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INHERITANCE PATTERNS, LAND TENURE ARRANGEMENTS AND THE GENDERED ADAPTATION OF SMALLHOLDER FARMERS TO CLIMATE VARIABILITY IMPACTS: A CASE OF TWO ECOLOGICAL ZONES OF GHANA

BY

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DECLARATION

I, Alexander Nii Adjei Sowah, do hereby declare that with the exception of references to other people's work, which have been duly acknowledged, this thesis is the result of my own research carried out at the Institute of Statistical Social and Economic Research (ISSER), University of Ghana. This work has never been presented either in whole or in part for the award of any academic degree in this University or any other institution.

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We the undersigned supervisors certify that this is an original work we supervised the candidate to produce. We are convinced that this thesis meets the required standards set by the University of Ghana for the award of a Doctor of Philosophy Degree.

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ABSTRACT

Effects of climate variability continue to grow globally with extreme impacts in Sub-Saharan Africa where a combination of atmospheric, geographic features, poorly developed infrastructure and lack of appropriate technologies heighten the sensitivities and exposures of individuals and groups. The impacts of climate variability are not limited to living conditions but also the production of food by the largely agrarian population of the sub-continent. Scholars have noted that the largely rainfall dependent agriculture in the region will be mostly affected. Significant reduction in outputs of important staple crops such as maize are noted as evidence. The burdens of yield reduction and the attendant decrease in income for the provision of household needs are especially felt by smallholder farmers who are at greater risk of exposure due to the limited and constrained access to productive resources and adaptive options. It is noteworthy that, the risk of exposure and actual exposure tend to be gendered, resources for adaptation are therefore explored not only to address general household need but also specific gendered needs. The limitations and unequal access to both productive and adaptive resources are founded within contextual architecture of entitlements. The rules and norms on entitlement define the limits of access and control of resources such as land and other common use resources. Combining qualitative and quantitative research approaches, this thesis examined how norms on inheritance and land use arrangements influence adaptation to climate variability/change impacts of smallholder households. Also, the thesis investigated how the differences in adaptive options affect vulnerabilities to climate variability impacts. The study was conducted in two ecological zones of Ghana, the Bawku West district in the Savanna zone and the Nkoranza municipal in the Transitional zone. Four (4) communities were selected from each district making a total of eight (8) communities through a three-stage sampling

approach. Primary and secondary data were relied upon for the study. Rainfall data from1983-2018 was collected from the Ghana Meteorological Agency (GMet) to analyze the nature and extend of variability over time. Primary sources of data include household survey, focus group discussions, key informants and in-depth interviews. The household survey was conducted in a total of 798 households across the eight study communities. In each community, focus group discussions were held separately for men and women to facilitate an unencumbered expression of views and opinions on the dynamics of inheritance and its application. Additionally, in-depth and key informant interviews were conducted with family heads, community leaders and district assembly officials. The study found that there exists significant variability in rainfall data analysed over the past 30 years with impacts on the amount of average monthly rainfall during peak farming periods. Rainfall amounts have consistently reduced over the years and have become erratic and unpredictable. The changes have resulted in the disruption of planning and planting leading to losses and increased production cost. The poor rains have resulted in long dry spells and droughts facilitating pest growth and infestations. The fall armyworm was identified as a key challenge to the production of maize. Again, the gendered differentiated access to land and other resources due to inheritance practices especially patrilineal inheritance in Bawku West deepens the exposure and sensitivity of female-headed households to climate variability impacts. The need to enhance adaptive capacities was therefore highlighted by the study. This was found to influence the high intensities and severity of multi-dimensional livelihood vulnerability across all households surveyed. Based on the findings, it is important for education to be enhanced on the collective disadvantages of unequal inheritance and land use practices at community levels to improve access to and control of adaptive resources for effective adaptation to climate variability impacts.

DEDICATION

I dedicate this thesis to my life partner and the love of my life, Abena Kyere and my boys, Nii Adjetey Kwabena Kyere Sowah and Ataa Tei Mensah Kyere Sowah. They all conspired to ensure I never gave up.

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CHAPTER ONE

INTRODUCTION AND BACKGROUND

1.1 Introduction

The 21st century has witnessed rapid changes in climatic conditions. These changes pose significant threats to lives and properties globally (IPCC, 2007). The changes in global climatic conditions are largely influenced by dynamic interaction between atmospheric, oceanic, cryospheric as well as terrestrial and marine biospheres (Githeko *et al*., 2000; Chakraborty *et al*., 2000). Additionally, scientists have asserted that the observed changes in atmospheric composition are for a large part due to the increasing concentrations of greenhouse gases (carbon dioxide, methane and nitrous oxide), changes in land cover, land use and agricultural activities (IPCC, 2007; Collier *et al*., 2008; Yanda and Mubaya, 2011; Omambia *et al*., 2010). Though several scholars have confirmed the foregoing, there still exist disagreements on the primal causes of the observed changes. That is, whether climate change is induced by anthropogenic activities or as a result of natural climatic variability. These debates notwithstanding, the balance of scientific opinion is that changes in the composition of the atmosphere are accounted for largely by human activities resulting in significant shifts in global temperatures (IPCC, 2001; 2007; 2014).

The Intergovernmental Panel on Climate Chance report (2014) argues that, the total anthropogenic greenhouse gases (GHG) emissions have continued to increase from 1970 to 2010, with the highest amount falling between 2000 and 2010. The changes observed over the period are projected to result in extreme conditions in weather patterns with livelihood implications. Generally, the effects of climate change are projected to have enormous and devastating global consequences with the most adverse

impacts predicted to occur in developing countries especially in Sub-Saharan Africa (Serdeczny *et al,* 2017; IPCC, 2014; Niang *et al*, 2014). The greater susceptibility of countries in Sub-Saharan Africa to the effects and impacts of climate change and variability is due to a number of factors. These factors include, heavy dependence on climate sensitive activities such as rain-fed agriculture usually undertaken by smallholder farmers and the undeveloped nature of infrastructure to cope with and adapt to changing climatic conditions. Additionally, the geographic location of the region has been identified as one of the factors heightening its exposure to flood and rising temperatures (Serdeczny *et al*, 2017; IPCC, 2014; Omambia and Gu, 2010; Stern, 2007; IPCC, 2007).

Indeed, scholars such as Collier *et al*., (2008); Rosenzweig *et al*., (2001); Haile (2005); Stringer *et al*., (2009) have stressed that the combined effects of four major drivers namely, the Inter-Tropical Convergence Zone (ITCZ), the El Nino-Southern Oscillation (ENSO), circulation patterns in the Indian Ocean as well as the West African Monsoon determine the annual seasonality and variability of rainfall and temperature across the African continent. The rising temperatures therefore affect the natural interactions of these drivers, causing droughts, floods, heat waves, windstorms and other extreme weather events in Africa (Collier *et al.*, 2008; Nordhaus, 2007). The overall temperature in the entire African continent increased by approximately 0.5^0C or more during the 20^{th} century (Mohamed, 2011; Stern et al., 2011; Funk *et al*., 2012; Nicholson *et al.*, 2013). The general circulation models project an increase in warming across the continent, ranging from 0.2^OC per decade (low scenario) to more than 0.5^OC per decade (high scenario), (Hulme *et al*., 2001; Sivakumar *et al*., 2005; IPCC, 2007).

Consequently, Sub-Saharan Africa particularly West Africa and other Sahelian regions for example are projected to experience severe impacts on agricultural productivity

with severe risk to food security due to projected drop in the yields of maize and other staples of about 20% to 50% (Serdeczny *et al*, 2017; Niang *et al*., 2014; Rosenzweig, 2014). The erratic and unpredictable weather conditions are projected to worsen with extreme floods and droughts. Thus, multiple threats to economic growth and poverty reduction in Africa will be experienced leading to deepening vulnerabilities to climate change impacts in the long run (IPCC, 2007; Stern, 2011).

Besides, the influence of atmospheric factors which create extreme changes in climatic conditions, the heightened vulnerability to climate change effects by Africa is also due to high levels of poverty coupled with low adaptive capacities of majority of people especially the rural poor (Pidwimy, 2006 and IPCC, 2007). Climate change with its extremities in weather conditions will be manifested differently in different parts of the African continent. While parts of eastern Africa are projected to become wetter, other regions like the southern and northern parts of Africa will remain drier with more adverse effects (Collier *et al*., 2008; Hulme *et al.,* 2001). Regions with high temperature will continue to experience further rises in temperatures resulting in increased evaporations (Engelbrecht *et al.,* 2015). Agricultural production will therefore be affected due to the heavy reliance on rain-fed production systems (IPCC, 2007 and Mertz *et al*., 2009). Nassef *et al*. (2009) have pointed out that the semi-arid region of Africa, which is characterized by changes in climatic conditions on both inter-annual and multi-decadal scales, will be at greater risk of droughts, further emphasizing the region's vulnerability to climate change impacts.

The situation is no different in Ghana especially the sudden changes in climatic conditions resulting in loss of investments (Kemausuor *et al.,* 2011). The uncertainties with the climatic conditions have resulted in decreased yields and crop failures posing significant threats to livelihoods especially in northern Ghana (Laube *et al*, 2012).

Smallholder farmers are thus placed under enormous pressure since they tend to bear the greatest brunt of these changes due to the heavy reliance of their livelihoods on subsistence crop production and livestock rearing. The need to adapt to the changes either through diversifications or intensifications becomes even greater for them. Coupled with changes posed by globalizations through global free trade, context specific social cultural factors mediate adaptive options and strategies thereby limiting or enhancing adaptive capacities for different groups of people. These limitations or enablers affect access to water, conducive and fertile lands and critical inputs for agricultural production (Nori *et al*., 2008).

Social and cultural norms defining rules of access, use and control of resources provide the basis for rights and entitlements. The influence of these norms on adaptation tend to vary for different groups of people (Nyong *et al*., 2007; Ifejika Speranza *et al*., 2010). The different applications of social and cultural norms are based on status (both economic and residential), age, and other considerations such as gender (Gedzi, 2009; Arku, 2013; Wrigley-Asante *et al.*, 2017). The differentiation in access to resources is much pronounced relating to differences between men and women. These differences associated with guarantee of access are guided and founded within norms, values, taboos and other rules influencing exposures and sensitivity to climate variability impacts (McDowell and Hess, 2012; Paavola, 2008; Eakin, 2005). The gendered differentiated access to resources therefore has strong effects on the outcome of adaptation to the impact of climate variability. The need to analyse the effects of norms within specific context on adaptation is important to determine the different level of opportunities and barriers. This will facilitate understanding on how smallholder farmers navigate the complexities of such influences on access to and use of adaptive options, especially land in order to secure their livelihoods.

