 5.3 of section 5.2.1) Similarly, the results demonstrated that there is a high potential for dry season gardening activities in the village of Doggoh (see table 5.3 of section 5.2.1). However, results showed that the Charee dam (where the inhabitants of the village of Doggoh and others go about their dry season gardening dries quicker now than the past – see picture 5.1 of section 5.2.1). An enhancement of the dam could potentially translate into fewer people especially the youth migrating to southern Ghana during the dry season. The government of Ghana recognises 'managing water resources as climate change adaptation to enhance productivity and livelihoods as part of its 10 priority adaptation programmes.

- Similarly, Ghana has the national irrigation policy, which aims to put an area of 500,000 ha under irrigation in the medium-term (MoFA, 2011). As part of the implementation strategy, the policy targets to enhance the productivity of on-going irrigation activities amongst other things (i) undertake participatory appraisals to analyse the needs and potentials of existing schemes, and (ii) to undertake participatory rehabilitation or upgrading of existing schemes where feasible (MoFA, 2011).To this end, this research suggests that within the district assembly level (which is considered as the crucial level for the implementation of the country's national climate change adaptation programme- MoFA, 2011), the environmental committee at the Jirapa Municipality, the Ghana Irrigation Development Authority (GIDA), and the Water Resources Commission (WRC) should work in collaboration with the Doggoh village and other villages around the Charee dam to desilt the dam through participatory processes in order to enable farmers go about their dry season gardening activities. This will enhance the dry season gardening livelihoods of the people of Doggoh, the Jirapa municipality and beyond.
- The summary of the main findings in section 7.3 pointed out that farmers have displaced millet as a crop except for fewer households who cultivate it on a very small-scale basis. In addition, in chapter 6 section 6.3.2, the results revealed that even though millet is only available in less quantity in some households and not available in other households at all, the results revealed that households in the village of Doggoh and Tie prefer to eat that form of TZ. Policy-wise, the results here imply that the Savannah Agricultural Research Institute (SARI), the Crop Research Institute (CRI), in collaboration with other research institutes at Ghana's universities need to work in partnership with farmers in participatory processes to develop resilient varieties of millet, that would enable farmers to cultivate such crops and have access to their culturally preferred foods.

7.4.3 Objective 3

The results (see section 6.2.2) that food (specifically tuo-zaafi in the context of this study) is not just eaten for the sake of meeting the energy needs of the human body (i.e. physiological purposes) or nutritional aspects but also for nourishing social relations and ritual purposes. Therefore, this study suggests that in the design of development policies, planners should consider the cultural aspects of food to cater to the sustainable food security needs of people holistically. The results also showed that farmers' current cropping decisions due to CVC impacts have affected their culturally preferred foods. In section 6.3.2, the results demonstrated that because of the availability of maize (w) as that is the crop that currently does better under the prevailing climate in north-west Ghana, farmers, therefore, cultivate more of that than other crops and that has translated into more of that being available and households are 'forced' to prefer that form of tuo-zaafi in the Tie village. Regarding the implications for policy, the researcher suggests that policymakers dealing with developing adaptation measures should consider the foods preferences of locals to design robust policies that will reduce CVC impacts and at the same be sensitive to the cultural food needs of people.

7.5 Suggestions for future research

- A future study could expand the number of sample villages or contrast with another country location to provide further understanding. This study focused on two villages in the Jirapa municipality of north-west Ghana so results remain a reflection of local food preferences in that area. Although the focus was not to provide generalisation but to understand the role of culture in food adaptation decisions a nuanced, place-based study.
- During the research, there emerged interesting ideas around cultural values shaping farmers' perception of climate variability and change, the ritual uses of crops mainly sorghum, as well as the cultural values of foods.

- Thus, it would be fruitful in the future for studies to drill down on each of these themes to robustly contribute to knowledge. For example, it emerged from the study that sorghum has many rituals uses in the lives of the people of the Doggoh, and Tie villages and beyond in North-west Ghana. To this end, a study fully devoted to understanding the ritual uses of sorghum beyond biological and nutritional uses would tease out nuanced information that would contribute to knowledge.

Appendix A: An introduction letter from the University of Reading

University of Reading

School of Agriculture, Policy and Development
Agriculture Building
Earley Gate
Reading RG6 6AR

Phone: [redacted]
Fax:
Email:

14 December 2015

To whom it may concern,

Introduction for George Dakruah

I am writing as the Research Supervisor George Dakurah, a doctoral research student registered at the School of Agriculture, Policy and Development, University of Reading in the United Kingdom. As part of George's research, he will be undertaking fieldwork in the Jirapa District of the Upper West Region of North-western Ghana and the results will contribute towards his PhD thesis.

The research focuses on ***Climate Variability and Change, Smallholder farmers' decision making and food security in North-western Ghana***. The research will (1) explore smallholder farmers' perceptions of climate variability and change, compare views with meteorological data (2) analyse why farmers' are adapting or not adapting to climate variability and change, and the implications on their culturally preferred food needs and (3) examine agricultural information dissemination to smallholder farmers' with particular interest in whether the said information meets the needs of farmers. The results will be shared with stakeholders and could contribute to on-going activities in the region for effective support for food security.

George will need to engage with a range of different stakeholders during his fieldwork, including smallholder farmers, officials in the Ministry of Food and Agriculture, and Non-Governmental Organisations supporting agricultural and food security related programmes in Jirapa District. Smallholder farm households will be selected using a stratified random sampling technique to speak with a range of different households and key informants will be sampled using purposive and snowball techniques to speak with those with specific interest/knowledge.

The research has been reviewed according to the procedures specified by the University of Reading Research Ethics Committee and has been given a favourable ethical opinion for conduct. Participants in the study will also be provided anonymous reference numbers.

I would be grateful for any assistance that you can provide to George during his visit for fieldwork and should you wish to contact either myself or George, we would be happy to answer additional questions.

Yours faithfully

[redacted]

SCHOOL OF AGRICULTURE POLICY & DEVELOPMENT THE UNIVERSITY OF READING

Dr Henny Osbahr
Associate Professor in International Development
Walker Institute Research Associate

PhD Researcher - George Dakurah Email: g.dakurah@pgr.reading.ac.uk

Appendix B: Example of an informant sheet for respondents

University of Reading

Reference

INFORMATION SHEET: CASE STUDY HOUSEHOLDS

Hello, my name is George Dakurah; a PhD student at the School of Agriculture, Policy and Development, University of Reading (UK). I am undertaking fieldwork to collect empirical data in the Jirapa District and the results will contribute to my thesis for a Doctoral degree. This research seeks to understand smallholder farmers' decision-making under climate variability and change via crop selection, and the implications on future food security. Participants in this study include: village key informants, smallholder farm households, selected workers of the Ministry of Food and Agriculture and Non-governmental organisation (NGOs) officials. I am interested in crop cultivation, food use, agricultural problems, policy support (e.g. from government and non-governmental organisations) for agricultural activities, as well as smallholder farmer's adaptation to climate variability and change. Smallholder farm households are selected using stratified random sampling (to cover a range of different types of households) and officials from the Ministry of Food and Agriculture and NGOs are selected using purposive and snowball sampling techniques.

The anonymity of all respondents is guaranteed by the use of reference numbers on the key informant guides rather than names. The reference will only be used to identify your key informant data and will not reveal any other information about you. After capturing and storing information from research tools in password-protected electronic files, hardcopies of research tools shall be destroyed according to the University of Reading guidelines.

Participation in the study is entirely voluntary and you are free to withdraw at any time you feel uncomfortable or unwilling to participate, and you do not have to specify a reason. Any contribution can be withdrawn at any stage and removed from the research if desired. If you wish to withdraw, please contact the researcher within three months after this interview using the contact details below quoting the reference at the top of this page. If at any stage you wish to receive further information about the interview or project, please do not hesitate to contact Mr Dakurah.

By answering the interview questions, you are acknowledging that you understand the terms of participation and that you consent to these terms.

This application has been reviewed according to the procedures specified by the University Research Ethics Committee and has been given a favourable ethical opinion for conduct.

Researcher contact details:
Mr George Dakurah, School of Agriculture, Policy and Development, University of Reading, P.O. Box 237, Reading, Berkshire, England, RG6 6AR, UK

Email: g.dakurah@pgr.reading.ac.uk
Telephone: 00233-0503932772

Supervisor contact details:

Dr Henny Osbahr, School of Agriculture, Policy and Development, University of Reading, P.O. Box 237, Reading, Berkshire, England, RG6 6AR, UK

Email: h.osbahr@reading.ac.uk
Telephone: +44(0)1183788314

Appendix C: Example of village key informant interview guide

(Note each of the interview guides were adapted according to the key informant interviewed)

Village key informant interview guide: Policy support for agricultural activities

Village: Doggoh /Tie   Date: …........./......2016../...   Reference No: ……..

Sex of key informant: Male/Female   Age: …...   Household number……………….

Position in village…………………………..

Participatory exercises

1. Venn diagram to understand climate information dissemination
2. Venn diagram to understand crop selection information

Objectives

- To understand the sources of climate information to farmers
- To understand crop selection information sources to farmers
- To understand the relevance of agricultural information to the needs of farmers

Procedure 1

- Explain the purpose and objectives of the exercise to key informant
- Explain to key informant what is expected of them
- Ask key informant to identify and prepare a list of sources both within and outside the village where they get climate information from
- Ask key informant to draw a big circle in the centre of the flip chart that represents the village
- Inform key informant that anywhere outside the big circle is considered external source of information.
- Ask key informant to draw circles inside the village to show climate information sources they receive from within, and circles outside the big circle (village) to indicate the sources outside the village. The bigger the circle, the more important the climate information is to farming.

Questions for procedure 1

- Where does you village get climate information from?
  Probe: If source is outside the village, where is it located?
- What types of information do you get from each source?
- How often do you get information from each source?
- Who gets the information more in the village?
- What sources are more trustworthy or informative? Why?
- What kinds of behaviour have changed from climate information received?
- What sources would you want more information from? Why?
- What sort of information meets your farming needs? Why? - What are the current barriers to accessing information?

Probe: How can this be improved?

Procedure 2

- Explain the purpose and objectives of the exercise to participants
- Explain to participants what is expected of them
- Ask participants to identify and prepare a list of sources both within and outside the village where they get crop selection information from
- Ask participants to draw a big circle in the centre of the flip chart that represents the village
- Inform participants that anywhere outside the big circle is considered external source of information.
- Ask participants to draw circles inside the village to show crop selection information sources they receive from within, and circles outside the big circle (village) to indicate the sources outside the village. The bigger the circle, the more important the crop selection information is to farming.

Questions

1. What sources do you get crop selection information from?
   Probe: What specific crop selection information do you get from each source|?
2. What sources are trustworthy or informative? Why?
3. Who gets the information more in the village? Why?
4. How helpful if the information in crop selection?
   Probe: Does it enable you cultivate your preferred food needs?
5. What kinds of behaviours have changed from climate information received?
6. What do you think needs to be done to enable you get appropriate and relevant crop selection information?

Appendix D: Semi-Structured Questionnaire for households

Semi-Structured Questionnaire

Reference number ________________________________

Study site ……………………………………..

Date ______/_________/ 2016 __________

A: Household Demographic Characteristics

1. Household type:
   01- Poor 02- Semi-rich 03- Poor
2. Sex
   01- Male 02-Female
3. Age ________________________________
4. Marital Status

   01- Single 02- Married 03- Widowed 04- Divorced
5. Highest level of educational attainment
   01- No education 02- Primary 03- Junior High School (Middle School)

   04- Secondary (Senior High School) 05- Tertiary (Teacher, Nursing , Poly, University)
6. Are you head of your household?
   01- Yes 02 No
7. If 'no' in Q 6, what is your relation to household head?
   01- Spouse to household head 1st ☐ 2nd ☐ 3rd ☐
   02- Parent to head of household
   03- Child of head of household
   04- Orphan living in household
   05- Non-immediate relative of head of household
8. Were you born in this village?
   01- Yes 02-No
9. If 'no' to Q 8, answer the following questions
   a. Where were you born? ________________________________
   b. When did you move in here? ________________________________
   c. Why did you move in here?

   ……………………………………………………………………………………………
   ………………………………………………………………………………………..
10. How many people do you have in your household? ________________________________

11. Tell me about your household in the following regards:
12.

Household characteristic	Category	Number
Permanent Household members	Male children (Less than 18 years)	
	Female Children (less than 18 years)	
	Adult men (18^+ years)	
	Adult women (18^+ years)	
	Elderly men (65^+ years)	
	Elderly women (65^+ years)	
Non-permanent members of household	Male children (less than 18 years)	
	Feale children (less than 18 years)	
	Adult men (18^+ years)	
	Adult men (18^+ years)	
	Elderly women (65^+ years)	
	Elderly women (65^+ years)	

13. 10 years ago, how many people were in your household?
14. What do you think about your household population over the years?
    01- Increased 02- Decreased 03- Remained the same

<u>Household Livelihood Assets</u>

15. How do you have access to land for farming?

    01-Inheritance 02- Purchase 03- Rent 04- If other, please specify
16. How much land do you cultivate in acres? --------------------------------
- 17. What are the sources of irrigation for your household?
    b. What crops or vegetables are cultivated using irrigation?
    c. What are the major challenges confronting irrigation activities?
18. What livestock does your household own?
19. Do you have access to credit for your household activities?
    01-Yes 02- No
20. If yes in Q18, what are the sources?
21. Do you receive any remittances?
    01-Yes 02- No
22. If yes in Q20, what are the sources?
23. What are the main sources of income for **<u>men</u>** in your household?
    01- Agriculture (including crops and livestock)
    02- Paid labour in communal area
    03- Work in town/city
    04- Work in rural area

05- Money sent from family
06- Other, please specify

24. If you selected more than one alternative in Q. 22, do rank the selected options
    Agriculture (including crops and livestock) ☐
    Paid labour in communal area ☐
    Work in town/city ☐
    Work in rural area ☐
    Money sent from family ☐
    Other, please specify. … ☐

25. What are the main sources of income for **<u>women</u>** in your household?
    07- Agriculture (including crops and livestock)
    08- Paid labour in communal area
    09- Work in town/city
    10- Work in rural area
    11- Money sent from family Other, please specify
26. If you selected more than one alternative in Q. 24, do rank the selected options
    Agriculture (including crops and livestock) ☐
    Paid labour in communal area ☐
    Work in town/city ☐
    Work in rural area ☐
    Money sent from family ☐
    Other, please specify……… ☐
27. a. Do you belong to any group in this village?
    01-Yes 02- No
    b. If yes, provide details in the following regards:

Name of group	Date of formation	Purpose	Number of members

    c. How have you benefited from such a group?
    ……………………………………………………………………………………….