1.2 Problem Statement

Climate change adaptation has become an important subject in global discourse on development in recent times due to its potential to negate economic and developmental gains. Mitigating the effects of climate change and building resilience of affected groups and persons to adapt effectively to climate variability impacts have become key foci for international, regional and domestic policy making (Adger *et al*, 2013; Nielsen and Reenberg, 2010; Urwin and Jordan, 2008). The Paris declaration of 2015 on climate change has provided additional impetus in shaping policies and plans to enhance adaptation for different contexts and groups. An important step in adaptation to climate variability impacts is an emphasis on acknowledging the importance of local knowledge and belief systems in shaping adaptive options and strategies for people (Pauw, 2013; Fankhauser and Burton, 2011). The close attention given to contextual knowledge stems from the fact that constraints and opportunity to climate variability adaptation tend to be more or less entrenched in social structures and institutions (Yaro *et al*, 2015). The social structures and institutions tend to provide basis for the creation of differences in access, use and control of resources especially land. The social differences thus lead to the production of deeply grounded social inequalities fostered through cultural constraints and enablers. Consequently, different social categories are affected and may respond differently to climate change impacts (IPCC, 2000; Adger *et al*, 2001; FAO, 2011; Wrigley-Asante *et al*, 2017).

The unequal and differentiated access to resources needed for adaptation to climate variability impacts and possible livelihood diversifications are shaped by contextual factors determining rights and entitlements (Kelly and Adger, 2000; O'Brien et al, 2007; Agyei-Antwi *et al*, 2013). These, according to O'Brien *et al* (2007) are the outcome of overlapping influence of economic status of certain groups of people in

society particularly women who lack influence in decision making with further limitations on access to and control of common and productive resources. Therefore, the persistence of certain modes of adaptations are produced and reproduced by unequal social and gender relations embedded within cultural and social arrangements (Warnukonya and Skutsch, 2001; Carr, 2008).

Consequently, access to and use of adaptive options to address the expected or real impacts of climate variability tend to be different for men and women in securing their livelihoods. The constraints on women's capacity to utilize adaptive options in order to respond swiftly to the impacts of climate variability and change deepen their vulnerabilities (Demetriades and Esplen, 2008). According to Arora-Jonsson (2011), the situation constitutes "the intersection of socio-economic exes" reinforced by other factors to limit social and economic mobility. Exposure and sensitivity to climate variability impacts are therefore increased. The complex manifestations of the constraining factors also affect other vulnerable categories such as migrants/settlers.

Related closely to the influence of socio-cultural variables on adaptation to climate variability is the differential impact of climate variability, adaptive strategies as well as the differentiated outcome for different social groups. In an attempt to examine the influences of socio-cultural factors on adaptation to climate variability impacts, scholars such as Carr and Thompson, (2014); Arora-Jonson, (2011); Terry, (2009); Demetriades and Esplen, (2008); Denton, (2002) have explored the sources of maladaptation as well as the gendered differences in adaptive options and patterns. These studies have emphasized the need to interrogate the sources of differentiated gendered adaptation outcomes and the drivers of such outcomes.

In line with this call a number of studies have focused on context specific or differentiated adaptation to climate variability impacts and the influence of institutions on the direction and patterns of adaptation. These include Nielsen and Reenberg, (2010) – Burkina Faso, Yaro (2013), Codjoe *et al* (2013), Yaro *et al* (2015), and Wrigley-Asante *et al*. (2017) – all in Ghana. These studies have produced important knowledge on how socio-cultural norms can potentially enhance or limit the adaptive capacity of certain social categories such as women and migrants/settlers.

While these earlier works represent important milestones and basis for examining differential adaptation patterns, especially gendered dimensions of adaptation, there still remain gaps in the literature. Exploring how adaptive options are either constrained or enhanced and the gendered outcomes within specific socio-cultural context have been minimally explored. Additionally, most of such works have analysed socio-cultural factors in a much broader manner referring to them as "institutions", "knowledge" and "practices" without being specific. The general reference to socio-cultural factors strains understanding and targeting of interventions.

Against this backdrop, this study broadly seeks to fill the gap on the implications of inheritance and land use practices on climate variability adaptations especially as these factors provide the basis for access, use and control of land. It will specially examine how these factors influence gendered differences in adaptive options and strategies of smallholder farmers in the Nkoranza South municipal and Bawku West District. The two districts provided good basis for such analysis due to their unique socio-cultural differences and the growing evidence of climate variability impacts on smallholder agricultural production. While the Bawku West district is largely patrilineal regarding inheritance, the Nkoranza South municipal is predominantly matrilineal. The differences in heritance practices provide sound basis for comparison to ascertain the

complexities, rights and taboos, inherent in the inheritance and allocation of land, how the practices shape gender relations and establish social differentiations. Again, the increasing unpredictability and shifts as well as changes in rainfall patterns with the attendant longer dry spells are having effects on yields and incidence of pest infestations with dire consequences for the livelihoods of the significantly large proportion of smallholder households in the two districts.

Specifically, the study sought to interrogate the nature of inheritance patterns and land tenure arrangements within the two districts and how the applications such practices and arrangements influence options for adaptation especially its gendered outcomes. Importantly, the study ascertained how the gendered differentiated access to and use of adaptive options affect exposure and sensitivity to climate variability impact.

1.3 Overall Objective of study

The study sought to examine how socio-cultural norms on inheritance and tenure arrangements on access, use and control of land in both matrilineal and patrilineal systems influence adaptive options and vulnerability of smallholder farmer households in the Bawku West district and the Nkoranza South municipality to climate variability impacts.

1.4 Specific Objectives

In line with the overall objective the study specifically sought:

1. To examine the nature of climate variability and its effects on the livelihoods of smallholder households.
2. To assess the gendered implications of inheritance and land tenure arrangements on access and use of land by smallholder farmers.

3. To investigate how the gendered differences in accessing land and other adaptive options influence vulnerabilities and resilience to climate variability impacts.

1.5 Research Question

The underlying question of the study was: how do inheritance norms and, tenure arrangements on access, use and control of land influence the gendered adaptation and vulnerability of smallholder farmer households in the Bawku West District and Nkoranza South Municipality to climate variability/change impacts?

1.6 Specific Research Questions

In line with the specific objective, specific research questions include:

1. How has the variability in climatic conditions affected the livelihood of smallholder farmers especially during expected peak periods?
2. How are norms on inheritance and land use arrangement gendered?
    a. How do the inheritance patterns and land tenure arrangements determine access, use and control of land to shape the utilization of adaptive options?
3. How do the gendered differences in adaptive options shape vulnerability and build resilience for adapting to the impact of climate change?

1.7 Significance of Study

Climate variability and change is primarily felt through temperature rises and ecosystem transformations, but it also has grave implications for human survival. Social consequences of climate change are not gender neutral. Due to social inequalities and cultural constraints, men and women are affected differently. Depending on the socio-

cultural context, gender differences reduce the survival chances during climate change-related natural disasters.

This thesis set out to examine the influence of socio-cultural norms in shaping the gendered response to climate variability impacts. The work goes beyond a mere gendered analysis of climate variability impact to examine as well as investigate the mediatory influence of inheritance patterns/practices and land tenure arrangements in enhancing or limiting adaptive capacities of smallholder farmers. In doing so, the work adds to as well as expands the climate adaptation discourse on autonomous adaptation and the more significant question of context. Does context matter in climate change adaptation? The work highlighted how social and cultural norms shape and direct options for adaptation and their use by smallholder farmer households in rural communities. The gendered implications and its influences on sensitivity and response to climate variability impacts were explored especially its influence on vulnerabilities.

Additionally, the work showed how access to and use of resources do not necessarily guarantee successful adaptation. Issues of control provided a basis to raise significant questions on control of resources as important mediators to successful adaptation. Related to the control of resources was the question of maladaptation, which was explored by the study.

1.8 Organization of thesis

The thesis is organised in seven (7) chapters. Each chapter of the thesis focused on a distinct aspect of the study. The first three chapters constituted the introductory chapters. These chapters set the context and background for the thesis. They further provided the theoretical and methodological basis for the entire thesis. The following four chapters were the empirical chapters. These chapters presented the findings of the

study further discussing their implications in relations to the conceptual framework and literature. Each empirical chapter addressed an objective of the thesis, exploring the different themes obtained from the data. The last chapter summarized the findings of the study and explored its policy implications with conclusions.

Chapter One of the thesis introduced the subject and background of the entire study. It sets the work within the discourse identifying the lacunae in knowledge. After setting the basis for the thesis, the chapter presented the specific objectives of the study and questions guiding the attainment of the objectives. The significances of the study follows. The organization of the work closes the chapter.

The second chapter of the thesis contains the conceptual and empirical literature of the study. Based on both the conceptual and empirical works, the conceptual framework is presented showing in details how the study is conceived. The connections between the different variables under consideration are shown.

The third chapter focused on the methodological approaches of the study as well as the profiles of the two study districts. It provides details on sampling and selection of research participants and respondents, instrumentation, data collection and analyses. The chapter further highlights ethical considerations made in the course of the study and steps taken to address them.

The fourth chapter constituted the first empirical chapter of the thesis. The results were presented alongside the discussions. The chapter explored the nature of climate variability in the two districts and the effects on the livelihoods of smallholder farmer households. The chapter further explored the effects climate variability impacts have had on the different aspects of smallholder livelihoods.

Chapter Five of the thesis discussed the implications of inheritance and land tenure and land use arrangement on gendered adaptations and outcomes. It engaged largely with the different inheritance systems practiced in the areas of study and how the systems are either enhancing or limiting access to and use of adaptive options generally and land in particular. The chapter also explored how households navigate the limitations imposed on them by inheritance and land use arrangements to adapt to the impacts of changing climatic conditions.

Chapter Six, which is the final empirical chapter focused on how differences in access to and use of adaptive options influenced household vulnerabilities. The chapter made use of the multi-dimensional livelihood vulnerability index (MLIV) to establish the nature of vulnerabilities which different categories of households face as well as their determinants.

The seventh chapter summarised key findings of the study with conclusions. It offered recommendations for policy considerations. Areas for further studies were suggested to keep the wheels of research and knowledge production moving.

CHAPTER TWO

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 Introduction

The chapter explores both theoretical and empirical literature on climate change, climate change adaptation and the interface between climate change and other variables. The social context within which adaptive resources are sourced and used is also looked at. In doing so, inheritance patterns, land tenure and land use arrangements are discussed paying attention to how they influence adaptations. The review further explores different concepts of vulnerability especially social vulnerability and how it helps to understand climate sensitivity exposures and adaptive responses. These concepts and analytical frameworks and approaches provided the bases to construct a conceptual framework for the study.

2.2 Understanding Climate Change and Variability – Debates on meanings

The concepts of climate change and variability have been debated among scholars, climate scientists, policy makers and development experts. The debates have centred on whether the two terms in the manner they are used convey the same meaning and interpretation. Also, there exist contentions on the expanse and application of the terms "climate change" and "climate variability". These debates derived from the types of observed changes, manifestations of the changes and sources of change or factors causing the change. Quite apart from these contentions and debates, there is also the school of thought that considers the climate change debate as "over stretching" observed changes by characterising such changes as new and unprecedented. Peilke (2004) notes that it may be too early to press the panic bottom since similar extreme changes were observed in the 1500s. The on-going debates, attributions of cause and

concerns about climate change according to Hampton (2015) are the expression of factional or personal interests pertaining to the observed variability or changes in climatic conditions. His observation was aptly captured by Tyson, thus:

> "Once upon a time, people identified the god Naptune as the source of storms at sea. Today we call these storms hurricanes. We know when and where they start. We know what drives them. We know what mitigates their destructive power. And anyone who has studied global warming can tell you what makes them worse. The only people who still call hurricanes "act of God" are the people who write insurance forms" (Tyson 2007: 361).

The need for clarity on the meanings of climate change and climate variability have become even more important as the two tend to be viewed as the same and even used interchangeably in climate related discourses.

Variations in the climate are observed as a continuous process at different levels (Ghil 2002). These variations can be either pronounced in the case of the El Nino or subtle such as marginal increase or decrease in atmospheric temperature for short periods. The Intergovernmental Panel on Climate Change in its glossary of terms and definitions refers to climate variability as the

> "Variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all temporal and spatial scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forces (external variability)" (IPCC, 2014:121).

It is worth noting that the IPCC's definition of variability in climatic conditions did not attribute the responsibility of causation of the observed variations in the mean climatic indicators to specific sources. Its definition therefore presents a vague conception of the cause of observed changes. Just like in the case of climate variability, the IPCC definition of climate change lacked specificity regarding the sources of causation. The notable difference between the definition of climate variability and climate change are the consistency and time frame within which the observed changes have occurred. Climate change is thus defined as a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). Climate change may be due to natural internal processes or external forces, or to persistent anthropogenic changes in the composition of the atmosphere or in land use (IPCC, 2014: 120).

The IPCC's definition varies slightly from the definition of the United Nation's Framework Convention on Climate Change (UNFCCC), which views climate change as a change of climate which is attributed directly or indirectly to human activity with the potential of altering the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. The cause or causes of climate change is clearly attributed to human activities. These activities are cited as the prime factors leading to significant changes in atmospheric composition whereas climate variability is assigned natural causes. The clear variations noted between climate change and climate variability by the UNFCC definition offers a window of identifying what constitutes change or variability for climate scientists and policy makers. The UNFCC definition has therefore had enormous influence on the formulation of climate policy (Chakrabarti, 2015). Alterations in life style and economies are prescribed as the best or in some quarters the only way to forestall

extreme outcomes. In spite of its influence on policies for mitigation globally, Peilke (2004) has observed that the conceptualization of climate change by the UNFCC is problematic in that perceiving the drivers of climate change as largely anthropogenic result in the carbonization of the discourse and to an extent shift attention from adaptation. Adaptation, which is very vital to safeguarding livelihoods in the face of extreme climatic changes, tends to be neglected when the focus of policy is essentially on reducing emissions.

2.3 Global Climate Change in Perspective

While natural factors may contribute to changes in climatic conditions, the balance of the debates in most cases show that human activities contribute significantly to global warming and hence climate change. The rapid rise in global carbon oxide levels, which is largely due to anthropogenic factors, the IPCC contends that about 95% of the observed changes in the global climate system since the 1950s are attributable to human activities (IPCC, 2007; 2013). These activities have had both mild and extreme effects on global climatic changes. Additionally, there is about 97% consensus among climate scientists that human activities are largely responsible for the observed changes in the global climate system (Anderegg *et al.*, 2010; Dora & Zimmerman, 2009; Oreskes, 2004). Anthropogenic factors such as urbanization, population growth, burning of fossil fuel, deforestation, and desertification, advancement in science and technology and poor agriculture practices are believed to account for significant proportions of global climate change (IPCC, 2007; 2013; 2018; Williams, 2012). Nevertheless, according to the IPCC (2013) burning of fossil fuel and deforestation are the two major anthropogenic contributors to global warming.

In effect, greenhouse gases such as carbon dioxide, methane, chlorofluorocarbons, nitrous oxide, ozone, fluorinated gases are released into the atmosphere through human activities. (IPCC, 2013; Williams, 2012). Carbon dioxide concentration has however been identified as the largest share of gases in the atmosphere (IPCC, 2013). Efforts have therefore been focused on reducing carbon dioxide concentration in the atmosphere by most international charters, treaties, accords, agreement and declarations on climate change (Chakrabarti, 2015; IPCC, 2018). For instance, the Paris Agreement and its Intended Nationally Determined Contributions put a cap on the release of carbon dioxide among states (UNFCCC, 2016). This is very important as carbon dioxide concentration in the atmosphere continue to rise. As revealed by the IPPC (2013), as at 1800, the concentration of carbon dioxide in the atmosphere was 288ppm but this increased to 376ppm by 1999. Monitoring of the carbon dioxide levels has shown continued increases over the years, reaching 405pmm in 2017, more than 100 times of the recorded increases over the past 60 years (Lindsey, 2018). There has been a further increase to 410 ppm in 2019 according to the National Oceanic and Atmospheric Administration (NOAA). Greenhouse gases in the atmosphere alter the composition of the atmosphere resulting in global warming. The IPCC (2013) indicates that by 2010, carbon dioxide, methane, nitrous oxide and fluorinated gases contributed 76%, 16%, 6% and 2% respectively to global greenhouse gases in the atmosphere which further increased global warming and hence climate change.

Substantial evidence of climate change and its impacts exist in literature (IPCC, 2007; 2012; 2013; 2018; Fleurbaey *et al*., 2014; CH2014-Impacts, 2014; Melillo *et al.*, 2014). Rising global temperature, unreliable, erratic and unpredictable rainfall are evidence of climate change with accompanying effects such as rising sea levels, melting of artic ice, spread of diseases and pathogens (IPCC, 2013). Moreover, the frequent occurrence

of climate related disasters such as flood, drought, cyclones and tsunamis attest that the world is experiencing changing climatic conditions (IPCC, 2012; 2013; 2014; 2018; Chakrabarti, 2015; Logah *et al*., 2013; Sarpong & Anyidoho, 2012; Akudugu, 2012; Akudugu & Alhassan, 2013; Yaro, 2010; Armah *et al*., 2010). While these extreme climate events occur across the globe, their occurrence in developing regions of the world such as in Africa and Asia are much more rampant with extremely devastating effects (FAO *et al*, 2017; IPCC, 2012; 2013; 2014).

The Fifth Assessment Report of the IPPC showed that the decade of 2000s has been the warmest (IPCC, 2014). However, 1983-2012 was the world's warmest thirty-year period since the last 800 years. For instance, between 1880 and 2012, global warming was about 0.85^{o}C but this increased to 0.89^{o}C between 1901 and 2012 as well as 0.725^{o}C between the period of 1951 and 2012 (IPCC, 2013). Since 1950, an increase of 0.1^{o}C per decade has been observed in global land surface temperature while ocean air temperature witnessed an increase of 0.11^{o}C per decade between 1971 and 2010 (IPCC, 2013). Future projections of global surface temperature stand at 0.3^{o}C to 0.7^{o}C for the period of 2016 to 2035. However, between 2081 and 2100, temperature is projected to increase by 0.3^{o}C to 0.7^{o}C, 1.1^{o}C to 3.1^{o}C, and 2.6^{o}C to 4.8^{o}C for the low concentration scenario, medium concentration scenario and high concentration scenario respectively (IPCC, 2013).

In the case of sea level rises, various studies have revealed a rise in global and regional sea levels (Church & White, 2011; IPCC, 2013; 2018) as well as local sea level rise (Woodworth *et al*., 2009). While these studies used different modeling process to estimate the rise in sea levels, they all conclude that there has been a rise in sea levels, owing to anthropogenic climate change (Gregory *et al*., 2006; Church *et al*., 2005) and probably the volcanic eruption of Mountain Pinatubo in 1991 (Church *et al*., 2005). For

instance, the tide gauge observation combined with satellite altimetry measurement revealed about +1.8 ± 0.5mm rise in sea level per year over the last fifty years while the altimetry measurement alone revealed a rise in sea level of +3.2 ± 0.9mm per year since 1993 (IPCC, 2013). Lindsey (2018), indicated that an increase of 3inches (77mm) in sea levels in 2017 constitutes the highest average recorded since 1993. According to Church and White (2011), the observed trend in sea levels will continue to increase even if there is stabilization in the concentration of greenhouse gases in the atmosphere accompanied by a drastic reduction in the emission of greenhouse gases. The rise in sea levels observed by the IPCC in 2013 according to Gomitz *et al*., (2019) have significantly increased to levels higher than projected due to increasing loose of glacier and ice sheets. The rise in sea levels is said to be at an annual average of 0.13inches (3.2mm). The rapidly rising sea levels have resulted in dangerous floods with devastating effects on communities living along the coast (Nunez, 2019).

Besides the observed changes in temperature, sea levels and glacier, there have been phenomenal changes in rainfall patterns and climate related disasters. It is generally believed that the rise in temperature will lead to a significant increase in rainfall across the globe (IPCC, 2013). For instance, the IPCC indicated that there is a possibility of 1 to 3% increase in global mean precipitation for every 1^{o}C. However, studies on rainfall patterns have mixed results with regional variations. For instance, climate analysis from 1901 to 2005 showed a decrease trend in Western and Sahel Africa while the Americas, Eurasia and Southwest Australia showed increasing trends in precipitation (IPCC, 2007; Chakrabarti, 2015).

2.4 Climate change in sub-Saharan Africa

Although, climatic changes are global in nature, they are not uniformly distributed as Africa and Asia experience more rampant changes (FAO et al., 2017; IPCC, 2007; 2013; 2018). For instance, the Alliance for a Green Revolution in Africa (AGRA) showed that temperature in Navrongo in Ghana reached 43^{o}C while temperature in Vioolsdrif in South Africa recorded as high as 47.3^{o}C (AGRA, 2014). Future projections of temperature in Africa show that the continent is expected to observe a rise in temperature above the projected global average (IPCC, 2007; 2013; Joshi *et al*., 2011; Sanderson *et al*., 2011; James & Washington, 2013). About 2^{o}C and 4^{o}C rise in temperature is expected to occur in Africa in the mid-21st century and the latter parts of the 21st century respectively. As a matter of concern, West Africa is expected to observe 3^{o}C to 6^{o}C rise in temperature between 2080 and 2100 (IPCC, 2007; Joshi *et al*., 2011; Sanderson *et al*., 2011; James & Washington, 2013). The increasing temperatures companied by dwindling precipitations will worsen if global carbon emission levels remain unchecked.