28. Do you hold any leadership position in this village?
29. If 'yes' to Q 27, what is your position?

<u>Household diet</u>

30. As a dagao, what are the **<u>three</u>** (3) major staple foods of your household?
    01- Tuo-zaafi 02- "Belebele" 03- "Kpoglo" 04- Rice 05- Rice with beans
    06- Rice with Bambara groundnuts 07- If other, please specify
    ………………………………..
31. Rank the selected staple foods in Q29 with 1 being the most important and 3 being the least important.
32. What kind of food is regularly eaten by your household for **<u>breakfast</u>**? Please choose **<u>one</u>**.
    01- Porridge (millet) **02**- Porridge (millet) **03**- Porridge (maize) **04**- Porridge (

Sorghum) **05**- Tuo-zaafi (millet) **06**- Tuo-zaafi (maize) **07**- Tuo-zaafi (Beans) **08**-
Tuo-zaafi (Bambara groundnuts) **09**- Rice only **10**- Rice with beans **11**-Rice with Bambara groundnuts **12**-Belebele (beans) **13**- Belebele (Bambara groundnuts)

33. What kind of food is regularly eaten by your household for **<u>lunch</u>**? Please choose **<u>one</u>**. **01**- Porridge (millet) **02**- Porridge (millet) **03**- Porridge (maize) **04**- Porridge (
Sorghum) **05**- Tuo-zaafi (millet) **06**- Tuo-zaafi (maize) **07**- Tuo-zaafi (Beans) **08**-
Tuo-zaafi (Bambara groundnuts) **09**- Rice only **10**- Rice with beans **11**-Rice with Bambara groundnuts **12**-Belebele (beans) **13**- Belebele (Bambara groundnuts)

34. What kind of food is regularly eaten by your household for **<u>supper</u>**? Please choose **<u>one</u>**.
01- Porridge (millet) **02**- Porridge (millet) **03**- Porridge (maize) **04**- Porridge (
Sorghum) **05**- Tuo-zaafi (millet) **06**- Tuo-zaafi (maize) **07**- Tuo-zaafi (Beans) **08**-
Tuo-zaafi (Bambara groundnuts) **09**- Rice only **10**- Rice with beans **11**-Rice with Bambara groundnuts **12**-Belebele (beans) **13**- Belebele (Bambara groundnuts)

35. What type of ***<u>tuo-zaafi</u>*** did your household prefer to eat in the **<u>past</u>**?
01- Millet *tuo-zaafi* *02-* Maize *tuo-zaafi* *03-* Bambara groundnuts *tuo-zaafi*
04- Beans *tuo-zaafi* *05-* Sorghum *tuo-zaafi*
36. What type of ***<u>tuo-zaafi</u>*** does your household prefer to eat **<u>now</u>**?
01- Millet *tuo-zaafi* *02-* Maize *tuo-zaafi* *03-* Bambara groundnuts *tuo-zaafi*
04- Beans *tuo-zaafi* *05-* Sorghum *tuo-zaafi*
37. If the ***<u>tuo-zaafi</u>*** your household prefers today is different from what you ate in the past, what accounts for the change?
………………………………………………………………………………………………
………………………………………………………………………………………………
… ………………………………………………………………………………………
……
…
38. What type of ***<u>tuo-zaafi</u>*** did your household regularly eat in the **<u>past</u>**?
01-Millet *tuo-zaafi* *02-* Maize *tuo-zaafi* *03-* Bambara groundnuts *tuo-zaafi*
04- Beans *tuo-zaafi* *05-* Sorghum *tuo-zaafi*
39. What type of ***<u>tuo-zaafi</u>*** does your household regularly eat **<u>now</u>**?
01- Millet *tuo-zaafi* *02-* Maize *tuo-zaafi* *03-* Bambara groundnuts *tuo-zaafi*

04-Beans *tuo-zaafi* 05- Sorghum *tuo-zaafi*

40. If the ***tuo-zaafi*** your household eats regularly **now** is different from that of the **past**, what brings about the change?

………
……

………
…… ………

Crop cultivation, food use and social functions

41. Choose **three** crops that your household widely cultivated in the **past**.

    01- Millet 02- Sorghum 03- Beans 04- Yam 05- Maize (yellow) 06- Maize (white)

    07- Bambara groundnuts 08- Groundnuts

42. Rank the selected crops in Q40 with 1 being the most cultivated and 3 being the least cultivated

    1…………………………………………..
    2………………………………………….
    3………………………………………….

43. Choose **three** crops that are widely cultivated by your household **now?**

    01- Millet 02- Sorghum 03- Beans 04- Yam 05-Maize (yellow) 06- Maize (white)

    07- Bambara groundnuts 08- Groundnuts

44. Rank the selected crops in Q42 with 1 being the most cultivated and 3 being the least cultivated

    1…………………………………………..
    2………………………………………….
    3………………………………………….

45. Which crops does your household cultivate around the compound? Probe: Why does your household cultivate such crops around the compound?
46. Which crops does your household cultivate in the bush farms?
    Probe: why does your household cultivate such crops in the bush farms?
47. Which crops are your **food** and **cash** crops?
48. Which crops do you think your household **canno**t stop growing if their yields are not good enough?

    01- Millet 02- Sorghum 03- Beans 04- Yam 05- Maize (yellow) 06- Maize (white)

    07-Bambara groundnuts

49. Explain why your household will persist to cultivate such crops in Q. 47

……
……
……
……
……
…… ……………………………

To what extent do you agree with the following statements?

50. **Millet** plays a vital role in the food needs of my household
    01- Strongly agree 02- Agree 03- Neither agree or disagree 04- Disagree 05- Strongly disagree
51. **Maize** plays a vital role in the food needs of my household
    01-Strongly agree 02- Agree 03- Neither agree or disagree 04- Disagree 05- Strongly disagree
52. **Sorghum** plays a vital role in the social functions of my household
    01- Strongly agree 02- Agree 03- Neither agree or disagree 04- Disagree 05- Strongly disagree
53. **Millet** plays a vital role in the social functions of my household
    01- Strongly agree 02- Agree 03- Neither agree or disagree 04- Disagree 05- Strongly disagree
54. *No **tuo-zaafi,** no food in a dagao household*
    01-Strongly agree 02- Agree 03- Neither agree or disagree 04- Disagree 05- Strongly disagree
55. No ***pito****, no funeral celebration in the Dagaaba land*
    01-Strongly agree 02- Agree 03- Neither agree or disagree 04- Disagree 05- Strongly disagree

Challenges confronting agricultural activities

56. What are the major problems confronting agricultural activities in your household?
57. Rank the three most challenging problems in Q55 with 1 being the most challenging and 3 being least challenging
58. Have you observed any changes in rainfall onset over the last 20-30 years and now?

    01-Yes 02-No

59. If 'yes' in Q57, what is your observation?

    01- It starts earlier now than in the past

    02-It starts later now than in the past

    03- More unpredictable

60. When did the rainy season start in the **past**?

01- January 02- February 03-March 04- April 05- May 06- June 07- July

61. In which month does the rainy season start **now**?

01- January 02-February 03- March 04-April 05- May 06-June 07-July

62. Have you observed any changes in rainfall cessation over the last 20-30 years and now?

01-Yes 02-No

63. If 'yes' in Q61, what is your observation?

01– It cesses earlier now than the past

02- It cesses later now than the past

03- More unpredictable

64. In what month did the rainy season end in the past?

01-July 02- August 03 -September

04 -October 05 –November 06- December

65. In what month does the rainy season end now?

01-July 02- August 03 -September

04 -October 05 –November 06- December

66. Have you observed any changes in the length of the season 20-30 years and now?

01- Yes 02-No

67. If 'yes' in Q65, what are your observations?

01-Rainy season now is longer

02-Rainy season in the past is longer

03-Rainy season is more variable now

68. From your own perspective, what could account for any changes in rainfall?

………
………
………
………………………..

69. What are your observations about droughts in Ghana now and 20-30 years back?

01- Less Drought 02-More drought 03- The same

70. Which years has Ghana experienced droughts?

……………………………………………………………………………

71. What are your observations about floods in Ghana now and 20-30 years back?

01- Less floods 02-More floods 03- The same

72. Have you been told of droughts that occurred before you were born?

01- Yes 02 –No

73. If yes in Q71, answer the following questions:

a. Which years did these droughts occur …………………………………………………………….

b. Who told you about these droughts? ……………………………………………………………

c. What did they tell you about the droughts?

……
……

……
……

…….

74. Have you observed any changes in temperature 20-30 years back and now?

01-Yes 02- No

75. If 'yes' in Q73, what is your observation?

01-Warmer now than the past 02-Cooler now than the past 03-Very unpredictable

Decision making under climate variability and change

76. Are there some crops that your household wishes to cultivate under the current climate but cannot?

Probe:

Which crops and why?

To what extent do you agree with the following statements?

77. **Millet** produces very good yield under climate variability and change

01- Strongly agree 02- Agree 03- Neither agree or disagree 04- Disagree 05- Strongly disagree

78. **Sorghum** produces good yield under climate variability and change

01- Strongly agree 02- Agree 03- Neither agree or disagree 04- Disagree 05- Strongly disagree

79. **Groundnuts** produces good yield under climate variability and change

01-Strongly agree 02- Agree 03- Neither agree or disagree 04- Disagree 05- Strongly disagree

80. My household focuses on cultivating crops that form our **staple foods** under climate variability and change

01- Strongly agree 02- Agree 03- Neither agree or disagree 04- Disagree 05- Strongly disagree

81. My household focuses on the cultivation of crops that produce **good yields** under climate variability and change

01- Strongly agree 02- Agree 03- Neither agree or disagree 04- Disagree 05- Strongly disagree

82. My household cannot stop cultivating **millet** if it produces poor yield under climate variability and change

01-Strongly agree 02- Agree 03- Neither agree or disagree 04- Disagree 05- Strongly disagree

83. My household cannot stop cultivating **sorghum** if it produces poor yield under climate variability and change

01- Strongly agree 02- Agree 03- Neither agree or disagree 04- Disagree 05- Strongly disagree

84. My household cannot stop cultivating **maize** if it produces poor yield under climate variability and change

01- Strongly agree 02- Agree 03- Neither agree or disagree 04- Disagree 05- Strongly disagree

Access to agricultural information

85. My household receives climate information that meet our farming needs

01- Strongly agree 02- Agree 03- Neither agree or disagree 04- Disagree 05- Strongly disagree

86. My household receives crop selection information that meets our cultural adaptation pathways

01- Strongly agree 02- Agree 03- Neither agree or disagree 04- Disagree 05- Strongly disagree

87. My household has changed some farming practices based on agricultural information received

01- Strongly agree 02- Agree 03- Neither agree or disagree 04- Disagree 05- Strongly disagree

Appendix E: Example of Stakeholder Level Key informant Interview Guide

Interview Guide for Key Informants (District Level- NGOs and Government Agencies)

THEMES

A) General mandate of organisation

1. What roles do your organisation play in the development of the district? Probe:
   -Tell me a little about the various divisions and the functions of each
2. Do you partner with some organisations within the district in carrying out your work?
   Probe: if yes, which organisations-what have you done with each
3. How long have you been operating in the district?
4. What sort of support do you give to farmers in the district?
   Probe:
   - Which division and personal within your organisation is in charge of what? - How did your organisation map out the needs of farmers?

B) Knowledge on agricultural activities

1. What forms of agricultural activities are practiced in the Jirapa district?
   Probe:
   - What kinds of crops are largely cultivated?
   - Tell me about the specific varieties of the crops cultivated in the district - What types of animals are reared?
2. Do you know of any crops that were cultivated in the past (say 20-30years) back which are no longer cultivated or have diminished in quantity of cultivation?
   Probe:
   Which crops?
   How did you know about that?
3. Which crops do well under the current climate?
   Probe:
   Why do they do well?
   Are there any input requirements?

C) Problems confronting agricultural activities

1. What are the major challenges to agricultural activities in the district?
   Probe:
   Why is each stated factor in Q1 a problem to agricultural activities? Which ones are more problematic than others? Why?
2. Do you think climate variability and change exist in the district? Probe:
   If yes, what are the manifestations of climate change in the district?
   What evidence do you rely on to say climate variability and change exist?
   What are the causes?
   What impacts does it have on farming activities?
   Which crops are at great risk to the impacts?

(D) **Agricultural information dissemination**

- Information type, communication strategy and transfer

1. What sort of agricultural information do you give to farmers?
   Probe:
   What specific climate related information?
   What specific crop selection information?
   What specific farm inputs information?
   What specific farming practices information?
2. Can you tell me how each of the above mentioned information in Q1 is communicated to farmers?
   Probe:
   Who disseminates the information? How is the dissemination done?
   Who gets the said information (e,g young, older people, literate population etc)? Why target such people?

- Limits, barriers and acceptance regarding information dissemination

3. What major problems confront your organisation in an attempt to disseminate agricultural information to farmers?
   Probe:
   What are the limits and barriers to information dissemination?
4. How are farmers responding to the above agricultural information disseminated to them? Probe:
   - What is valued and what is not valued?
   - Any evidence about change of behaviour based on the information disseminated?

(E) **Adaptation to climate variability and change verses food preferences**

1. What crop type or variety does better under climate variability and change? Probe: What are the requirements of such crops?

2. Do you factor in farmers' food preferences in your dissemination of crop selection information to them?
3. What are the limits to adaptation to climate variability and change?
   Probe: What specific support does your organisation give to farmers to enhance their adaptive capacity?

Appendix F: Understanding crop cultivation in Doggoh and Tie using participatory budget: underlying factors that influence farmer choice of crops

Understanding crop cultivation in Doggoh and Tie using participatory budget: underlying factors that influence farmer choice of crops

Household code………… Sex of household head: …………… Village …………….

Procedure

-Initial discussion with each household about the crops that are cultivated

-What factors are taken into consideration when deciding which crop to cultivate?

-Scoring exercise to understand the relative importance of these decision making factors

-Ask farmers to rank the importance of each criterion in their decision making (with one being the most important and 10 being the least important)

Criteria	Crop	Variety		Crop	Variety		Crop	Variety			Crop	Variety			Crop	Variety		Crop	Variety				Crop	Variety		Importance of criteria
	GN			SG			MZ (Y)				MZ (W)				ML			BN					BG			
Yield																										
Income																										
Drought tolerance																										
Preferred food crop																										
Important role in funerals																										

Check list questions

1. Tell me about where each crop is located and why?

   Probe:

   Which ones are cultivated around the compound farms and bush farms? Why?

2. Are there any varieties of the above-mentioned crops that were cultivated in the past which are no longer cultivated now?

   Probe:

   - Why are they no longer cultivated?
   - When did you start cultivating the new varieties of the crops in Q2?
   - Where did you get such varieties from? e.g. groundnuts, sorghum etc.

	O JAN	00 FEB	000 MAR	0000 APR	00000 MAY	000000 JUNE	0000000 JULY	00000000 AUG	000000000 SEPT	0000000000 OCT	00000000000 NOV	00000000 0000 DEC
GN Act												
SG Act												
MZ(Y) Act												
MZ(W) Act												
ML Act												
BN Act												
BG Act												
YM Act												
GN Labour People Days												

SG Labour People Days												
MZ(Y) Labour People Days												
MZ(W) Labour People Days												
ML Labour												
People Days												

BNS Labour People Days												
Yam labour People days												
BG Labour People Days												
GN Cash spent												
SG Cash spent												

MZ(Y) cash spent												

M(W) cash spent												
ML cash spent and inputs												
BNS cash spent and inputs												
Yam cash spent and inputs												
BG cash spent and inputs												
GN income and outputs												

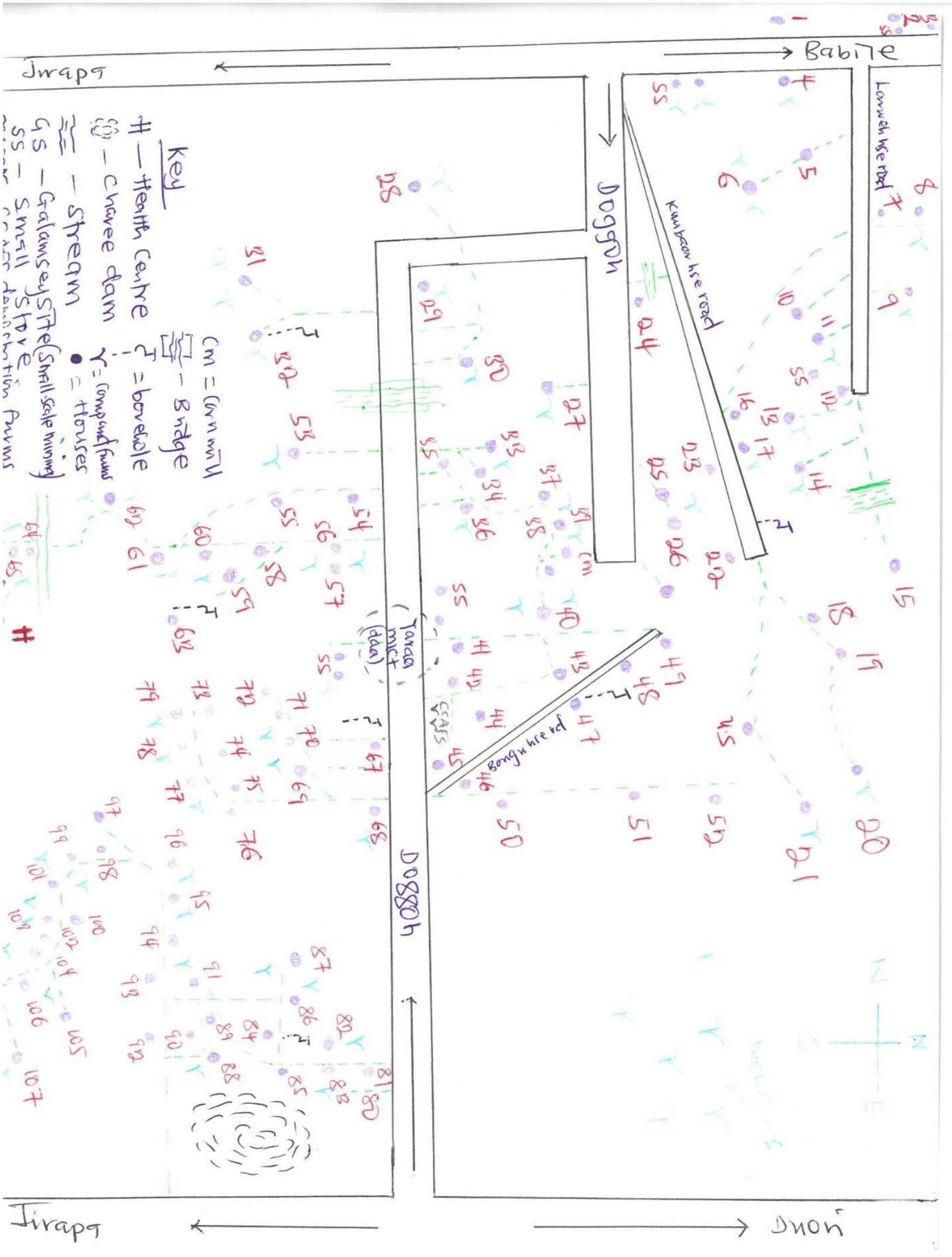
SG income and outputs												
MZ(Y) income and outputs												
MZ(W) income and outputs												
ML income and outputs												

SG income and outputs												
MZ(Y) income and outputs												
MZ(W) income and outputs												
ML income and outputs												

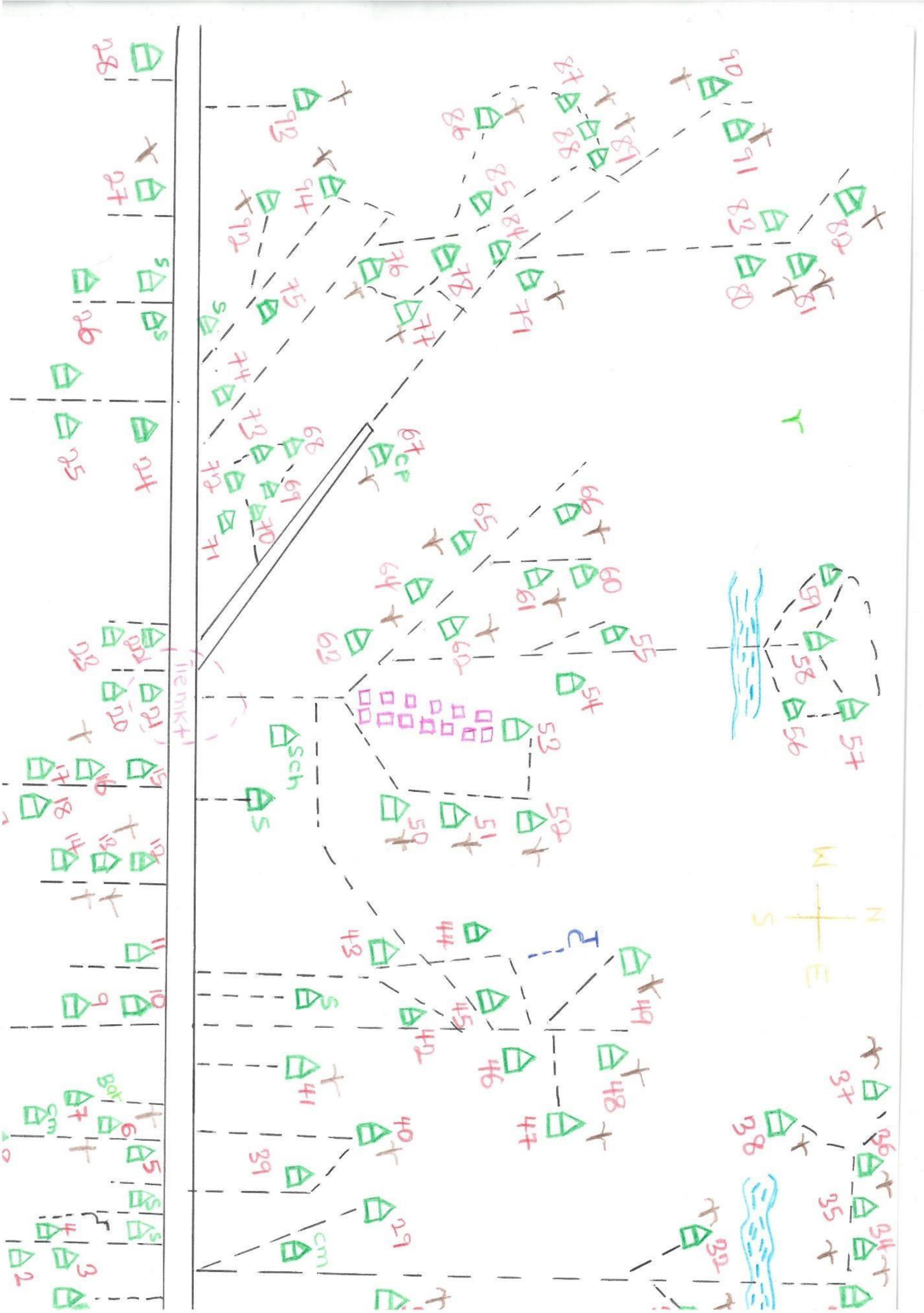
BNS income and outputs												
Yam income and outputs												
BG income and outputs												
GN balance												
SG balance												
MZ(Y) balance												
MZ(W) balance												

ML balance												
BNS balance												
Yam balance												
BG balance												

Appendix G : Map of Doggoh (Produced from the social mapping exercise carried out by village analysts)



Appendix H: Map of Tie (Produced from the social mapping exercise that out by village analysts)



Appendix I:Demographic characteristics of respondents (Doggoh and Tie villages) Demographic characteristics of the respondents of Doggoh village

Sex	**Male**	**60 (80.0%)**	**Total n (%)**
	Female	**15 (20.0%)**	**75 (100%)**
Age	**25-40**	**17 (22.7%)**	**Total n (%)**
	41-65	**39 (52.0%)**	**75 (100%)**
	66-95	**19 (25.3%)**	
Wealth status	**Poor**	**25 (33.3%)**	**Total n (%)**
	Semi-rich	**25 (33.3%)**	**75 (100%)**
	Rich	**25 (33.3%)**	
Marital status	**Single**	**1 (1.3%)**	**Total n (%)**
	Married	**68 (90.7%)**	**75 (100%)**
	Widowed	**6 (8.0%)**	
Educational attainment	**No education**	**60 (80.0%)**	**Total n (%)**
	Primary	**9 (12.0%)**	**75 (100%)**
	Junior High	**2 (2.7%)**	
	Secondary/senior High	**3 (4.0%)**	
	Tertiary	**1 (1.3 %)**	

Demographic characteristics of the respondents of Tie village

Sex	**Male n (%)**	**52 (69.3%)**	**Total n (%)**
	Female n (%)	**23 (30.7%)**	**75 (100%)**
Age	**25-40**	**19 (25.3%)**	**Total n (%)**
	41-65	**35 (46.7%)**	**75 (100%)**
	66-90	**21 (28.0%)**	
Wealth status	**Poor**	**25 (33.3%)**	**Total n (%)**
	Semi-rich	**25 (33.3%)**	**75 (100%)**
	Rich	**25 (33.3%)**	
Marital status	**Single**	**2 (2.7%)**	**Total n (%)**
	Married	**53 (70.7%)**	**75 (100%)**
	Widowed	**20 (26.7%)**	
Educational attainment	**No education**	**60 (80%)**	**Total n (%)**
	Primary	**8 (10.7%)**	**75 (100%)**
	Junior High	**6 (8%)**	
	Secondary/senior High	**1 (1.3%)**	

Appendix J:A cross-tabulation of farmers' perception of climate variability and change by sex, age, level of education and wealth in the Doggoh and Tie villages