Changes in rainfall patterns have also been observed with downward trends in West Africa (IPCC, 2007). About 20-40% decrease in rainfall has been recorded in West Africa between 1931-1960 and 1968-1990 (IPCC, 2007; Sissoko *et al*., 2010). This situation is however not the same in all parts of the continent. A study by Fabusoro *et al*. cited in AGRA (2014) reveals that rainfall in Nigeria was increasing by 65mm per month per annum between 1982 and 2010 in the sub humid regions of the country. Similarly, other projections show that, West and East Africa are expected to be the wettest regions in Africa while Southern Africa continue to experience declines in precipitation (Platts *et al*., 2015; IPCC, 2007).

These changes, accompanied by increasing climate related disasters such as drought, and flood, among others increase the vulnerability of Africa. Already, Africa is considered one of the most vulnerable regions in the world with respect to climate change (IPCC, 2007; 2013; 2018; FAO *et al*., 2017; AGRA, 2014; Fleurbaey et al., 2014). Africa's economies depend on climate sensitive sectors such as agriculture, energy and forestry. In addition, high poverty rates in Africa coupled with a relatively large number of smallholder farmers engaged in agriculture make adaptation and adaptive capacity very challenging. Moreover, poor natural resource management and increase in conflicts in Africa make the continent vulnerable to climate change (IPCC, 2007; 2014; 2018; FAO, 2012; 2015a; UNDP, 2004; Yaro, 2010; Armah *et al*, 2010; Akudugu, 2012; Akudugu & Alhassan, 2013; Collonny-Boutin & Smith, 2016). These have serious implications on global food security in general and food security in Africa in particular (Rarieya & Fortun, 2010; FAO, 2012; 2015a; 2015b; FAO et al., 2017; IPCC, 2014; 2018; Serdeczny et al., 2016; Pedercini *et al*., 2012). The impact is even more severe among smallholder famers in Africa who contribute about 80% of food supply in Africa (FAO, 2012; AGRA, 2014).

Ghana is not spared from the adverse impacts of climate change. Ghana's economy is largely agrarian with agriculture contributing 18.3% as at 2018 to gross domestic product (GDP) and employing nearly two-thirds of the country's population (World Factsheet, 2018; MOFA, 2013). Nearly 70% of the population is either involved in agricultural production or an agricultural related sector (GSS, 2014). Agriculture in Ghana is also rain fed and dominated by peasant farmers with little capacity to adapt to climate change. It is therefore not surprising that climate change threatens agriculture and rural development initiatives of the Government of Ghana such as the Ghana Shared Growth and Development Agenda (GSGDA) and the Ghana Goes Green Policy

(Sarpong & Anyidoho, 2012; MESTI, 2010; NDPC, 2010). Frequent floods, prolonged droughts and changes in temperature and rainfall have negative implications on socio-economic development in Ghana. Besides the erratic rainfall patterns smallholder farmers are threatened by increasing infestation of pest on farms (Kumasi *et al*., 2019; Banso *et al*., 2019). The fall armyworm attack which occurred from 2016-2018 was estimated to have affected more than 1000 hectares of farmlands in the Northern parts of Ghana alone by the Savanna Agricultural Research Institute (SARI) of the Council for Scientific and Industrial Research (CSIR). The total land area affected nationwide is estimated at 18,000 hectares by the crop research institute. The estimated cost of the impact in Africa stands at US$13 billion (Ghana Business News, 2019). Ghana's share of these losses stands at an estimated US$163 million (Godwin *et al*., 2017) Further to these extreme burdens placed on smallholder farmers, the Ministry of Environment, Science, Technology and Innovation (MESTI) (2013) reports that Ghana witnessed 1^{o}C increase in temperature, the country is expected to observe further increase in temperature of about 1.7^{o}C to 2.04^{o}C by 2030. Rainfall in Ghana has been reported to be erratic, unpredictable and unreliable, making rain fed agriculture and the agricultural sector in Ghana more vulnerable to climate change (Armah et al., 2010; Akudugu, 2012; Akudugu & Alhassan, 2013; MESTI, 2013; Aninagyei & Appiah, 2014).

With these changes in Ghana, studies have documented the impact of climate change on agriculture productivity (Asante *et al*., 2013; Aninagyei & Appiah, 2014; Mawunya & Adiku, 2013; MacCarthy, Adiku & Yangyuoru, 2013; Olesen et al., 2013), food security (Quaye, 2008; Antwi, 2013; Akudugu & Alhassan, 2013), livelihood (FES & GAWU, 2012; Akudugu, 2012) and economic development (Asafu-Adjaye, 2013). Other studies have focused on adaptation strategies (Quaye, 2008; Yaro, 2010; World

Bank, 2010; Tachie-Obeng, 2010; Adiku, 2013) and climate change perceptions/local knowledge (Codjoe, 2013).

The impacts and effects of climate change are seen in varied sectors in society. The costs as well as effects are felt in health, economic outcomes and further influence the architecture of entitlement. These effects have the potential to negatively impact gains made in development trajectories.

The sensitivity of agriculture to climate change cannot be over emphasized. Nelson *et al* (2009) have highlighted the potential of climate change to change the patterns and productivity of crops, livestock and fishery systems with implications on distribution, markets and food access. The difficulty to secure food has been projected by Godfray *et al*. (2010) to be very acute for the resource poor. The effects of climate change on the availability, accessibility, utilization and stability of food systems will be dire (FAO, 2008). This challenge is projected to deepen by 2050 when the earth's population approaches the nine (9) billion threshold.

The most visible and challenging of these effects is seen in the increasing fall in global food supplies through loss of harvest and general disruptions in agricultural production cycles characterised by food shortages (Easterling *et al*, 2007). This is especially felt in developing countries and Africa in particular where subsistence productions are greatly strained due to the unpredictability of rainfall patterns. Additionally, the heavy dependence either directly or indirectly of the rural poor on agriculture for income and food paint a bleak picture (Berdegue and Fuentealba, 2011). The strain placed on already scarce resource may lead to increased out migration as an adaptive option from rural and resource poor areas.

Furthermore, the increase in the frequency of natural disasters such as flood, hurricanes, heat waves, fires and others will place a huge strain on national economies as they will have to rebuild damaged infrastructure and resettle displaced people. These extremities are expected to increase in frequency and intensities (IPCC, 2001).

2.5 Differential effects of climate change on resource access

An important fact stated in the climate change discourse is the heightened risk of vulnerable groups to climate change impact especially women who constitute a greater proportion of the global poor (Resurreccion, 2011). While the Intergovernmental Panel on Climate Change (IPCC) and other international organizations such as the Food and Agriculture Organization (FAO) of the United Nations have noted the differential impact of climate change, efforts have continued to lag in addressing the specific gendered needs of those most at risk of climate change induced vulnerabilities (IPCC, 2001; FAO, 2011).

In spite of the heavy burden placed on women to provide for the daily nourishment of families and households in rural communities their access to and control of resources are very limited (Bryceson, 2019; Rousseau *et al*., 2019; Britwum and Akorsu, 2019; Apusigah, 2009). Rural women often manage complex household tasks and pursue multiple livelihood strategies and livelihood options woven around the rural economy with agriculture as its backbone. Their activities typically include producing agricultural crops, tending animals, processing and preparing food, working for wages in agricultural or other rural enterprises, collecting fuel and water, engaging in trade and marketing of produce, caring for family members and maintaining homes (Atuoye *et al*, 2019).

The differentiated impact of climate change on women is largely a product of social norms, traditional roles and the tilting of power structures in favour of men (Schalateck, 2011). Since women's right regarding the ownership and control of the means of production especially land is not guaranteed, their ability to adapt to climate change impact is greatly curtailed. Rodenberg (2009:27) stressed that, "in the aftermath of natural disasters, the lack of ownership titles (*customary or legally*) pose enormous problems to women, as they are denied the right to buy a new plot of land".

A policy brief released by SEND Ghana in 2014 captures this issue succinctly:

> "In almost all cultures and traditions in Ghana, gender is not only a key determinant of access to productive resources but also the basis for the division of labour within the household, the social value attributed to different types of work, and bargaining power. Gender inequalities which are widespread in agriculture and rural employment manifest in forms such as limited access to assets, inputs and services – including land, livestock, other productive assets, labour, extension and limited financial services, and mechanization" (Page 6).

In spite of the substantial increase in budgetary allocation for the agricultural sub-sector to a consistent 10% threshold since 2006, investment in women within the sector have not seen any marked improvement (SEND Ghana, 2014; FAO, 214). In light of this, the Ghana Statistical Service reports that, the Agricultural sector recorded the highest growth rate of 12.7% in the first quarter of 2014 (GSS, 2014c). These benefits have however not been equitably distributed between male and female farmers. Indeed, male farmers have benefited more than female in government programmes such as the Youth in Agricultural Programme, the Northern Rural Growth Programme, fertilizer subsidies and others.

Furthermore, water shortages, spreading deforestation and other consequences of climate change limit women's scarce time resources. The strain on the health of women with the increasing time of travel in search of water, fuel wood and sheer, as in the case of Northern Ghana is enormous (SEND Ghana, 2014). It must also be noted that, women and children are most at risk of water borne diseases due to contamination of water bodies as a result of both scarcity and competition for use of the same sources of water with animals. Similarly, women often lack the financial resources and the legal framework to pursue alternative livelihoods in the face of growing soil degradation thereby limiting their scope of adaptive options, and deepening their vulnerability to the impacts of climate change.

Although women possess great potential to take active role in the mitigation of climate change, their specific knowledge and their experience, for instance, in developing alternative food-security strategies, often remain untapped (ICIMOD, 2011). This according to FAO is due largely to the very little emphasis placed on understanding the different adaptive strategies men and women apply in order to secure their livelihoods in the face of climate change.

2.6 Climate change adaptation

Adaptation to climate variability and change has become important to safeguard livelihoods as its impacts and effects continue to grow (van Valkengoed and Steg, 2019). The effects of extreme climate events are not limited to human systems but also affecting the environment and the balance of entire ecosystems (Mara *et al*, 2019). The consequences of such events are leading to significant losses in livelihoods and extreme environmental impacts - extinction of plant and animal species (Reid, 2019). Consequently, conversations on adaptation have shifted from the necessity for adaptive

actions to the possible ways of guaranteeing successful adaptation (Biesbroek *et al*, 2013).

A number of social science studies on climate change adaptation have therefore focused on the factors enhancing and limiting or constraining adaptation generally and particularly how specific groups and populations come to use distinct adaptive options and the outcomes of such options in relation to their exposure and sensitivity to future climate events (examples include, Moser and Ekstrom, 2010; Neilsen and Reenberg, 2010; Adger *et al*., 2009; O'Brien et al, 2009). Though most of the studies have found different determinants of adaptation to climate variability and change impacts, non-climatic factors have been found to constitute important basis for the choice of adaptive options individuals and groups use in addressing the impact of climate variability on their livelihoods (Biesbroek *et al*., 2013). The non-climatic factors are usually deeply entrenched and difficult to change or overcome (Storbjork, 2010). The social and cultural factors shaping adaptation constitute significant part of the non-climatic factors (Antwi-Agyei *et al*., 2015; Neilsen and Reenberg, 2010). They provide the basis and foster unequal and constrained access to adaptive resources, which influence social vulnerability (Adger and Kelly, 1999; Kelly and Adger, 2000). The social and economic inequalities created due to community specific unequal and differentiated access to adaptive resources have gendered outcomes (Carr and Thompson, 2014), with implications on vulnerability. Women in this case are disproportionately affected by climate variability and change impacts consequently deepening their exposure to further climatic events (Arora-Johnson, 2011).

Adaptation to climate impacts is therefore context specific. Use of available adaptive options is defined by levels of impacts, types of resources available for adaptation and the permissive scope of the patterns of entitlement (Fussel and Klien, 2006). Adaptation

to climate change impacts especially among smallholder farmers involves alterations to livelihood patterns and changes to economic activities through diversifications and intensifications (Cuni-Sanchez *et al*, 2019; Fosu-Mensah *et al*., 2012). Ellis (1998; 2000; 2005) has noted that smallholder farmer households diversify their livelihoods as a matter of necessity or by choice. In most cases however, rural smallholder households diversify out of necessity to ensure the security of their livelihoods. The factors that underlie livelihood diversifications include, "seasonality, risk, labour markets, credit markets, asset strategies, and coping strategies" (Ellis, 2000, page 289). These factors differentiate the cost and benefits of diversification. Livelihood diversifications as adaptive strategies may be, a) on-farm, characterized by intensification and introduction of new crops and varieties, b) off-farm, where farmers are engaged in farm-based activities outside their own farms for income and c) non-farm, which involved shifts from farm-based activities to other livelihoods or income generating activity (Martin and Lorenzen, 2016; Ellis and Allison, 2004).

2.6.1 Socio-cultural factors as mediators to climate change adaptation

The influence of socio-cultural values and norms on adaptation cannot be over-emphasized especially within specific contexts. The choices of people and groups relating to access and use of readily available options to mitigate the effects of climate change or variability on their lives can either be constrained or enhanced by factors such as; status in community (indigene or migrant/settlers), land tenure systems, and inheritance patterns and rights (Matrilineal versus Patrilineal). In spite of the dwindling effects of customary allodia rules through the growing commodification of land and large-scale land acquisitions (Tsikata and Yaro, 2014) as well as the weakening value placed on the extended family and lines of descent, customary rules operating within most rural communities which determine access and control of economic and landed

resources especially land for farming and other purposes continue to operate. These rules are meant to safeguard lineage and community interests (Tsikata, 1997).

Socio-cultural values and norms therefore constitute a collection of beliefs, practices and standards which shape actions and prescribe sanctions for subversions (Rokeach, 1973; 1979). Because values systems and norms evolve overtime and through collective consensus, they are coercive and deviation from them are viewed as threats to the entire system (O'Brien and Wolf, 2010). In this way, the range of choices and options available for coping with social and environmental challenges as well as the decisions for the utilizations of available options are made based on the degree to which individuals and groups are culturally and socially allowed or enabled to have access to and use available options (O'Brien *et al.*, 2007). Adaptation to climate change impacts thus becomes a social process. As noted earlier, the greater context in which both the actors and the system of interest are embedded provides the enabling and constraining contextual conditions that shape adaptive actions (Moser and Ekstrom, 2010). Certain modes of adaptations and outcomes are therefore produced and reproduced due to people's ability or inability to transcend the permissive zones of variation.

Viewed in this manner, arrangements to reduce levels of sensitivity to climate variability impacts and the set of actions to take in addressing the impacts of the variability are contextually mediated through value systems and norms (*rules of access*) (Kelly and Adger, 1999; O'Brien *et al*., 2009). The social norms may include the rights and privileges assured or guarantee to specific individuals based on their origin – indigene/migrant, gender – male/female, eligibility to inherit based on the type of inheritance system operating – matrilineal/patrilineal, and the different land use and ownership arrangements. The forms of rights imputed by the social norms to specific individuals do not only guarantee their rights to access resources especially land but are

able to manage and make decision about the use of such resources by others (Apusigah, 2009). The form and direction of adaptation are thus directly and indirectly influenced by the degree to which the norms empower individuals to have access to, use and control adaptive options. Though levels of access and use of resources especially land are limited or enhanced by the norms, the norms also provide opportunity for certain types of diversifications to secure livelihoods.

2.7 Changing rules and allocations: Inheritance and land tenure

Societies have regarded land as a very critical and strategically important cultural and economic asset (Abdulai *et al*, 2011). However, many vulnerable groups in societies all over the world such as women, children and migrants have suffered various forms of abuse, discrimination and harassment, which have hindered their access to ownership, and usage of land. Tenure arrangement defining conditions of access to land was practiced in feudal England during the 11th Century (Bruce, 1998). The right to hold land was thus a means through which land owners or land lords controlled and exacted loyalties and rates from tenants. Land tenure practices have however undergone significant changes in modern times. These changes include monetization of transactions to guarantee security of tenure, non-interference and uninterrupted use of land for longer or shorter periods.

Land tenure arrangements in most African countries tend to be complex due to its close linkage with rights, inheritance and identity (Place, 2009). Due to the largely communal ownership of land, lands are vested in leaders such as chiefs and family heads as custodians. Most land tenure systems are therefore customary in nature, founded on the norms and values systems of specific cultures. Access to land through these systems are based on connections to lineages (inheritance), patronage and in some

cases purely transactional especially in context where land access has been individualized and monetized (Peter, 2009; Place and Otsuka, 2001). The growth in demand for land due to globalization, large scale land acquisition and the flight of foreign direct investments, are influencing changes in local and customary land tenures systems and arrangements. The changes these systems are undergoing have implications for land access and use (Bohannan, 2018; Tsikata and Yaro, 2014)

In Ghana, as in many African countries, gender and kinship relations play a central role in how land rights and production relations are determined. Under customary land tenure systems, control over resources generally follows clearly defined gender-segregated patterns based on traditional norms, which operate in ways that limit rights of women to land compared to men.

Under Ghanaian customary law, land rights have a three-tier structure (Bentsi-Enchill 1964; Ollenu 1962 in Takane 2002). The first-tier is the land rights held by the entire groups. Land controlled by ethnic groups is clearly demarcated, and the land within each territory ultimately belongs to the people of the ethnic group as a whole. The paramount chief as the head of the ethnic group is the ultimate custodian of the land. In reality, however, several divisional chiefs, under the paramount chief, are entrusted with the management of the land within their territory and make decisions regarding land. The second-tier consists of the rights that individuals or lineages hold to actually utilize the land and make decisions about it. The third-tier is the "usufruct" right obtained through various agrarian contracts.

An FAO study (2004) shows that in patrilineal systems men– viewed as the custodians over land tend to be given more access rights to land than women. The same study notes that the assumption that women will marry and obtain land from their husbands tends

to affect the extent to which women can access lineage lands. But in as much as marriage is regarded as the main channel for women's access to land, it is also perceived as a potential conduit through which land can be lost to another lineage (FAO 2004). Women in intra-clan marriages (endogamy) therefore tend to possess greater land security than those who marry outside their clans (exogamy).

Bukh (1979) contends that the patrilineal rule assigning a woman's children to a different lineage from her own is a special problem facing women in such societies. She explains that a woman's own family will not allow her to use lineage forest land to grow tree crops for fear that her children will claim her trees, conveying land from her own lineage to their father's. Marriage also tends to be a major source of land for women in matrilineal systems. Nevertheless, sources for these groups of women are widening, as women are now able to source land from brothers, uncles, and fathers (Duncan *et al* 2009). However, the pattern of land loss and consolidation is different. In his study of some matrilineal communities in Akyem Abuakwa, Amanor (2000) showed that female lineage members of those communities tend to prefer passing on their lands to daughters, in response to what they regard as unfair male control over land. In recent times, access to land in Northern Ghana ranges from traditional patrilineal inheritance, to purchase and borrowing.

Traditionally, indigenes mostly access land through inheritance, gifts, begging and borrowing. Women access land through marriage and family relations, in which case they use their husband's or brothers' or even fathers' lands or by begging, or borrowing from other men. Migrants on the other hand access land through various tenancy arrangements, and purchase. The mode of accessing land varies in accordance with the land use. All over Northern Ghana it is reported that, agricultural land is not for sale, but given free of charge for use only. This is common in the rural areas. In the case of

housing land and other commercial and industrial land use, land is sold for cash mostly in the urban and peri-urban areas resulting in a situation where the poor and less powerful lose out to those with the means of acquiring lands (Tsikata and Yaro, 2014).

Another strategy through which land is acquired by the landless or resource poor in society is through shared cropping arrangements of different kinds. As Bentsi-Enchill (1964) indicates, migrant and settler farmers and sometimes women typically enter into an *Abunu* or *Abusa*[1] or seasonal tenancy arrangement to obtain lands for farming. Most of these arrangements are entered into with men largely due to the reluctance of landlords to engage women in tenancy arrangements. The perceived lack of physical capacity or strength- to farm the allocated lands to its optimum in order to increase the share of returns for the landlords have accounted for this (Assaga and Hiron, 2019).

Although the linkages between climate change and land tenure are complex and indirect, the effects of climate change and variability are felt through changes in natural ecosystems, land capability and land use systems. Increasingly, these changes are likely to place the diminishing supply of land under greater pressure, for both productive use and human settlement (Quan & Dyer, 2008). The past decade has seen several communities in Sub-Saharan Africa implement certain agroforestry techniques in an attempt to adapt to current environmental trends and climate change.

[1] The abunu and abusa are variants of sharecropping agreements. Under the abunu system, two forms are identifiable - *dua mmiɛnkyɛ* or division two (where the tree crops say, cocoa are divided into two including land and the tenant-farmer's portion remains with him/ her through the lifetime of the plantation) and *apaso abunu* (where the farm proceeds are equally shared between landlord and tenant). In the case of the *abusa*system, the proceeds from the sale of farm produce is shared in the ratio 1:2 between landowner and tenant-farmer respectively (Asaaga and Hirons, 2019 page 5).

Some of the efforts made in certain communities in Zambia for example include the planting of fast-growing nitrogen fixing trees as a form of climate smart agriculture – aimed at contributing to dual food security and climate change adaptation improvements for resource-poor farmers. Harvey *et al* (2014) also indicated that poor smallholder farmers would be most vulnerable to the adverse impact of climate change. This technique of agroforestry has the potential for improving soil fertility, crop yields, and a range of additional benefits on smallholders' farms (Mbow *et al* 2014) However, its uptake by smallholder communities across much of sub-Saharan Africa including Ghana has remained persistently low. An abundance of literature highlights a range of contributing factors, including cash and resource constraints, inaccessibility of agricultural inputs, incompatible land management practices, such as land preparation by fire and livestock browsing, and insecure tenure rights, as well as disincentives driven by cultural practices, such as matrilineal inheritance (Mercer, 2004). From the foregoing, it may be noted that land access and use under both matrilineal and patrilineal systems have undergone some transformations and modifications as a result of the pressures of population growth, cash-crop led marketization, commoditization of lands, large scale migration, and rapid urbanization among other modern trends which have produced increased competition and land scarcity resulting in increasingly politicized conflicts over land (IIED, 1999, cited in Crook; 2005).