Onset (past)	Feb	**Mar**	April	May	Total n (%)
Male	9 (15.0%)	**44 (73.3%)**	6 (10.0%)	1 (1.7%)	60 (100.0)
Female	1 (6.7%)	**12 (80.0%)**	1 (6.7%)	1 (6.7%)	15 (100.0)
Onset (now)	Mar	Apr	May	**June**	Total n (%)
Male	1 (1.7%)	6 (10.0%)	21 (35.0%)	**32 (53.3%)**	60 (100.0)
Female	1 (6.7%)	2 (13.3%)	5 (33.3%)	**7 (46.7%)**	15 (100.0)
Cessation (past)	Sept	Oct	**Nov**	Dec	Total n (%)
Male	1 (1.7%)	6 (10.0%)	**47 (78.3%)**	9 (10.0%)	60 (100.0)
Female	0 (0.0%)	0 (0.0%)	**14 (93.3%)**	1 (6.7%)	15 (100.0)
Cessation (now)	Aug	Sept	Oct	Nov	Total n (%)
Male	2 (3.3%)	24 (40.0%)	33 (55.0%)	1 (1.7%)	60 (100.0)
Female	1 (6.7%)	8 (53.3%)	6 (40.0%)	0 (0.0%)	15 (100.0)

Onset of rainfall (past)		Feb	**Mar**	April	May	Total n (%)
Age	25-40	1 (5.9%)	**14 (82.4%)**	2 (11.8%)	0 (0.0%)	17 (100.0%)
	41-65	6 (15.4%)	**29 (74.4%)**	4 (10.3%)	0 (0.0%)	39 (100.0)
	66-95	3 (15.8%)	**13 (68.4%)**	1 (5.3%)	2 (10.5%)	19 (100.0)
Onset of rainfall (now)		Mar	April	May	**June**	Total n (%)
Age	25-40	0 (0.0%)	1 (5.9%)	5 (29.4%)	**11 (64.7%)**	17 (100.0)
	41-65	0 (0.0%)	5 (12.8%)	17 (43.6%)	**17 (43.6%)**	39 (100.0)
	66-95	2 (10.5%)	2 (10.5%)	4 (21.1%)	**11 (57.9%)**	19 (100.0)
Cessation of rainfall (past)		Sept	October	**November**	December	Total n (%)
Age	25-40	1 (5.9%)	0 (0.0%)	**15 (88.2%)**	1 (5.9%)	17 (100.0)

	41-65	0 (0.0%)	4 (10.3%)	**30 (76.9%)**	5 (12.8%)	39 (100.0)
	66-95	0 (0.0%)	**2 (10.5%)**	**16 (84.2%)**	1 (5.3%)	19 (100.0)
Cessation of rainfall (now)		August	September	**October**	November	Total n (%)
Age	25-40	2 (11.8%)	6 (35.3%)	**9 (52.9%)**	0 (0.0%)	17 (100.0)
	41-65	1 (2.6%)	21 (53.8%)	**16 (41.0%)**	1 (2.6%)	39 (100.0)
	66-95	0 (0.0%)	5 (26.3%)	**14 (73.7%)**	0 (0.0%)	19 (100.0)

Onset (past)	Feb	**Mar**	Apri	May	Total n (%)
Poor	3 (12.0%)	**19 (76.0%)**	3 (12.0%)	0 (0.0%)	25 (100)
Semi-rich	4 (16.0%)	**18 (72.0%)**	2 (8.0%)	1 (4.0%)	25 (100)
Rich	3 (12.0%)	**19 (76.0%)**	2 (8.0%)	1 (4.0%)	25 (100)
Onset (now)	March	Apri	May	**June**	Total n (%)
Poor	0 (0.0%)	2 (8.0%)	14 (56.0%)	**9 (36.0%)**	25 (100)
Semi-rich	1 (4.0%)	1 (4.0%)	10 (40.0%)	**13 (52.0%)**	25 (100)
Rich	1 (4.0%)	5 (20.0%)	2 (20.0%)	**17 (68.0%)**	25 (100)
Cessation (past)	Sept	Oct	**Nov**	Dec	Total n (%)
Poor	0 (0.0%)	2 (8.0%)	**20 (80.0%)**	3 (12.0%)	25 (100)
Semi-rich	1 (4.0%)	1 (4.0%)	**20 (80.0%)**	3 (12.0%)	25 (100)
Rich	0 (0.0%)	3 (12.0%)	**21 (84.0%)**	1 (4.0%)	25 (100)
Cessation (now)	Aug	Sept	**Oct**	Nov	Total n (%)
Poor	0 (0.0%)	15 (60.0%)	**10 (40.0%)**	0 (0.0%)	25 (100)
Semi-rich	2 (8.0%)	9 (36.0%)	**14 (56.0%)**	0 (0.0%)	25 (100)
Rich	1 (4.0%)	8 (32.0%)	**15 (60.0%)**	1 (4.0%)	25 (100)

Onset of rainfall (past)		February	**March**	April	May	Total n (%)
Education	Educated	3 (20.0%)	**10 (66.7%)**	2 (13.3%)	0 (0.0%)	15 (100.0)
	Uneducated	7 (11.7%)	**46 (76.7%)**	5 (8.3%)	2 (3.3%)	60 (100.0)
Onset of rainfall (now)		Mar	April	May	**June**	Total n (%)
Education	Educated	0 (0.0%)	2 (3.3%)	4 (26.7%)	**9 (60.0%)**	15 (100.0)
	Uneducated	2 (3.3%)	6 (10.0%)	22 (36.7%)	**30 (50.0%**)	60 (100.0)
Cessation of rainfall (past)		Sept	October	**November**	December	Total n (%)
Education	Educated	0 (0.0%)	1 (6.7%)	**12 (80.0%)**	2 (13.3%)	15 (100.0)
	Uneducated	1 (1.7%)	5 (8.3%)	**49 (81.7%)**	5 (8.3%)	60 (100.0)
Cessation of rainfall (now)		August	September	**October**	November	Total n (%)
Education	Educated	0 (0.0%)	5 (33.3%)	**9 (60.0%)**	1 (6.7%)	15 (100.0)
	Uneducated	3 (5.0%)	27 (45.0%)	**30 (50.0%)**	0 (0.0%)	60 (100.0)

Tie Village

Onset of rainfall (past)		Feb	**Mar**	April	May	Total n (%)
Sex	Male	3 (5.8%)	**42 (80.8%)**	6 (11.5%)	1 (1.9%)	52 (100.0)
	Female	0 (0.0%)	**19 (82.6%)**	1 (4.3%)	3 (13.0%)	23 (100.0)
Onset of rainfall (now)		April	May	**June**	July	Total n (%)
Sex	Male	8 (15.4%)	19 936.5%)	**21 (40.4%)**	4 (7.7%)	52 (100.0)
	Female	0 (0.0%)	10 (43.5%)	**12 (52.2%)**	1 (4.3%)	23 (100.0)
Cessation of rainfall (past)		Oct	**Nov**	Dec	Total n (%)	
Sex	Male	4 (7.7%)	**42 (80.8%)**	6 (11.5 %)	52 (100.0)	
	Female	1 (4.3%)	**21 (91.3%)**	1 (4.3%)	23 (100.0)	

Cessation of rainfall (now)		Aug	Sept	**Oct**	Total n (%)
Sex	Male	2 (3.8%)	22 (42.3%)	**28 (53.8%)**	52 (100.0)
	Female	0 (0.0%)	13 (56.5%)	**10 (43.5%)**	23 (100.0)

Onset of rainfall (past)		Feb	**Mar**	April	May	Total n (%)
Age	25-40	1 (5.3%)	**14 (73.7%)**	3 (15.8%)	1 (5.3%)	19 (100.0)
	41-65	1 (2.9%)	**28 (80.0%)**	3 (8.6%)	3 (8.6%)	35 (100.0)
	66-90	1 (4.8%)	**19 (90.5%)**	1 (4.8%)	0 (0.0%)	21 (100.0)
Onset of rainfall (now)		April	May	**June**	July	Total n (%)
Age	25-40	2 (10.5%)	10 (52.6%)	**5 (26.3%)**	2 (10.5%)	19 (100.0)
	41-65	4 (11.4%)	11 (31.4%)	**17 (48.6%)**	3 (8.6%)	35 (100.0)
	66-90	2 (9.5%)	8 (38.1%)	**11 (52.4%)**	0 (0.0%)	21 (100.0)
Cessation of rainfall (past)		October	**November**	December	Total n (%)	
Age	25-40	3 (15.8%)	**16 (84.2%)**	0 (0.0%)	19 (100.0)	
	41-65	2 (5.7%)	**29 (82.9%)**	4 (11.4%)	35 (100.0)	
	66-90	0 (0.0%)	**18 (85.7%)**	3 (14.3%)	21 (100.0)	
Cessation of rainfall (now)		August	September	**October**	Total n (%)	
Age	25-40	1 (5.3%)	8 (42.1%)	**10 (52.6%)**	19 (100.0)	
	41-65	0 (0.0%)	18 (51.4%)	**17 (48.6%)**	35 (100.0)	
	66-90	1 (4.8%)	9 (42.9%)	**11 (52.4%)**	21 (100.0)	

Onset of rainfall (past)		February	**March**	April	May	Total n (%
Wealth	Poor	2 (8.0%)	**17 (68.0%)**	3 (12.0%)	3 (12.0%)	25 (100.0)
	Semi-rich	1 (4.0%)	**22 (88.0%)**	1 (4.0%)	1 (4.0%)	25 (100.0)
	Rich	0 (0.0%)	**22 (88.0%)**	3 (12.0%)	0 (0.0%)	25 (100.0)
Onset of rainfall (now)		April	May	**June**	July	Total n (%)
Wealth	Poor	2 (8.0%)	8 (32.0%)	**12 (48.0%)**	3 (12.0%)	25 (100.0)
	Semi-rich	1 (4.0%)	15 (60.0%)	**8 (32.0%)**	1 (4.0%)	25 (100.0)
	Rich	5(20.0%)	6 (24.0%)	**13 (52.0%)**	1 (4.0%)	25 (100.0)
Cessation of rainfall (past)		October	**November**	December	Total n (%)	
Wealth	Poor	2 (8.0%)	**22 (88.0%)**	1 (4.0%)	25 (100.0)	
	Semi-rich	2 (8.0%)	**22 (88.0%)**	1 (4.0%)	25 (100.0)	
	Rich	1 (4.0%)	**19 (76.0%)**	5 (20.0%)	25 (100.0)	
Cessation of rainfall (now)		August	September	**October**	Total n (%)	
Wealth	Poor	1 (4.0%)	11 (44.0%)	**13 (52.0%)**	25 (100.0)	
	Semi-rich	1 (4.0%)	12 (48.0%)	**12 (48.0%)**	25 (100.0)	
	Rich	0 (0.0%)	12 (48.0%)	**13 (52.0%)**	25 (100.0)	

Onset of rainfall (past)		February	**March**	April	May	Total n (%)
Education	Educated	1 (6.7%)	**11 (73.3%)**	2 (13.3%)	1 (6.7%)	15 (100.0)
	uneducated	2 (3.3%)	**50 (83.3%)**	5 (8.3%)	3 (5.0%)	60 (100.0)
Onset of rainfall (now)		April	May	**June**	July	Total n (%)
Education	Educated	3 (20.0%)	2 (13.3%)	**8 (53.3%)**	2 (13.3%)	15 (100.0)
	Uneducated	5 (8.3%)	27 (45.0%)	**25 (41.7%)**	3 (5.0%)	60 (100.0)
Cessation of rainfall (past)		October	**November**	December	Total n (%)	
Education	Educated	1 (6.7%)	**12 (80.0%)**	2 (13.3%)	15 (100.0)	
	Uneducated	4 (6.7%)	**51 (85.0%)**	5 (8.3%)	60 (100.0)	
Cessation of rainfall (now)		August	September	**October**	Total n (%)	

Education	Educated	1 (6.7%)	5 (33.3%)	**9 (60.0%)**	15 (100.0)
	Uneducated	1 (1.7%)	30 (50.0%)	**29 (48.3%)**	60 (100.0)

Appendix K: An illustration of the summary of daily rainfall data for 2014 and 2015

```
[1] STATION  : 'Babile'
[1] VARIABLE : 'rain'
[1] YEAR     : 2014
 MONTH  Jan  Feb  Mar  Apr  May  Jun   Jul   Aug   Sep  Oct  Nov  Dec
   DAY **** **** **** **** **** ****  ****  ****  **** **** **** ****
     1  0.0  0.0  0.0  0.0  0.0  0.0   0.0   1.2   5.0 14.4  1.3  0.0
     2  0.0  0.0  0.0  0.0 10.7  0.0  15.5   2.7   0.0  5.0  0.0  0.0
     3  0.0  0.0  0.0  0.0  0.0  5.4   0.0   0.0   2.0  0.0  0.0  0.0
     4  0.0  0.0  0.0  0.0 29.0  0.7   0.0   0.0   0.0  4.0  0.0  0.0
     5  0.0  0.0  0.0  0.0  3.0 11.7   0.0   2.2   0.0  0.0  0.0  0.0
     6  0.0  0.0  0.0 51.2  0.0  0.0   0.0   0.0   0.0  5.7  0.0  0.0
     7  0.0  0.0  0.0  0.0  9.3  0.0   0.0   0.0   0.0  0.0  0.0  0.0
     8  0.0  0.0  0.0  0.0  7.2  3.3   0.0   0.0  14.8  0.0  0.0  0.0
     9  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0   7.5  0.0  0.0  0.0
    10  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0   0.0  0.0  0.0  0.0
    11  0.0  0.0  0.0  0.0  0.0 28.5   0.0   0.0   0.0 13.7  0.0  0.0
    12  0.0  0.0  0.0  0.0  0.0  0.0  59.4   0.0   4.4  0.0  0.0  0.0
    13  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0   1.7  0.0  0.0  0.0
    14  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0     m  0.0  0.0  0.0
    15  0.0  0.0  0.0  0.0  0.0  0.0   0.0  39.8   4.7  0.0  0.0  0.0
    16  0.0  0.0  0.0  0.0  0.0  0.0  16.3   0.0   0.0  0.0  0.0  0.0
    17  6.5  0.0  0.0  0.0  0.0  0.0   0.0   0.0   8.9  0.0 33.5  0.0
    18  6.3  0.0  0.0  0.0  0.0  0.0   0.0  21.5   0.0  0.0 11.5  0.0
    19  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0  15.3  0.0  0.0  0.0
    20  0.0  0.0  0.0  0.0  0.0  0.0   0.0  22.6   0.0  0.0  0.0  0.0
    21  0.0  0.0  0.0  0.0  0.0  0.0  13.9  69.7   0.0  0.0  0.0  0.0
    22  0.0  0.0  0.0  0.0  0.0  7.7   0.0   0.0  72.3  0.0  0.0  0.0
    23  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0   0.0  0.0  0.0  0.0
    24  0.0  0.0  0.0  0.0  7.7  0.0   0.0   0.0   0.0  0.0  0.0  0.0
    25  0.0  0.0  0.0  0.0  0.0  0.0   0.0  23.9   8.2  0.0  0.0  0.0
    26  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0   3.3  0.0  0.0  0.0
    27  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0   0.0  0.0  0.0  0.0
    28  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0   3.2  0.0  0.0  0.0
    29  0.0       0.0  0.0  0.0  0.0  35.8   3.7   0.0  0.0  0.0  0.0
    30  0.0       0.0  0.0  0.0  0.0   0.0  24.0   0.0 11.1  0.0  0.0
    31  0.0       0.0       6.7        0.0   6.5        0.0         m
 STATS ____ ____ ____ ____ ____ ____  ____  ____  ____ ____ ____ ____
   sum 12.8    0    0 51.2 73.6 57.3 140.9 217.8 151.3 53.9 46.3    0
[1]
```