In a developing economy such as Ghana, access to land and natural resources is important for improving the livelihoods of poorer groups. Farmers' livelihood decisions with respect to cropping strategies and labour input are strongly influenced by land tenure arrangements (DFID, 2000 cited in Adjei-Nsiah 2006: 142). Several scholars (Gavian and Ehui, 1999; Gavian and Fafchamps, 1996; Fraser, 2004) argue that contractual arrangements such as land renting and sharecropping reduce incentives to

invest in soil fertility management due to tenure insecurity. Gavian and Fafchamps (1996) reported that tenure insecurity incites farmers to divert soil-enhancing resources to more secure fields whenever possible.

Adjei-Nsiah, Leeuwis, Giller, Sakyi-Dawson, Cobbina, Kuyper, Abekoe and Van Der Werf, (2004) also found an association between tenure insecurity among migrant farmers especially, and limited attention to regeneration of soil fertility. The use of land becomes problematic as it generates rift between landowners and migrant farmers. Adjei-Nsiah *et al.* (2004) further argue that landowning indigenes often accuse migrants of degrading their lands, which in turn makes land owners reluctant to rent land to migrant farmers beyond two years. The migrants cite tenure insecurity and high cost of land rent as reasons for not investing in soil fertility regeneration.

Another reason is that the migrants mainly seek to satisfy their pressing economic needs rather than maintaining the land for long-term investment or use. Thus, it appears that there is a widespread lack of trust between the migrants and the indigenes. The indigenes do not trust that when they rent land to migrants for a longer period, they will take good care of it. The migrants on the other hand are afraid that when they invest in soil fertility, they will not be allowed to reap the full benefits (Adjei-Mensah *et al.*, ibid). Therefore, the problem that arise is the conflicts that exist between the natives and migrants over tenurial arrangement involving the terms of reference during land acquisition.

The change of route of access to land may deepen the poverty of the marginalized and poor groups of the society who hitherto could access land for use only, using social networks, as against ownership. This is because, the customary system made it easier for women and migrants who could not own land in the property rights sense, to access

land for their livelihood. With the changing access routes in favour of cash payment, such groups may not be able to access land again if they cannot purchase it for their use. Since women constitute the majority of the poor in Africa, very few women can own land in the property right sense under commoditization of land. These circumstances are therefore expected to exacerbate the exclusion of vulnerable groups such as women and migrants from land ownership and use.

2.8 Definition of terms/concepts

A number of terms and concepts were used in this study. They are defined and explained to facilitate understanding of their usages in the work.

Climate variability: The two concepts/words are used in the work either together with climate change or alone. It connotes variations or shifts in the climate observed as a continuous process at different levels (Ghil 2002). These variations can be either pronounced in the case of the El Nino or subtle in the form of a marginal increase or decrease in atmospherics temperature for short periods. The IPCC in its glossary of terms and definitions refers to climate variability as the "variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all temporal and spatial scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forces (external variability)" (IPCC 2014 page 121).

The variability referred to in the thesis may be due to natural internal processes or external forces, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. The combination of the United Nation's Framework

Convention on Climate Change (UNFCCC) and the Intergovernmental Panel on Climate Change provide a basis for this explanation.

Socio-cultural norms: This refers to all forms of inheritance practices and land tenure arrangements within the study sites. The inheritance patterns include the matrilineal, patrilineal and double decent systems. The land tenure arrangements encompass all context specific tenure systems and allodia rules on the bequeathal and transfer of community and family lands for farming, building and other purposes.

Smallholder farmer: The concept of smallholder farmer tends to connote different understanding and description in different places. Its depiction is hinged on the nature of land access and the general availability of land for agricultural purposes. Land holdings have been used as a key characterization a smallholder farmer (Chamberlin, 2007). Indeed Ekboir *et al.*, (2006) conceives a smallholder farmer to be a farmer who has less than 5 hectares of land under production. The study adapted this definition as the measure of a smallholder farmer. Though the use of only land holding appears to limit the full expanse of who a smallholder farmer is, Jayne *et al.*, (2003) point the strong correlation between land holdings and poverty by stressing the linkage between the size of land a farmer has access to and use for cultivation and household income and other variables.

Vulnerability: The use of vulnerability in this work refers to sensitivity and response to the impact of climate variability. It encompasses the three components of vulnerability including *exposure* to varying degrees of climate conditions, *sensitivity* to the impacts of shifts or changes in climatic conditions or extremes and *adaptive capacity* to address the effects of climate conditions. In this way, vulnerability is the likelihoods of facing the negative effects of climate variability (IPCC, 2012). The

assessment of vulnerability is based on the five (5) sustainable development capitals. These include, human, natural, financial/economic, social and physical capital. The more or less a household has determined the depth of vulnerability relative to climate variability impacts. Importantly, vulnerability in this context is seen as a social process emanating from the influence of social and cultural institutions on the ability of groups and individuals to use community-based resources in this case land. The stress on sensitivity and response is hinged on the understanding that the architecture of entitlement may increase the exposure of people to climate extremes and at the same times influence their accessibility to resource and thus their response to impacts.

Adaptive Capacity: The IPCC defines adaptive capacity as "The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences" (IPCC, 2014, page 118). The adaptive capacities are therefore hinged on resources access embedded within the contextual architecture of entitlement.

Sensitivity: The extent to which a system is affected negatively or positively by climate related events. Sensitivity levels tend to be cumulative as previous effects of climate related event directly influence future sensitivity levels (IPCC, 2001).

Exposure: Exposure in this work refers to the degree to which people or resources are negatively affected by climate variability and change impacts due to where they are located. For instance, households whose farms are located in places prone to flooding have a high exposure compared to those on higher grounds and therefore less likely to experience flooding on their farms.

2.9 Theories/Concepts underlying the study

The study was grounded in three theories/concepts. These concepts provided the basis for drawing linkages and connections between the key variables of the study namely inheritance patterns and land tenure and use arrangements and their implication on adaptation to climate variability impacts. The concepts/theories used include contextual vulnerability by O'Brien *et al*., (2007), Architecture of entitlement by Kelly and Adjer (2000, 1999) and intersectionality as an analytical framework.

Kelly and Adger (2000) concept of architecture of entitlement provided a clear basis for analysing the linkages between social, economic and institutional factors that influence levels of access to adaptive resources and how the degree of access shape the nature of vulnerability to climate variability impacts within a community thereby promote or constrain options for adaptation. In this way specific variables of interest include inheritance patterns, rules governing access and control of communal and family resources especially land. Residential status in community, indigene or migrant/settler also constituted an important analytical variable in the study. It is argued in this study that gender (female vs. male) and other socio-demographic variables which shape the strength and capacity of men and women as well as residential status in community (settler vs. indigene) represent important variables in how the contextual factors embodied in socio-cultural norms and values inhibit or enhance adaptive options of people.

Additionally, O'Brien *et al*. (2007) concept of contextual vulnerability which constitutes a human security framing of vulnerability as a function of the determinants of entitlement helped to understand how the architecture of entitlement in communities engender vulnerability for different social groups especially the gendered outcomes. The concept suggests that climate variability and change occur in the context of

political, institutional –both formal/governmental and **traditional (which is the focus of the study)**, economic and social structures, which interact in dynamic ways to influence exposure and response to climate variability and change.

Underlying these concepts is Kimberley Crenshaw's (1988; 1991) intersectionality approach as an analytical framework. In this way the concept is used to interrogate how the interlocking systems of power impact those who are most marginalised, women and migrants, in society (Cho, Crenshaw and McCall, 2013). The core argument here is that the different sources of social differentiations tend to reinforce each other. As Collins (2012) notes, cultural patterns of oppressions are not only interrelated but are bound together and influenced by the intersectional systems of society. Using intersectionality as an analytical approach therefore considers the historical, social and political context and recognises the unique experiences of individuals based on the intersection of all relevant aspects of the social experience (Collins, *ibid*).

The specific theories, concepts and analytical frameworks used in the study are outlined in the sections that follow.

2.9.1 Architecture of Entitlement (Adger and Kelly, 1999; Kelly and Adger, 2000)

The concept as suggested by Adger and Kelly (1999) and Kelly and Adger (2000) constitutes a basis for understanding social vulnerability as a consequence of climate change. Vulnerability they argued is occasioned by the extent to which different social groups and persons are entitled to access and use socially and culturally available resources to manage the impact of stresses, especially climate extremes. Entitlement is therefore expressed as:

"The extent to which individuals, groups or communities are 'entitled' to make use of resources which determines the ability of that particular population to cope with and

adapt to stresses" (Adger and Kelly, 1999:256). The architecture of entitlement therefore provides the basis for social vulnerability as a result of the way access to resources is mapped. In order to assess social vulnerability Adger and Kelly identified three integral things to be considered.

1. A deliberate analysis of the social and economic bases for entitlement, which is expressed at the individual level
2. How the entitlements are distributed at the community level and
3. The institutional context, within which entitlements are formed, contested and distributed over times and among groups.

The social and cultural context is therefore key for climate change adaptation due to their mediatory effects. The cultural context and the social differentiation of entitlements in this way constrain the adaptive capacity of certain groups while enhancing that of others. The differentiations imposed by the systems of entitlements thus create unequal social relations with the consequence of deepening vulnerabilities through maladaptation and use of unsustainable adaptive options by marginalised group. The cyclical use of unhelpful and unsuccessful adaptive strategies to deal with climate change impacts have been noted by *O'Brien et al.,* (2007) as rooted deeply in social and cultural norms on access and use of resources. O'Brien *et al.* (2007) concept of contextual vulnerability will be discussed in the next section.

The inequalities created through differentiated access to adaptive resources are rarely addressed in the course of adaption but are rather reproduced and deepened through repeated exposure to climate extremes (Cannon, 1994).

2.9.2 Contextual Vulnerability (O'Brien *et al.*, 2007)

O'Brien *et al*., (2007) in their paper, "Why different interpretations matter in climate change discourses", present two approaches to understanding and interpreting

vulnerabilities arising from changing climatic conditions, especially extreme ones. The two approaches are, outcome vulnerability (scientific framing) and contextual vulnerability (human security framing). The scientific frame therefore seeks to measure the degree to which human actions lead to climate change in order to evolve ways of addressing such changes or mitigating them. The human security framing on the other hand views climate change as a process of change resulting in varied impacts and effects on people and societies. It therefore seeks to explore ways to either stop the on-going process of change or adjust systems and life styles to adapt to the changes in order to safeguard livelihoods. Resources are therefore sought to facilitate adaptation for different categories of people.

Contextual vulnerability therefore constitutes an important building block augmenting the architecture of entitlement as presented by Adger and Kelly (1999) to analyse social vulnerability to climate variability and change impacts. According to O'Brien *et al*. (2007),

> "Contextual vulnerability is founded on a process based and multi-dimensional view of climate– society interactions. Both climate variability and change are considered to occur in the context of political, institutional, economic and social structures and changes, which interact dynamically with contextual conditions associated with a particular 'exposure unit'. …. Contextual conditions influence the exposure to climate variability and change, as well as potential responses. Responses can in turn affect both the processes and contextual conditions" (page 76).

Consequently, actions to reduce vulnerabilities of specific marginalized groups entails reshaping contextual norms and entitlement to guarantee equitable access and use of

resources or adaptive options (Athanasiou and Baer, 2011, Adger *et al*., 2006). Using such lenses to interrogate climate change vulnerability facilitates the identification of opportunities and challenges to adaptation to climate variability and change impacts.

2.9.3 The Intersectionality Approach (Crenshaw, 1989, 1991)

The intersectionality theory used in feminist discourse and critical race theory to explore and conceptualise the complex interrelationships of gender, race, ethnicity and other forms of social divisions (Yuval-Davis, 2006) is used in this study. Since it was first used by Kimberley Crenshaw in 1989 with a follow up in 1991 to engage the "sameness" and "difference" discourse in relation to the multiple oppressions of women with colour (black women) in the American legal context, the use of the concepts has evolved into an analytical tool to understand social differentiations and divisions which result in the creation of disadvantages for specific social groups especially women (Nash, 2008). The theory has been used as a method and a disposition, a heuristic and an analytic tool (Carbado *et al*., 2013). Its development has therefore been shaped by the "acute awareness of the limitation of using gender as a single analytical category" for assessing unequal power relations and disproportionate gendered resource access (McCall, 2008)

The scope of intersectionality has thus been widened. "The widening scope of intersectional scholarship and praxis has not only clarified intersectionality's capacities; it has also amplified its generative focus as an analytical tool to capture and engage contextual dynamics of power" (Cho et al., 2013:788). Using intersectionality as an analytical tool has deepened its adoption in other disciplines to interrogate and discuss how "gender, and other social dynamics" are intricately woven (Lewis 2013). The heart of intersectional analysis is the understanding that women (and men) are

involved in intersecting social relations that structure their lives and determine their experiences.

The application of the intersectionality theory as an analytical framework in this thesis is to enable an unpacking of the power relations regarding the distributions of resources and levels of access. Additionally, using the approach will facilitate an analysis of the intersection of gendered and other social categories in shaping in however inheritance norms are applied to affect access, use and control of land.

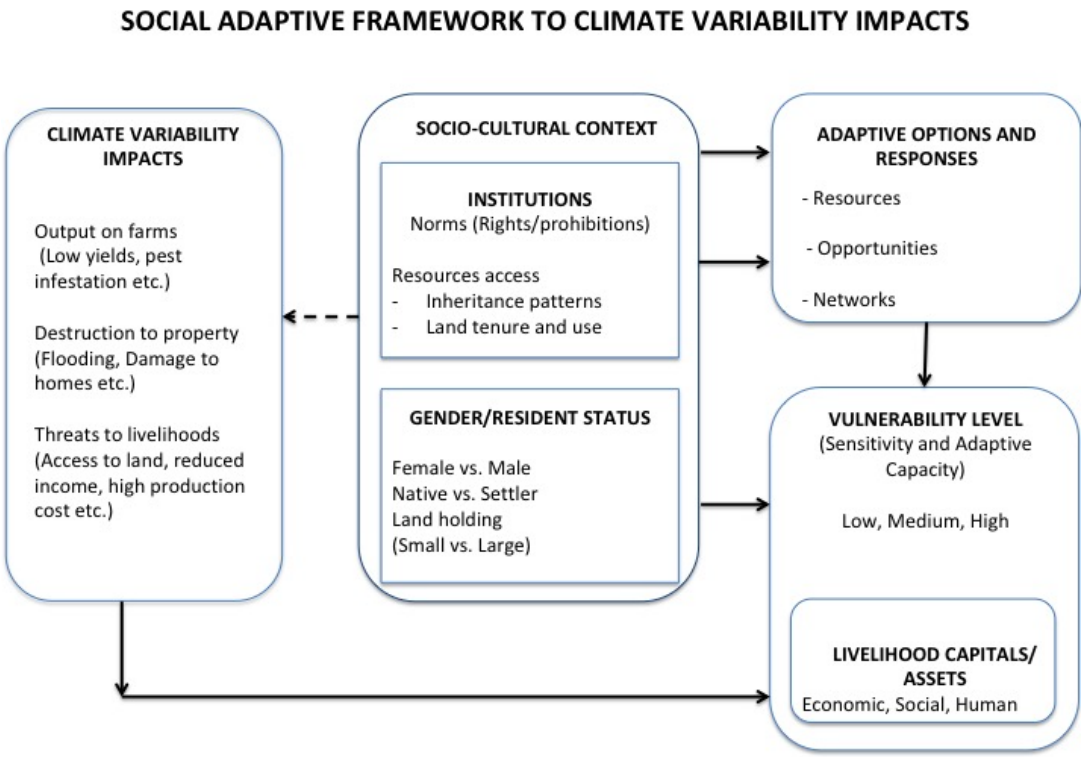
2.10 Conceptual Framework

The conceptual framework for the study is underlined by the architecture of entitlement theory, the contextual vulnerability theory and the intersectional approach. The framework guided the study to understand the influence of community based socio-cultural factors, individuals' ability to adapt to changes and impacts brought about by variability in climatic conditions. The core argument of the framework is that, social and cultural factors come together in different ways to enhance or constrain options and responses to the effects of climate induced changes experienced. In this way, adaptive responses to the impacts are mediated or shaped by the socio-cultural factors thereby influencing the nature of adaptive responses and the kinds of opportunities accessible and usable. The nature of adaptive responses thus impact on the vulnerabilities of individuals and groups depending on the strength of their social, natural, physical, financial/economic and human capitals. Vulnerability in this regard is conceived as a social process – social vulnerability, places individuals and groups squarely within social and cultural processes which guarantee access, use and control of resources. The conception of vulnerability also considers how institutional arrangements to control

resources use may impose restrictions and limit adaptation processes by certain groups of people.

The study argues that due to the many complexities involved in navigating the process of adaptation to climate variability, socially constructed categories of differentiation interact to create an ordered system privileging certain groups of people within the social setting while at the same time denying or disadvantaging others. The consequent effects may lead to either enhancing or hindering access to, use and control of adaptive options shaping the vulnerability index of individuals and collectives. Scoones' (1998) economic/financial, social, human, natural, physical capitals of the sustainable livelihood framework served as the basis to determine the vulnerability index of households. The analysis of these capitals considered the cumulative and knock-on effects of each capital on the other. Analyzing their strength and impacts in this way ensured that those that derive their influence from others are noted to avoid double counting. The process ensured that attribution and rationalizations are clear.

Figure 2. 1 Social Adaptive Framework to Climate Variability Impacts



Source: Author's construct, 2018

Figure 2.1 shows the different levels of connections, linkages and interplay of social and cultural factors as well as their outcomes. While a number of naturally occurring phenomena have been cited as important sources of global warming leading to climate change, anthropogenic factors constitute a key part of the causes of such changes. The consensus of attribution from both climate scientists and policy makers is that anthropogenic factors contribute close to 97% to global warming and climate change. The socio-cultural context therefore provides the platform for all human activities leading to emissions and increased carbon footprints. Though the localized activities within the rural communities such as bush burning, felling of trees and others are not significant enough to influence global climatic changes, they add to the total sum and contribution of anthropogenic factors. The influence of the activities within the socio-

cultural context is thus shown in the diagram using a doted arrow to indicate the lose connection or influence on global climate change and impacts.

The conceptual framework indicates that climate variability, which stems from the combined consequence of increasing global temperatures and anthropogenic factors has a number of impacts on smallholder farmers including output on farms (poor and low yields), destruction to property, threat to livelihoods etc. These effects and impacts of climate variability directly shape the forms of vulnerabilities experienced by different categories of persons within a specific context based on their levels of sensitivity to the impacts and adaptive responses. It must be noted that sensitivity and adaptive responses are shaped by the strength of a person or group's economic, natural, physical, social and human capitals, which are the result of the interplay of socio-cultural factors.

The socio-cultural factors in this regard embodies the institutions (non-material aspects of culture) determining access, use and control of resources in the community and the rights as well as opportunities accorded to people based on their gender, resident status in the community and land holding. The social and cultural factors dictate who is entitled to inherit and from whom, granting access to both family and community resources especially land. Besides inheritance, the land tenure arrangements (renting, shared cropping, labour tenancies or freehold) can influence use, control and possible transfer for income.

Socio-cultural variables due to their effects on access, use and control of both family and community resources influence the adaptive capacities of groups and individuals. As a result, the adaptive capacities and responses of individuals and groups are shaped by their degrees of permissible access and use. The greater the degree of access the better a household's ability to fashion appropriate responses to the impacts of climate

variability its livelihoods. In this way the adaptive options and responses affect the vulnerability statuses – exposure and sensitivity- of those affected by climate variability impacts.

From the foregoing, the process of adapting to climate variability is mediated by strong and coercive socio-cultural factors (inheritance and land tenure arrangements). The tools and resources to address the impacts of climate variability, how a person or household plans to use the tools and resources to secure livelihoods or even diversify livelihoods and the success of such actions are dependent directly or indirectly on how the socio-cultural variables play out.

Weak adaptive capacity and response result in increased exposure and sensitivity to climate impacts whereas strong adaptive capacity and response lead to decreased exposure and sensitivity to climate variability impacts.

2.11 Conclusion

The chapter has so far explored the concept of climate variability and change. In spite of debates and contestations on the sources of climatic changes the world is currently undergoing, the balance of opinion is that anthropogenic factors contribute immensely to the changes. The anthropogenic factors stem from the quest for development and improvement of livelihoods, through industrialization, urbanization and an unbridled drive for the use of natural resources. Reviewed works have indicated that the increasing effects of the rapidly changing climate call for deliberate actions to adapt to the changes at the global, national and community levels. Adapting through the use of adaptive options and resources however are founded on the degree to which recourses could be accessed and used. The use of resources in this way are guided by rules which create inequalities and differential vulnerability for marginalized group with significant

gendered outcomes. The entrenched non-climatic factors in the form of inheritance patterns and land use arrangement become bases for exposure, sensitivity and eventual state of vulnerability to climate variability and change impacts experienced.

CHAPTER THREE

METHODOLOGY AND PROFILE OF STUDY SITES

3.1 Introduction

This chapter presents the specific methodological approaches used in the study. It provides details on study design and approaches used while offering justifications for their use. It further provides details on the selection of study sites and unit of analyses for the study. The profiles of the study sites selected for the study is also presented in the chapter highlighting their suitability for the study. The presentation of this chapter is divided into different sections spelling out specific details under each section. The study design and approaches are presented with empirical and theoretical rationale for the options used. A mixed method approach was used based on a pragmatic philosophical orientation. Profiles of study areas, sampling procedures, sampling techniques, sample size and target populations are discussed. Instrument design and process of data collection and analyses are also discussed.