[1] STATION : 'Babile'
[1] VARIABLE : 'rain'
[1] YEAR : 2015

MONTH	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
DAY	****	****	****	****	****	****	****	****	****	****	****	****
1	0.0	0.0	0.0	0.0	0.0	0.0	13.3	9.6	4.9	4.9	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	7.4	0.0	0.0	0.0	8.1	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	27.2	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	11.2	35.3	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34.0	11.6	11.2	0.0	0.0
10	0.0	0.0	0.0	4.6	0.0	0.0	0.0	6.9	4.2	4.2	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	66.8	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.9	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	7.7	6.2	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	40.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	4.5	0.0	0.0	0.0	12.7	29.5	0.0	12.5	12.5	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	7.1	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34.5	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0	8.3	8.3	0.0	25.5	14.3	0.0	0.0
25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0
26	0.0	0.0	0.0	0.0	18.7	0.0	36.4	0.0	0.0	0.0	0.0	0.0
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.1	0.0	0.0	0.0
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	0.0		0.0	0.0	0.0	12.7	0.0	5.6	0.0	0.0	0.0	0.0
30	0.0		0.0	0.0	0.0	0.0	0.0	11.9	0.0	0.0	0.0	0.0
31	0.0		6.8		0.0		0.0	0.0		0.0		m
STATS												
sum	0	4.5	6.8	12.0	63.9	44.2	147.0	259.1	77.4	47.1	0	0

[1]

Appendix L: An illustration of the summary of daily rainfall data for 1983, 1984 and 2007

```
[1]
[1] STATION  : 'Babile'
[1] VARIABLE : 'rain'
[1] YEAR     : 1983
 MONTH   Jan  Feb  Mar  Apr   May  Jun   Jul  Aug   Sep  Oct  Nov  Dec
   DAY  ****  ****  ****  ****  ****  ****  ****  ****  ****  ****  ****  ****
     1   0.0  0.0  0.0  0.0   4.6  0.0   0.0  0.0   0.0  0.0  0.0  0.0
     2   0.0  0.0  0.0  0.0   0.0  0.0   0.0  0.0   0.0  0.0  0.0  0.0
     3   0.0  0.0  0.0  0.0   0.0  0.0   1.0  1.0   0.0  0.0  0.0  0.0
     4   0.0  0.0  0.0  0.0   0.0  0.0  21.3  0.0   0.0  3.1  0.0  0.0
     5   0.0  0.0  0.0  0.0   0.0 11.2   4.1  0.0  37.3  0.0  0.0  0.0
     6   0.0  0.0  0.0  0.0   0.0  0.0   0.3  0.8   0.3  0.0  0.0  0.0
     7   0.0  0.0  0.0  0.0   3.8  0.0   0.3  0.0  21.6  0.0  0.0  0.0
     8   0.0  0.0  0.0  0.0   0.0  0.0   0.0  0.5   0.0  0.0  0.0  0.0
     9   0.0  0.0  0.0  0.0   0.0  0.0   0.0  5.6  31.7  0.0  0.0  0.0
    10   0.0  0.0  0.0  0.0   0.0 18.3   0.0  0.0   0.0  0.0  0.0  0.0
    11   0.0  0.0  0.0  0.8   0.0  0.0  16.0 24.7   8.6  0.0  0.0  0.0
    12   0.0 16.0  0.0  0.0   0.0  0.0   0.0  0.0   0.0  0.0  0.0  0.0
    13   0.0  0.0  0.0  0.0   0.3  0.0   0.8  0.0  17.0  0.0  0.0  0.0
    14   0.0  0.0  0.0  0.0   0.0  0.0   0.0  0.0   5.1  0.0  0.0  0.0
    15   0.0  0.0  0.0  0.0   0.0  0.0   0.0  0.0   0.5  0.0  0.0  0.0
    16   0.0  0.0  0.0  0.0   0.0  0.0  35.1  0.0   2.8  0.0  0.0  0.0
    17   0.0  0.0  0.0  0.0  28.7  0.0   0.3  0.0   6.9  0.0  0.0  0.0
    18   0.0  0.0  0.0  0.0   0.0 27.9   0.0  0.0   0.0  0.0  0.0  0.0
    19   0.0  0.0  0.0  0.0   0.0  0.0   0.0  0.0   0.0  0.0  0.0  0.0
    20   0.0  0.0  0.0  0.0  43.4  0.0   0.0  2.5   0.0  0.0  0.0  0.0
    21   0.0  0.0  0.0  0.0   0.0  0.0   0.0  0.0   0.0  0.0  0.0  0.0
    22   0.0  0.0  0.0  1.5   0.0 18.3   0.0  0.0  31.5  0.0  0.0  0.0
    23   0.0  0.0  0.0  0.0   0.0  0.0   0.0  0.0   0.0  1.8  0.0  0.0
    24   0.0  0.0  0.0  2.5   0.0  0.8   0.0  1.5   0.0  0.0  0.0  0.0
    25   0.0  0.0  0.0  0.0   0.0  6.9   0.0  0.5   0.0  0.0  0.0  0.0
    26   0.0  0.0  0.0  7.1   0.0  0.0   0.0 29.5   0.0  0.0  0.0  0.0
    27   0.0  0.0  0.0  0.0   0.0  0.0   2.3  0.0   0.0  0.0  0.0  0.0
    28   0.0  0.0  0.0  0.0   0.0  0.0   1.0  0.0   0.0  0.0  0.0  0.0
    29   0.0       0.0  0.0   0.0  0.0   0.0  3.6   0.0  0.0  0.0  0.0
    30   0.0       0.0  0.0  20.3  0.0  27.7  2.5   0.0  0.0  0.0  0.0
    31   0.0       0.0        0.0        0.0  0.0        0.0       0.0
 STATS  ____  ____  ____  ____  ____  ____  ____  ____  ____  ____  ____  ____
   sum     0 16.0     0 11.9 101.1 83.4 110.2 72.7 163.3  4.9     0     0
[1]
[1]
```

[1] STATION : 'Babile'
[1] VARIABLE : 'rain'
[1] YEAR : 1984

MONTH	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
DAY	****	****	****	****	****	****	****	****	****	****	****	****
1	0.0	0.0	0.0	0.0	0.0	0.0	1.0	24.4	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	26.7	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0
7	0.0	0.0	0.7	0.0	2.5	8.1	15.5	0.0	3.8	35.6	0.0	0.0
8	0.0	0.0	0.0	0.0	6.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	14.5	0.0	0.0	0.0	0.0	4.6	0.0	0.0
10	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.5	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.5	5.3	6.9	22.1	0.0
12	0.0	0.0	23.1	0.0	0.0	0.0	0.0	11.4	33.0	0.0	4.3	0.0
13	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0	3.8	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	9.1	0.0	12.7	0.0	0.0	0.0
15	0.0	0.0	0.0	2.4	0.8	0.0	11.4	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	21.1	0.0	24.9	3.6	0.0	4.1	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.1	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	16.3	0.0	10.9	11.4	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	9.7	3.3	0.3	23.4	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	11.2	0.0	0.0	0.0	29.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.5	0.8	0.0	9.7	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0	0.0	10.5	3.3	0.0	0.0	0.0	0.0
25	0.0	0.0	0.0	1.8	1.0	0.0	8.3	0.0	0.0	0.0	0.0	0.0
26	0.0	0.0	0.0	0.0	36.1	14.5	6.6	2.5	18.3	0.0	0.0	0.0
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	0.0	0.0	0.0	0.0
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	0.0	0.0	0.0	0.0	0.0	0.0	27.9	9.7	18.8	0.0	0.0	0.0
30	0.0		0.0	16.6	0.0	6.1	0.0	3.8	0.0	0.0	0.0	0.0
31	0.0		0.0		64.5		2.0	16.3		0.0		0.0
STATS												
sum	0	0	23.8	20.8	174.1	83.7	117.8	128.9	136.6	51.2	27.2	0

[1]

[1] STATION : 'Babile'
[1] VARIABLE : 'rain'
[1] YEAR : 2007

MONTH	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
DAY	****	****	****	****	****	****	****	****	****	****	****	****
1	0.0	0.0	0.0	4.6	7.1	0.0	26.2	0.0	0.0	m	m	m
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	m	m	m
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	m	m	m
4	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	0.0	m	m	m
5	0.0	0.0	0.0	6.9	0.0	0.0	0.0	0.0	2.8	m	m	m
6	0.0	0.0	0.0	0.0	0.0	13.7	5.3	1.0	0.0	m	m	m
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.8	0.0	m	m	m
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.0	m	m	m
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	m	m	m
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	m	m	m
11	0.0	0.0	0.0	6.1	0.0	0.0	26.7	0.0	35.6	m	m	m
12	0.0	0.0	0.0	21.3	0.0	0.0	0.0	0.0	0.5	m	m	m
13	0.0	0.0	0.0	0.0	69.3	0.0	2.8	0.0	0.0	m	m	m
14	0.0	0.0	0.0	0.0	0.0	7.8	0.0	0.0	15.5	m	m	m
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	9.0	m	m	m
16	0.0	0.0	0.0	0.0	0.0	31.3	1.3	1.4	7.8	m	m	m
17	0.0	0.0	0.0	23.1	0.0	0.0	38.3	0.0	0.0	m	m	m
18	0.0	0.0	0.0	50.0	0.0	0.0	23.6	0.0	0.0	m	m	m
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	m	m	m
20	0.0	0.0	0.0	1.8	0.0	0.0	29.5	2.6	0.0	m	m	m
21	0.0	0.0	0.0	0.0	0.0	4.1	0.0	0.0	10.3	m	m	m
22	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	m	m	m
23	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	m	m	m
24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	m	m	m
25	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	26.9	m	m	m
26	0.0	0.0	0.0	8.4	1.0	0.0	0.0	0.0	0.0	m	m	m
27	0.0	0.0	0.0	0.0	1.8	4.6	3.3	0.0	6.4	m	m	m
28	0.0	0.0	5.1	0.0	0.0	0.0	7.9	0.0	0.0	m	m	m
29	0.0		0.0	6.6	0.0	0.0	19.8	0.0	0.0	m	m	m
30	0.0		0.0	36.8	20.1	0.0	0.0	1.8	0.0	m	m	m
31	0.0		0.0		0.0		2.8	0.0		m		m
STATS												
sum	0	0	5.1	166.4	99.3	61.5	195.2	23.3	126.2	NA	NA	NA

[1]

Appendix M: Glossary of words

Word	Meaning
Belebelle	A staple food made with either beans or b. groundnuts flour in hot water
Be-ree	Seasoning leaves used for preparing *tuo-zaafi*
Kagyin	Pieces of sorghum tied together
Kou-rou	A local preservative for storing *tuo-zaafi* for longer days
Kpoglo	A traditional food made from a mixture of maize flour with b. groundnuts, or maize flour with beans and b. groundnuts prepared in hot water
Kundabuo	An improved variety of sorghum (brown colour)
Pogbabawullo	A variety of beans known as “how many wives” as it produces much yield hence men that cultivate it need many wives to assist in the harvesting
Poo-kye	An improved variety of beans (white colour)
Pou-roo	Seasoning leaves used in the preparation of *tuo-zaafi*
Sensere	A fried cake made from largely from beans flour, or b. groundnuts flour
Sowolle	A traditional food made from either beans with fried maize flour, or b. groundnuts with fried maize flour.
Tengan	Sacred grove- a collection of grove of trees used for performing sacrifices by elders

References

Abdulai, R. T., Issaka, E. & Ndekugri, I. A. (2007). Customary landholding institutions and housing development in urban centres of Ghana: case studies of Kumasi and Wa. *Habitat International,* **31,** 257-267.

Adger, W. N., Dessai, S., Goulden, M., Hulme, M., Lorenzoni, I., Nelson, D. R., Naess, L. O., Wolf, J. & Wreford, A. (2009). Are there social limits to adaptation to climate change? *Climatic Change,* **93,** 335-354.

Adjei-Nsiah, S. (2012). Climate Change and Shift in Cropping System: From Cocoa to Maize Based Cropping System in Wenchi Area of Ghana. *British Journal of Environment and Climate Change,* **2,** 137-152.

(AFC), A. f. C. (2012). The Ghana Food Security Research with a Focus on the Upper West Region. *Submitted to Mennonite Economic Development Associates (MEDA). Final Report*

Ajzen, I. (1985). From Intentions to Actions: A Theory of Planned Behavior. In: J., K. & J., B. (eds.) Action Control. SSSP Springer Series in Social Psychology. Berlin, Heidelberg: Springer.

Ajzen, I. (1991). The Theory of Planned Behaviour Organisational Behaviour and Human Decision Processes 50 179-211.

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**.

Al-Hassan, R. & Diaox, X. (2007). Regional Disparities in Ghana: Policy options and public involvement implications. *Sustainable Solutions for ending hunger and poverty* International Food Research Institute

Amadou, M. L., Villamor, G. B., Attua, E. M. & Traore, S. B. (2015). Comparing farmers' perceptions of climate change and variability with historical climate data in the Upper East Region of Ghana *Ghana Journal of Geography* **7,** 47-74.

Anaglo, J. N., Boateng, S. D. & Boeteng, C. A. (2014). Gender and Access to Agricultural Resources by Smallholder Farmers in the Upper West Region of Ghana. *Journal of Education and Practice* **5**.

Andrew, D. J., Ngure, F. M., Pelto, G. & Young, S. L. (2013). What Are We Assessing When We Measure Food Security? A Compendium and Review of Current Metrics1. *Advanced Nutrition* **4,** 481-505.

Antwi-Agyei, P. (2012). *Vulnerability and adaptation to of Ghana's food production systems and rural livelihoods to climate variability.* University of Leeds

Arbuckle, J. G., Prokopy, L. S., Haigh, T., Hobbs, J., Knoot, T., Knutson, C., Loy, A., Mase, A. S., McGuire, J., Morton, L. W., Tyndall, J. & Widhalm, M. (2013). Climate change beliefs, concerns, and attitudes toward adaptation and mitigation among farmers in the Midwestern United States. *Climatic Change,* **117,** 943-950.

Arbuckle Jr, J. G., Morton, L. W. & Hobbs, J. (2013). Farmer beliefs and concerns about climate change and attitudes toward adaptation and mitigation: Evidence from Iowa. *Climatic Change,* **118,** 551-563.

Asante, W. A., Acheampong, E., Kyereh, E. & Kyereh, B. (2017). Farmers' perspectives on climate change manifestations in smallholder cocoa farms and shifts in cropping systems in the forest-savannah transitional zone of Ghana. *Land Use Policy,* **66,** 374-381.

Assan, J. K., Caminade, C. & Obeng, F. (2009). Environmental variability and vulnerable livelihoods: minimising risks and optimising opportunities for poverty alleviation. *Journal of International Development,* **21,** 403-418.

Ayanlade, A., Radeny, M. & Morton, J. F. (2017). Comparing smallholder farmers' perception of climate change with meteorological data: A case study from South-western Nigeria. *Weather and Climate Extremes,* **15,** 24-33.

Ball, R. & Pounder, L. (1996). Efficient but Poor Revisited. *Economic Development and Cultural Change* **44,** 735-760.

Bandura, A. (2001). Social Cognitive Theory: An agentic perspective *Annual Rev of Psychology,* **52**.

Banuoku, D. F., Tampulu, S. F., Guri, B. Y., Dakyaga, F., Jambabdu, L., Marshall, A., Derbile, E. K. & Gubbels, P. (2017). Analysis of rural livelihoods, farming systems and resilience *SAIRLA programme (Sustainable Agricultural Intensification Research and Learning in Africa).*

Benneh, G. (1988). Types of farm labour in Northern Ghana Research Review 4, 28-34.

Benning, R. B. (1990). *A History of Education in Northern Ghana 1909-1976,* Accra, Ghana University Press

Binswanger, H. P. & Sillers, D. A. (1983). Risk aversion and credit constraints in farmers' decision making: A re-interpretation. *Journal of Development Studies* **20,** 5–21.

Bhatti, A. U. & Khan, M. M. (2012). Review: Soil management in mitigating the adverse effects of climate change. *Soil Environmental* **31,** 1-10.

Birch, L. L. (1999). Development of Food Preferences *Annual Review of Nutrition* **19,** 41-62.

Boesveldt, S., Bobowski, N., McCrickerd, K., Maître, I., Sulmont-Rossé, C. & Forde, C. G. (2018). The changing role of the senses in food choice and food intake across the lifespan. *Food Quality and Preference,* **68,** 80-89.

Borges, J. A. R., Emvalomatis, G. & Laansinl, O. A. (2014). Adoption of Innovation in agriculture: a critical review of employed models *Working Paper.* Wageningen University

Borges, J. A. R. & Lansink, A. G. J. M. (2016). Identifying psychological factors that determine cattle farmers' intention to use improved natural grassland. *Journal of Environmental Psychology,* **45,** 89-96.

Brunstrom, J. M. (2014). Mind over platter: pre-meal planning and the control of meal size in humans. *Int J Obes (Lond),* **38 Suppl 1,** S9-12.

Bryant, C. R., Smit, B., Brklacich, M., Johnston, T., Smithers, J., Choitti, Q. & Singh, B. (2000). Adaptation in Canadian agriculture to climate variability and change *Climate Change,* **45,** 181-201.

Bryman, A. (2016). *Social Research Methods* Oxford University Press

Burgess, R. G. (1989). *Field research: a sourcebook and manual.* London and New York, Routledge

Burke, E. J., Brown, S. J. & CHRISTIDIS, N. (2006). Modelling the Recent Evolution of Global Drought and Projections for the Twenty-First Century with the Hadley Centre Climate Model. Journal of Hydrometeorology

Burke, M. B., Muguel, E., Satyanath, S., Dykema, J. A. & Lobell, D. B. (2009). Warming increases the risk of civil war in Africa. *Proceedings of the Academy of Sciences* **106,** 20670-20674.

Carter, T. R., Parry, M. L., Harasawa, H. & Nishioka, S. (1994). IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptations. London: University College London

Chan, D. K. & Fisbein, M. (1993). Determinants of college women's intentions to tell their partners to use condoms. *Journal of Applied Social Psychology,* **23,** 1455-1470.

Chanyanov, A. V. (1924). *The Theory of Peasant Economy. English Translator published in 1986,* USA, The University of Winsconsin Press.

Chin, H., Choong, W. W., Alwi, S. R. W. & Mohammed, M. A. H. B. (2016). Using Theory of Planned Behaviour to Explore Oil Palm Smallholder Planters' Intention to Supply Oil Palm Residues. *Journal of Cleaner Production*

Chipanshi, A. C., Chanda, R. & Totolo (2003). Vulnerability assessment of the maize and sorghum crops to climate change in Botswana. *Climatic change,* **61** 339–360.

Christensen, J. H., Hewistson, B., Busuioc, A., Chen, A., Gao X, H., I., Jones, R., Koli, R. K., Kwon, W. T., Laprise, R., V.M., R., Menendez, C. G., Raisanen, J., Rinke, A., Sarr, A. & Wheton, P. (2007). Regional climate projections. *In:* Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K. B., Tignor, M. & Miller, H. L. (eds.) *Climate change 2007: the physical science basis. Contribution of working group I to the fourth assessment report of the intergovernmental panel on climate change.* Cambridge University Press.

Clay, E. (2002). Food Security: Concepts and Measurement, paper for FAO Expert Consultation on Trade and Food Security: Conceptualising the Linkages *Trade Reforms and Food Security: Conceptualising the linkages.* Rome: FAO.

Codjoe, S. N. A. & Owusu, G. (2011). Climate change/variability and food systems: evidence from the Afram Plains, Ghana. *Regional Environmental Change,* **11,** 753-765.

Collins, J. M. (2011). Temperature variability over Africa. *Journal of Climate* **24,** 3649-36666.

Corbett, J. (1988). Famine and household coping strategies. *World Development*, **16** 1099-1112.

Corr, R. (2002). Reciprocity, communion, and sacrifice. Food in Andean ritual and social life. *Food and pathways*, **10,** 1-25.

Creswell, J. N. (2014). *Research Design: Qualitative, Quantitative and Mixed Methods Approaches* Thousand Oaks, CA: Sage

Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process*, Sage Publications.

Dake, K. (1991). Orienting Dispositions in the perception of risk- an anlysis of comtemporary worldviews and cultural biases. *Journal of Cros-cultural psychology* **22,** 61-82.

Dake, K. (1992). Myths of nature- culture and the social construction of risk. *Journal of social issues*, **48,** 21-37.

Denscombe, M. (2017). *The Good Research Guide for Small Research Projects* London, Open University Press.

Denzin, N. K. (1970). *The research act in Sociology: a theoretical introduction to social methods,* London, Butterworths.

Derkyi, M., Adiku, S. G. K., Nelson, V., Dovie, B. D., Codjoe, S. & Awuah, E. (2018). Smallholder farmers' perception of climatic and socio-economic factors influencing livelihoods in the transition zone of Ghana. *AAS Open Research*, **1**.

Devereux, S. (2001). Sen's Entitlement Approach: Critiques and Counter-critiques. *Development Studies* **29,** 254-263.

Diallo, I., Sylla, M. B., Giogi, F., gaye, A. T. & Camara, M. (2012). Multi-model GCM-RCM ensemble based projections of temperature and precipitation over West Africa for the early 21st Century. *International Journal of Geophysics*

Doggu, M. N. (2015). *Death and the hereafter among the Dagaaba of Northwestern Ghana: A critical reflection towards anthropological religious and philosophical studies.* PhD University of Ghana

Dohmen, T., Falk, A., Huffman, D., Marklein, F. & Sunde, U. (2009). Biased probability judgment:

Evidence of incidence and relationship to economic outcomes from a representative sample. *Journal of Economic Behavior & Organization,* **72,** 903-915.

Drewnowski, A. (1997). Taste Preference and Food Intake Annual Review Nutrition 17, 237-53.

Ellis, F. (1992). Household strategies and rural livelihood diversification. *Journal of Development Studies*, **48,** 21-37.

Elum, Z. A., Modise, D. M. & Marr, A. (2017). Farmer's perception of climate change and responsive strategies in three selected provinces of South Africa. *Climate Risk Management,* **16,** 246257.

EPA (2000). Climate change vulnerability and adaptation assessment of the agricultural sector of Ghana. *Final report* Accra Ministry of Environment Science and Technology

Ericksen, P. J., Thornton, P. K., Cramer, L., Jones, P. & Herrero, M. (2011). Mapping hotspots of climate change and food insecurity in the global tropics. [15th September 2016].

Falloon, P. D. & Betts, R. A. (2010). Climate impacts on European agriculture and water management in the context of adaptation and mitigation- the importance of an integrated approach *Sci. Total Environ* **408,** 5667-5687.

FAO (1996). Report of the world food summit Rome Food and Agriculture Organisation of the United Nations

FAO (2002). The state of food insecurity in the world 2001. Rome Food and Agriculture Organisation of the United Nations

FAO (2005). FAO STATISTICS Rome: Food and Agriculture Organisation of the United Nations

Ferrier, N. & Haque, C. E. (2003). Hazards risk assessment methodology for emergency managers: A standardized framework for application. *Natural hazards,* **28,** 271-290.

Fides, N. (1991). *Meat- a natural symbol* Routledge

Fieldhouse, P. (1986). Food and Nutrition: Customs and Culture Croom Helm.

Fieldhouse, P. (1996). Food and Nutrition: Customs and Culture Cheltenham Nelson Thomes Ltd.

Fieldhouse, P. (2002). *Food and Nutrition, Customs and Culture,* Cheltenham, Neslon Thornes Ltd.

Fielding, K. S., Terry, D. J., Masser, B. M. & Hogg, M. A. (2008). Integrating social identity theory and the theory of planned behaviour to explain decisions to engage in sustainable agricultural practices. *Br Journal of Social Psychology* 23-48.

Fisbein, M. & Ajzen, I. (1975). Belief, attitude, intention and behaviour: An introduction to theory and research. Reading

Fleuret, A. (1986). Indigenous Responses to Drought in Sub-Saharan Africa. *Disasters* **10,** 224-227.

Forde, C. G., Leong, C., Chia-Ming, E. & McCrickerd, K. (2017). Fast or slow-foods? Describing natural variations in oral processing characteristics across a wide range of Asian foods. *Food Funct,* **8,** 595-606.

Fountaine, B., Roucou, P. & Monerie, R. A. (2011). Changes in African Monsoon region at medium -term horizon using 12 AR4 coupled models under the A1b emission scenario. *Atmospheric Science Lett,* **12,** 83-89.

Friss-Hansen, E. (1995). Seeds for African Peasants: Peasants' Needs and Agricultural Research–the Case of Zimbabwe. Uppsala, Sweden: The Nordic Africa Institute

Gandure, S., Walker, S. & Botha, J. J. (2013). Farmers' perceptions of adaptation to climate change and water stress in a South African rural community. *Environmental Development,* **5,** 39-53.

Garcia-Bailo, B., Toguri, C., Eny, K. M. & El-Sohemy, A. (2009). Genetic variation in taste and its influence on food selection. *OMICS,* **13,** 69-80.

Gibbs, G. R. (2002). *Qualitative analysis: explorations with NviVo,* Buckingham, England Oppen University Press.

Gilbert, N. (2008). Researching Social Life 3ed. London: Sage.

Gitau, R., Makasa, M., Kasonka, M., Sinkala, L., Chintu, M., Tomkins, A. & Fileau, S. (2005). Maternal micronutrient status and decreased growth of Zambian infants born during and after the maize price increases resulting from the Southern African drought of 2001-2002. *Public Health Nutrition* **8,** 837-843.

Gliessman, S. R. (2007). The Ecology of Sustainable Food Systems. Boca Raton, Florida CRC press.

GMET (2016). Statistics on missing and available data from stations in the Upper West Region Accra Ghana Meteorological Agency

Goldberg, G. (2003). Plants: Diet and Health. The Report of the British Nutrition Foundation Task Force. Blackwell Oxford

Gray, D. E. (2014). *Doing research in a real world,* London Sage

Gregory, P. J., Ingram, J. S. & Brklacich, M. (2005). Climate change and food security. *Philos Trans R Soc Lond B Biol Sci,* **360,** 2139-2148.

Gross, R., H. Schoeneberger, Pfeifer, H. & Preuss, H. J. A. (2000). *The four dimensions of food and nutrition security: Definitions and concepts,* Internationale Weiterbildung und Entwicklung gGmbH (InWent) and FAO.

GSS (2014). 2010 Population and Housing Census *District Analytical Report, Jirapa District.* Accra, Ghana.

Habiba, U., Shaw, R. & Takeuchi, Y. (2012). Farmer's perception and adaptation practices to cope with drought: Perspectives from Northwestern Bangladesh. *International Journal of Disaster Risk Reduction,* **1,** 72-84.

Hansen, J., Marx, S. & Weber, E. (2004). The Role of Climate Perceptions, Expectations, and Forecast in Decision Making. *The Argentines Pampas and South Florida.* USA: The Earth Institute at Columbia University

Harris, M. (1987). Foodways: Historical Overview and Theoretical Prolegomenon. *Food and Evolution: Toward a Theory of Human Food Habits*

Hassan, M. N. & Stern, R. D. (1988). A Simple Method for Analysing Daily Rainfall Data-A Case Study for Kota Bharu *Pertanika* **11,** 101-106.

Hawtin, M. & Percy-Smith, J. (2007). *Community Profiling: a practical guide,* McGraw Hill, Open University Press.

Hoggart, L., L. & Davies, A. (2002). *Researching Human Geography,* London Oxford University press.

Horsefield, G. D. (2016). *Investigating the Factors that lead to the Construction of Gendered Perceptions of Climate variability and Change of Communal Framers in Agro-ecological Zones II and III of Zimbabwe.* PhD University of Reading

Howitt, D. (2016). *Introduction to qualitative methods in psychology,* Harlow, England, Pearson.

Hulme, M., Adger, N., Dessai, S., Lorenzoni, I., Naess, L. O. & Wreford, A. (2007). Limits and barriers to adaptation: four propositions. *Working Paper*. .

Hulme, M., Doherty, R., Ngara, T., New, M. & Lister, D. (2001). African Climate Change: 1900-2100. *Climate Research* **17,** 145-168.

Ingram, J. S. I., Roncoli, M. & Kirshen, P. (2002). Opportunities and constraints for farmers of West Africa to use seasonal precipitation forecasts with Burkina Faso as a case study. *Agricultural Systems,* **74,** 331-349.

IPCC (2007). Climate change 2007: impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

IPCC (2014). Climate Change 2014 : Synthesis Report. . *In:* Pachani, R. K. & Meyer, L. A. (eds.) *Contribution of Working groups I, II and III to the fifth Assessment Report of the Intergovernmental Panle on Climate Change*

Issahaku, A. Z. & Maharjan, L. K. (2014). Crop substitution behaviour among food crop farmers in Ghana: an efficient adaptation to climate change or costly stagnation in traditional agricultural production system? *Agricultural and Food Economics,* **2**.

James, R. & Washingston, R. (2013). Changes in African Temperature and Precipitation associated with degrees of global warming *Climate Change,* **117,** 859-872.

Jones, L. & Boyd, E. (2011). Exploring social barriers to adaptation: Insights from Western Nepal. *Global Environmental Change,* **21,** 1262-1274.

Jost, C., Kyazze, F., Naab, J., Neelormi, S., Kinyangi, J., Zougmore, R., Aggarwal, P., Bhatta, G., Chaudhury, M., Tapio-Bistrom, M., Nelson, S. & Kristjanson, P. (2016). Understanding gender dimensions of agriculture and climate change in smallholder farming communities. Climate and Development, 8, 133-144.

Joshi, M., Hawkins, E., Sutton, R., Lowe, J. & Frame, D. (2011). Projections of when temperature change will exceed 2^0C above pre-industrial levels *Nature Climate Channge* **1,** 407-412.

Jung, G. & Kunstmann, H. (2007). High-resolution regional climate modelling for the Volta region of West Africa. *Journal of Geophysical Research,* **112**.

Kamruzzaman, M. (2015). Farmers' Perceptions on Climate Change: A Step toward

Climate Change Adaptation in Sylhet Hilly Region. *Universal Journal of Agricultural Research,* **3** 53-58.

Keating, A. (2010). Food Security in Australia- the logistics of vulnerability. Melbourne RMIT University

Kemp, P. R., Cornelius, J. M. & Reynolds, J. F. (1994). Temporal discontinuities in precipitation in the central North American prairie. *International Journal of Climatology*

Knox, J., Hess, T., Daccache, A. & Wheeler, T. (2012). Climate change impacts on crop productivity in Africa and South Asia. *Environmental Research Letters,* **7**.

Kolleh, J. B. & Jones, M. T. (2015). Rice farmers' perception of climate change and adaptation strategies in the Ketu North District of the Volta Region of Ghana. *African Journal of Agricultural Research* **13,** 782-791.

Kruger, R. A. (1998). *Focus Groups: A practical guide for applied research,* Newbury Park, CA Sage. Kumar, R. (2011). *Research Methodology a step-by-step guide for beginners,* London Sage

Kumar, T. T. (1988). History of rice in India, Delhi, Gian Publishing House.

Kulamarva, A. G., Sosle, V. R. & Raghavan, V. G. S. (2009). Nutritional and rheological properties of sorghum. *International journal of food properties,* **12,** 55-59.

Kulp, K. & Ponte, J. G. (2000). *Handbook of Cereal Science and Technology,* New York., Marcel Dekker

Kurukulasuriya, P. (2008). A Ricardian analysis of the impact of climate change on African cropland *Afjare* **2**.

Kurukulasuriya, P. & Mendelsohn, R. (2007). A Ricardian Analysis of the Impact of Climate Change on African Cropland. *Policy Research Working Paper; No. 4305.* Washingston World Bank

Kusakari, Y., Asubonteng, K. O., Jasaw, G. S. & Dayuor, F. (2018). Farmer - perceived effects of climate change on livelihoods in Wa West District, Upper West Region of Ghana *Journal of Disaster Research* **9,** 516-528.

Ladislaus, C. B., Yanda, P. Z. & Ngana, J. (2010). Indigenous knowledge in seasonal rainfall prediction in Tanzania: a case of the South-western Highland of Tanzania. *Journal of Geography and Regional Planning* **3,** 66-72.

Laube, W., Schraven, B. & Awo, M. (2012). Smallholder adaptation to climate change: dynamics and limits in northern Ghana. *Climate Change* **111,** 753-774.

Leach, M., Mearns, R. & Scoones, I. (1999). Environmental Entitlements: Dynamics and Institutions in Community-Based Natural Resource Management. *World Development* **27** 225-247.

Li, Y. & Yan, X. (2009). Climate change and drought: A risk assessment of crop-yield impacts. Climate Research

Li, S., Juhasz-Horvath, L., Harrison, P. A., Pinter, L. & Rounsevell, M. D. A. (2017). Relating farmer's perceptions of climate change risk to adaptation behaviour in Hungary. *J Environ Manage,* **185,** 21-30.

Limantol, A. M., Keith, B. E., Azabre, B. A. & Lennartz, B. (2016). Farmers' perception and adaptation practice to climate variability and change: a case study of the Vea catchment in Ghana. *Springerplus,* **5,** 830.

Lipton, M. (1968). The Theory of the Optimising Peasant. *Journal of development Studies* **4,** 327-351.

Lobell, D. B., Burke, M. B., Tebaldi, C., Mastrandrea, M. D., Falcon, W. P. & Naylor, R. L. (2008). Prioritising climate change adaptation needs for security in 2030. *Science* **319,** 607-610.

Maddison, D. (2007). The Perception of and Adaptation to Climate Change in Africa *Policy Research Working Paper*

Mahon, R. (2002). Adaptation of fisheries and fishing communities to the impacts of climate change in the CARICOM region. *Mainstreaming Adaptation to Climate*

Change (MACC) of the Caribbean Center for Climate Change (CCCC). Washington, D.C: Organization of American States.

Mamba, S. F. (2016). Factors Influencing Perception of Climate Variability and Chnage among Smallholder Farmers in Swaziland *Indian Journal of Nutrition* **3**.

Marshall, M. N. (1996). The Key informant technique. *Family Practice***,** 92-97.

May, T. (2011). *Social Research: Issues, Methods and Process,* Maidenhead, Berskshire Open University Press

McCrickerd, K., Lim, C. M., Leong, C., Chia, E. M. & Forde, C. G. (2017). Texture-Based Differences in Eating Rate Reduce the Impact of Increased Energy Density and Large Portions on Meal Size in Adults. *J Nutr,* **147,** 1208-1217.

Mckevith, B. (2004). Nutritional aspects of cereals. Briefing Paper. *British Nutrition Foundation Bulletin,* **29,** 111-142.

Meehl, G., Stocker, T., Collins, W. D., Friedlingstein, P., Gaye, A. T., Gregory, J. M., Kitoh, A., Knutti, R., Murphy, J. M., Noda, A., Raper, S. C. B., Watterson, I. G., Weaver, A. J. & Zhao, Z. (2007). Global climate projections climate change 2007: The physical science basis. The Physical Science Basis.

Mela, D. (1999). Food choice and intake: the human factor. *Proceedings of the Nutrition Society,* **58,** 513-521.

Menapace, L., Colson, G. & Raffaelli, R. (2015). Climate change beliefs and perceptions of agricultural risks: An application of the exchangeability method. *Global Environmental Change,* **35,** 70-81.

Mendola, M. (2005). Farm household production theories: A review of institutional and behavioral responses. *Asian Development Review,* **24,** 49–68.

Mertens, D. M. (2010). *Research and Evaluation in Education and Psychology: Integrating Diversity with Quantitative, Qualitative, and Mixed Methods,* SAGE Publications.

Mette Vabo, H. H. (2014). The Relationship between Food Preferences and Food Choice: A Theoretical Discussion. *International Journal of Business and Social Science* **5**

Minia, Z. (2004). Climate scenarios developed for climate change impacts assessment in Ghana. *The Netherlands Climate Change Studies Assistance Programme (NCCSAP) Phase 2-Part 1.* Environmental Protection Agency.

Minia, Z. (2008). Climate change scenario development *In:* Agyemang-Bonsu, W. K. (ed.) *Ghana Climate Change Impacts, Vulnerability and Adaptation Assessments.* Accra: Environmental Protection Agency.

MoFA (2011). Agriculture in Ghana Facts and Figures 2010. Accra Statistics, Research and Information Directorate

Monerie, R. A., Foutine, B. & Roucou, P. (2012). Expected future changes in African monsoon between 2030 and 2070 using some CMIP 3 and CMIP5 models under a medium-low RCP scenario. *Journal of Geophysics***,** 1984-2012.

Morton, J. F. (2007). The impact of climate change on smallholder and subsistence agriculture. *Natl Acad Sci* **104** 19680-19685.

Moscardi, E. & de Janvey, A. (1977). Attitudes toward risk among peasants: An econometric approach. *American Journal of Agricultural Economics,* **59,** 710-716.

Moser, S. C. & Ekstrom, J. A. (2010). A framework to diagnose barriers to climate change adaptation.

Proceedings of the National Academy of Sciences, **107,** 22026-22031.

Moyo, M., Mvum, B. M., Kunzekweguta, M., Mazvimavi, K. & Craufurd, P. (2012). Farmer Perceptions of Climate Change and Variability in Semi-arid Zimbabwe in relation to Climatology Evidence *African Crop Science Journal* **20,** 317-335.

Mubaya, C. P., Njuki, J., Mutsvangwa, E. P., Mugabe, F. T. & Nanja, D. (2012). Climate variability and change or multiple stressors? Farmer perceptions regarding threats to livelihoods in Zimbabwe and Zambia. *Journal of Environmental Management,* **102,** 9-17.

Muro, M. & Jeffrey, P. (2008). A critical review of the theory and application of social learning in participatory natural resource management processes. *Journal of Envirnmental Planning and Management* **51,** 325-344.

Musyoka, J. K. (2009). Investigating the Start of Rains by Exploring Daily Rainfall Data from Makindu. Reading Statistics for Applied Climatology (e-SIAC) SSC, University of Reading.

Naab, J. B. & Koranteng, H. (2012). Gender and climate Change Research Results: Jirapa, Ghana .Working Paper No. 17. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Nairobi Kenya

Nearing, M., Pruski, F. & O'neal, M. (2004). Expected climate change impacts on soil erosion rates: a review. *Journal of Soil and Water Conservation,* **59,** 43-50.

New, B. H., David, B. S., Alois, T., Andries, K., Atanasio, M., Bernard, G., Caio, A. S. C., Dorcas, N., Masisi, E. K., Ernest, M., Francis, A., Hemed, S. J., K., A., J., Ebohang, B., Lubega, F., Marshall, L. M. & Robert, L. (2006). Evidence of trends in daily climate extremes over southern and West Africa. Journal of Geophysical Research 111.

Nguyen, T., Mula, L., Cortignani, R., Seddaiu, G., Dono, G., Virdis, S., Pasqui, M. & Roggero, P. (2016). Perceptions of Present and Future Climate Change Impacts on Water Availability for Agricultural Systems in the Western Mediterranean Region. *Water,* **8,** 523.

Nicholsen, S. E. (2001). Climatic and environmental change in Africa during the last two centuries. *Climate Research,* **17,** 123-144.

Nicholls, R. J. & Tol, R. S. T. (2006). Impacts and responses to sea-level rise: Aglobal analysis of the SRES scenarios over the 21st Century. Philos. T. Roy.Soc. A, 364, 1073-1095.

Nielsen, J. O. & Reenberg, A. (2010). Cultural barriers to climate change adaptation: a case study from Northern Burkina Faso. *Global Environmental Change,* **20,** 142-152.

Noack, A. & Pouw, R. M. N. (2014). A blind spot in food and nutrition security: where culture and social change shape the local food plate. *Agricultural Human Values*

Ofori-Sarpong, E. (2001). Impact of climate change on agriculture and farmers cropping strategies in the Upper East region of Ghana. *West African Journal of Applied Ecology,* **2,** 21-35.

Okumus, F. & Altinay, L. (2007). Gaining Access for Research: reflections from experiences. *Annals of Tourism Research***,** 293-316.

Osbahr, H., Dorward, P., Stern, R. & Cooper, S. (2011). Supporting Agricultural Innovation in Uganda to Respond to Climate Risk: Linking Climate Change and Variability with Farmer Perceptions. *Experimental Agriculture,* **47,** 293-316.

Osbahr, H., Twyman, C., Adger, N. & Thomas, D. S. G. (2008). Effective livelihood adaptation to climate change disturbance: scale dimensions of practice in Mozambique *Geoforum,* **39,** 1951-1964.

Ovuka, M. & Lindqvist, S. (2000). Rainfall variability in Murang'a District, Kenya: Meteorological data and farmers' perception. *Geografiska Annaler: Series A, Physical Geography,* **82,** 107-119.

Pahl-Wostle, C., Craps, M., Dewulf, A., Mostert, E., Tabara, D. & Tallieu, T. (2007). Social learning and water resources management. *Ecology and Society* **12**.

Parry, M., Rosenzweig, C., Iglesias, A., Fischer, G. & Livermore, M. (1998). Climate change and world food security: a new assessment. *Environmental Change,* **9,** 51-67.

Patt, A. & Schroter, D. (2008). Perceptions of climate risk in Mozambique: Implications for the success of adaptation strategies. *Global Environmental Change,* **18,** 458-467.

Parfitt (2005). Questionnaire design and sampling *In:* Flowerdew, R. & Martin, D. (eds.) *Methods in human geography: a guide for students doing a research project.* 2nd edition ed. Abingdon Routlegde

Perry, A. H. & Symnans, L. J. (1994). The wind hazard in the British Isles and its effects on transportation. *Journal of Transboundary Geography* **2,** 122-130.

Pielke, R., Prins, G., Rayner, S. & Sarewitz, D. (2007). Climate change 2007: lifting the taboo on adaptation. *Nature,* **445,** 597-598.

Pilgrim, F. J. (1961). What foods do people accept or reject? J. Am. Dietet. Asso, 38, 439-443.

Porter, J. R. & Semenov, M. A. (2005). Crop responses to climatic variation. *Philosophical Transactions of the Royal Society,* **360,** 2021-2035.

Ritchie, J., Lewis, J., Nicholas, C. M. & Ormston, R. (2014). *Qualitative Research Practice a guide for social science students and researchers* London Sage

Rist, S., Chidambaranathan, M., Escobar, C., Wiesmann, U. & Zimmermann, A. (2007). Moving from sustainable management to sustainable governance of natural resources: The role of social learning processes in rural India, Bolivia and Mali. *Journal of Rural Studies,* **23,** 23-37.

Roe, E. (1999). *Except-Africa: Remaking Development, Rethinking Power.,* New Brunswick NJ, Transaction Publishers.

Roncoli, C., Orlove, S. B., Kabugo, M. R. & Waisw, M. W. (2011). Cultural styles of participation in farmers' discussions of seasonal climate forecasts in Uganda. *Agric Human Values* **28,** 123138.

Rowell, D. P. (2012). Sources of uncertainty in future changes in local precipitation. *Climate Dynamics,* **39,** 1929-1950.

Rozin, P. (2006). *The Psychology of Food Choice* Guilford

Rozin, P. (2015). Food Preferences, Psychology and Physiology of. 296-299.

Rozin, P. & Vollmecke, T. A. (1986). Food Likes and Dislikes *Annual Rev. Nutr.* , **6,** 433-456.

Russel, H. B. (2011). *Research Methods in Anthropology: Qualitative and Quantitative Approaches* Plymouth, UK, Altamira.

Sahlins, M. (1978). *Culture and Practical Reason* Chicago University of Chicago Press.

Sanderson, M. G., Hemming, D. L. & Betts, R. A. (2011). Regional Temperature and precipitation changes under warming. *Philosophical transactions of the Royal Society A,* **369,** 85-98.

Sarantakos, S. (2013). *Social Research,* Basingstoke, Palgrave Macmillan.

Sauer, J. & Mendoza-Escalnate, A. (2007). Poor but allocative efficient - Evidence from the Eastern Amazon. *Agricultural Economics* **37,** 113-126.

Sen, A. (1981). *Poverty and Famines: An Essay on Entitlement and Deprivation* Oxford Clarendon Press

Schefer, M., Carpenter, S., Foley, J. A., Folke, C. & Walker, B. (2001). Catastrophic shifts in ecosystems. *Nature* **413,** 591-596.

Schmidhuber, J. & Tubiello, N. F. (2007). Global food security under climate change. *PNAS December 11,* **104,** 19703-19708.

Schultz, T. W. (1964). Transforming Traditional Agriculture. New Haven, USA: Yale University

Scoville-Simonds, M. (2018). Climate, the Earth, and God – Entangled narratives of cultural and climatic change in the Peruvian Andes. *World Development,* **110,** 345-359.

Scrinis, G. (2013). *Nutritionism: The science and Politics of Dietary Advice* New York Columbia University Press.

Senger, I., Borges, J. A. & Machado, J. A. D. (2017). Using the theory of planned behaviour to understand the intention of small farmers in diversifying their agricultural production. *Journal of Rural Studies,* **49,** 32-40.

Seo, S. N. & Mendelsohn, R. (2008). Measuring impacts and adaptations to climate change: a structural Ricardian mode of African livestock management *Agricultural economics* **38,** 151165.

Singh, C., Osbahr, H. & Dorward, P. (2018). The implications of rural perceptions of water scarcity on differential adaptation behaviour in Rajasthan, India. *Regional Environmental Change*

Slegers, M. F. W. (2008). "If only it would rain": Farmers' perceptions of rainfall and drought in semiarid central Tanzania. *Journal of Arid Environments,* **72,** 2106-2123.

Smith, B., Burton, I., Klien, R. J. T. & Wandel, J. (2000). An anatomy of adaptation to climate change and variability *Climate Change* **45,** 223-225.

Smith, M. L. (2006). The Archaeology of Food Preference. *The American Anthropologist* **108,** 480-493.

Smithers, J. & Smit, B. (1996). Agricultural system response to environmental stress. *In:* Libery, B. Q., .C (ed.) *Agricultural Restructuring and Sustainability: A geographical perspective.* Wallingford CAB International

Songsore, J. (1992). The ERP/Structural Adjustment Programmes: their likely impacts on the 'distant' rural poor in Northern Ghana. *In:* Ernest, A. (ed.) *Planning African Growth and Development, some current issues* Accra: ISSER/UNDP.

Songsore, J. & Denkabe, A. (1995). Challenging Rural Poverty in Northern Ghana: the case of the Upper West Region. Centre for Environment and Development, University of Trondhiem.

Staatz, J. M. (1990). Food security and agricultural policy. *paper presented to the Agric-Nutrition workshop sponsored by USAID.* Arlington.

Stakhiv, E. (1993). Evaluation of IPCC Adaptation Strategies .*Fort Belvoir.* Virginia: Institute for Water Resources

Stern, R. & Cooper, P. (2011). Assessing Climate Risk and Climate Change Using Rainfall Data: A case study from Zambia. *Experimental Agriculture,* **47,** 241.

Stern, R., Rijks, D., Dale, l. & Knock, J. (2006). *Instat Climatic Guide*, University of Reading Statistical Services Centre.

Stiglitz, J. (1989). Markets, Market Failures, and Development *American Economic Review* **79,** 197203.

Sullivan, S. A. & Birch, L. L. (1990). Pass the sugar, pass the salt: experience dictates preference. *Development psychology* **26,** 546-551.

Sutton, I. B. (1989). Colonial Agricultural Policy: the non-development of the northern territories of Ghana. *International Journal of Historical Studies* **22,** 637-369.

Tambo, J. A. & Abdoulaye, T. (2012). Smallholder farmers' perceptions of and adaptations to climate change in the Nigerian savanna. *Regional Environmental Change,* **13,** 375-388.

Taylor, J. G., Stewart, R. T. & Downton, M. (1988). Perceptions of Drought in the Ogallala Aquifer region *Environment and Behaviour* **20,** 150-175.

Terry, D. J. & Hogg, M. A. (1996). Group norms and the attitude behaviour relationship: a role for group identification *Personality and Social Psychology Bulletin* **22,** 776-793.

Terry, D. J., Hogg, M. A. & White, K. M. (1999). The theory of planned behaviour: self-identity, social identity and group norms. *The British Journal of Social Psychology,* **38,** 225-244.

Thomas, D. S. G., Twyman, C., Osbahr, H. & Hewitson, B. (2007). Adaptation to climate change and variability: farmer responses to intra-seasonal precipitation trends in South Africa. *Climatic Change,* **83,** 301-322.

Thornton, P. K., Jones, P. G., Ericksen, P. J. & Challinor, A. J. (2011). Agriculture and food systems in Sub-Saharan Africa in a 4 C+ world. *Philosophical transactions of the Royal Society,* **369** 117136.

Torpoco, E. A. (1997). Why We Eat What We Eat: Explanations for Hyman Food Preferences and Implications for Government Regulation. *Third Year Paper*

Trefrey, A., Parkins, J. R. & Cundill, G. (2014). Culture and Food Security: A case study of homestead food production in South Africa. *Food Security* **6,** 555-565.

Turner, J. C. (1982). Towards a cognitive redefinition of the social group. *In:* Tagfel, H. (ed.) *Socialidentity and intergroup relations.* Cambridge Cambridge University Press.

Tyler, S., Keller, M., Swanson, D., Bizikova, L., Hammill, A. & Zamudio, A. N. (2013). Climate resilience and food security: A framework for planning and monitoring. Winnepeg: The International Institute for Sustainable Development.

Umar, B. B. (2013). A critical review and re-assessment of theories of smallholder decision making: A case of conservation agriculture households, Zambia. *Renewal Agriculture and Food Systems,* **29,** 277-290.

USDA (2011). Ghana Climate Change Vulnerability and Adaptation Assessment. Washington DC: USAID Ghana.

Van der Geest, K. (2004). *We're Managing! Climate Change and Livelihood Vulnerability in Northwest Ghana*, African Studies Centre.

Van Maanen, J. & Knolb, D. (1985). The professional Apprentice! Observations on fieldwork role into organisation settings. *Research in Sociology of Organisation* 1-3.

Vaus, D. (2014). *Surveys in Social Research*, Abingdon, Routledge

Vereecken, C., Rovner, A. & Maes, L. (2010). Associations of parenting styles, parental feeding practices and child characteristics with young children's fruit and vegetable consumption *Appetite* **55**.

Walliman, N. (2005). *Your Research Project* London Sage.

Wasserman, J. & Jeffrey, C. (2007). Accessing distrustful populations: lesson from ethnographic research with street homeless. *Paper presented at annual meeting of the African Sociological association.* New York.

Wansink, B., Cheney, M. & Chan, N. (2003). Exploring comfort food preferences across age and gender1. *Physiology & Behaviour*, **79,** 739-747.

Weber, E. U. (2010). What shapes perceptions of climate change? *Wiley Interdisciplinary Reviews: Climate Change,* **1,** 332-342.

WFP (2013). Comprehensive Food Security and Vulnerability Analysis *Ghana 2012 Focus on Northern Ghana.* Rome. The World Food Programme of the United Nations

Wheeler, T. R., Craufurd, P. Q., Ellis, R. H., Porter, J. R. & Vara Prasad, P. V. (2000). Temperature variability and the yield of annual crops. *Agriculture, Ecosystems & Environment,* **82** 159-167.

White, K. M., Terry, D. J. & Hogg, M. A. (1994). Safe sex behaviour: the role of attitudes, norms, and control factors. *Journal of Applied Social Psychology,* **24,** 2164-2192.

Wineman, A. & Crawford, E. (2014). Climate change and crop choice in Zambia. *Selected Paper prepared for presentation at the Agriculture and Applied Economics Association's 2014 AAEA Annual Meeting* Minneapolis

Wlokas, H. L. (2008). The impacts of climate change on food security and health in Southern Africa. *Journal of Energy South Africa,* **19,** 12-20.

Woma, B. (2012). *The Socio-political dimension of Dagara funeral ritual music and dirge.* MA, Indiana University

Yaro, J. A. (2013). The perception of and adaptation to climate variability/change in Ghana by smallscale and commercial farmers. *Regional Environmental Change,* **13,** 1259-1272.

Yaro, J. A. (2006). Is deagrarianisation real? A study of livelihood activities in rural northern Ghana. . *Journal of Modern African Studies,* **44,** 125-156.

Yengoh, G. T., Armah, A. F., Onumah, E. E. & Odoi, J. O. (2010). Trends in Agriculturally-Relevant Rainfall Characteristics for Small-Scale Agriculture in Northern Ghana. *Journal of Agricultural Science* **2**.

Yin, R. K. (2014). *Case Study Research: Design and Methods*, London, Sage

Zeweld, W., Huylenbroeck, G., Tesfay, G. & Speelman, S. (2017). Smallholder farmers' behavioural intentions towards sustainable agricultural practices. *Journal of Envionmental Management* **187,** 71-81.

Ziervogel, G. & Ericksen, P. J. (2014). Adapting to climate change to sustain food security. *Climate Change*