3.2 Study Design and Approach

The study used a mixed method approach as espoused by Creswell (2009). This approach used strategies of inquiry that involve collecting data sequentially to understand the research problem and find relevant answers and responses to the research questions (Leech and Onwuegbuzie, 2009). In this regard, both qualitative and quantitative techniques were used in the selection of respondents, design of tools and techniques for the collection of data and analysis to answer the research questions (Bryman, 2016).

Using a mixed method approach is in keeping with the pragmatist philosophical foundations of scientific inquiry where the best-suited approaches are used to obtain desired results without neglecting acceptable scientific rigour (Biesta, 2010; Feilzer, 2010; Melles, 2008). The relevance of combining both quantitative and qualitative approaches emanates from the fact that, the two approaches facilitate the production of socially useful information for planning and decision-making (Feilzer, 2010). This will ensure that while validity of results is maintained, rules pertaining to each paradigm are adhered to (Morse and Niehaus, 2009).

Moreover, unlike the sole use of qualitative or quantitative approaches, mixed method approaches provide deeper and complete understanding of the subject under investigation, and offer a broader scope (Greene, 2007; Johnson *et al*., 2007). To harness the full potential of the methods combined; mixed method researchers ensure that the strengths of the qualitative and quantitative strands of their study overlap, while their weaknesses offset each other (Teddlie and Tashakkori, 2009). Thus, the quantitative strand can provide statistical power and generalizability while the qualitative element provides meaning, context and depth (Teddlie and Tashakkori, 2009). Mixed methods scholars have argued that combining qualitative and quantitative data is a natural method of everyday problem solving (Morgan, 2007; Tashakkori and Teddlie, 2010)

The integration of both qualitative and quantitative methods in research planning, sampling, data collection and analysis is best suited for exploring and examining the influence of socio-cultural factors on adaptation to climate variability impacts by smallholder farmer households. This is essential in this study where socio-culturally different contexts were studied to assess the influence of the different forms of inheritance patterns and land tenure arrangements on the gendered adaptation to climate

variability impacts. Combining qualitative and quantitative measures ensured that the different tools and techniques employed in the study addressed inherent inadequacies in each approach. In this way, important nuances were analyzed and connections between variables of concern were explored.

3.2.1 Philosophical basis for study design

The use of pragmatism as the philosophical basis of this work is based on the epistemological stance that, social phenomenon and social structures vary and may behave in different ways (Creswell & Plano Clark, 2007). Morgan (2007) has argued that different approaches are required to understand and analyse the multiple nature of social reality. This process helps to break away from the usually constraining and forced dichotomy of positivistic objectivity and the subjective interpretivism characterized by uncompromising and prescriptive use of quantitative and qualitative methodologies respectively. As Feilzer succinctly puts it, 'a paradigm can constrain intellectual curiosity and creativity, blind researchers to aspects of social phenomena, or even new phenomena and theories, and limit 'sociological imagination' (2010:7).

Pragmatism therefore presents the world as life itself with objective and subjective elements and sometimes a mixture of both. These differences come together to make life complete and meaningful. Therefore, using the best methods and approaches to investigate and understand social realities facilitate the capture of both observable-measurable- and unobservable aspects of social phenomenon to appreciate the full measure and manifestations of the subject of interest.

3.3 Background Characteristics of the Study Districts and Study sites

The study was conducted in two ecological zones of Ghana, the savannah and the transitional zones. The Nkoranza South Municipal and Bawku District were selected to

represent the transitional and savannah zones respectively. Changes in climatic conditions characterized by erratic and unpredictable rainfall as well as increasing seasonal changes leading to long dry spells and droughts have adverse outcomes on the livelihoods of smallholder farmers in the two districts. Scholars such as Asante and Amankwa-Mensah (2015) have noted with concern the growing impact of rising temperatures and dwindling rainfall on health, energy and agricultural production. These effects are felt even strongly in the Savannah belt of Ghana where the combined effects of increasing experiences of longer dry spells and destructive rains are posing greater risks to lives and property. In a similar vein, Owusu and Waylen, (2008) have pointed out that the transitional zone, which is very important for food production in Ghana is experiencing growing shifts in its rainfall climatology. The annual wet periods continue to shrink whiles the dry periods grow. Besides the shrinking of the overall wet periods, Owusu and Waylen (2013) have raised concern on the further shrinking of the second rain in the transition zone due largely to the changing rainfall climatology. The overall impacts of the observed changes in climatic conditions include disruption to planning of farming activities with implications on yields and income, increasing incidence of pest infestations, droughts, floods and rapid loss of soil fertility.

In addition to the increasing effects of climate variability/change on the productive lives of smallholder farmers in the two areas, the different inheritance patterns practised in each location were considered in their selection. This was because of the effects contextual rules on land access and other land use arrangements have on the ability of different social groups to access land. The two areas therefore provide important comparative insights into how norms embedded within inheritance patterns and land tenure arrangements influence the gendered differentiation of smallholder adaptation to climate variability impacts.

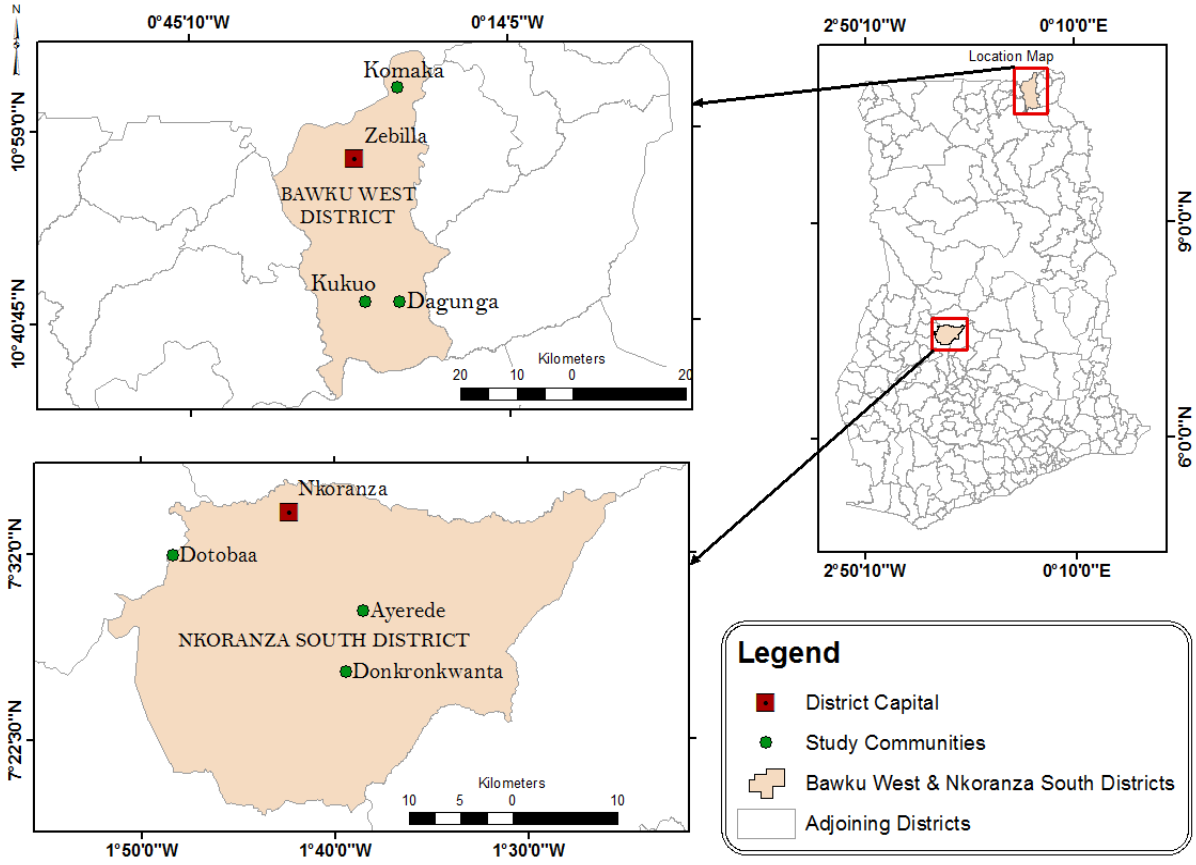
The Bawku West district's location near the White Volta exposes it to periodic flooding coupled with long periods of droughts that threaten livelihoods, through disruptions to farming communities along the river (GSS, 2014; Etwire *et al.*, 2013). The threat to livelihoods is more pronounce among smallholder households (Nakuja *et al*, 2012; Armah *et al*, 211). The increasing threats to livelihoods coupled with the patrilineal inheritance systems and complexities in the allocation of land especially in the case of women and migrants make the site a unique place to conduct a study. Communities selected for the Bawku West are Kukuo (South West), Komaka (North West), Dagunga (North East) and Gbango (South West). The district is located in the Upper East Region of Ghana.

Nkoranza South Municipal on the other hand is located in the transition zone of Ghana and administratively in the Bonno East Region. The municipality is gradually experiencing extreme climate variability with significant changes in the rainfall pattern (Dumenu & Obeng, 2016; Abu *et al*., 2014). These changes are party accounted for by increased felling of trees and other anthropogenic practices such as bush burning. Observed changes in the vegetation have led to a gradual reduction in rainfall and temperature rises over the past few years (GSS 2014). Also, large proportion of the population (nearly 34%) of the municipality are migrants most of who come from the three northern regions. The migrant population which is largely composed of smallholder farmers are especially challenged as their control over land, an important resource for adaptation, is constrained. In addition, the matrilineal inheritance system, which is reckoned through the female line, is practiced in the area. The inheritance practice in addition to land tenures practices- renting, shared cropping and freehold ownerships- within the area make the place suitable for the work. The important considerations here are the complexities in land access and the strategies used by

households to navigate the socio-cultural landscape to adapt to the impacts of climate variability. The specific communities selected for the study were Jerusalem No.1 (North West), Ayerede (North East), Dontro-Nkwanta (South West) and Dotobaa (South East).

The communities in each district were selected with the input and assistance of officers of the agricultural directorates. To obtain these specific communities for the study, a first stage of dividing each district into four parts using the directional points of the compass, that is, north, south, east and west. This was to ensure that the desired number of communities were dispersed and spread across each district. The second step was to randomly select a number of communities in each direction or quadrant. The selected communities were assigned random numbers after which a computer was used to select a community from each quadrant. The locations of the communities selected are shown in Figure 3.1.

Figure 3. 1 Map Bawku West and Nkoranza South districts showing study communities



Source: Authors depiction, 2019

3.4.1 Profiles of Study Areas

The study areas for the study are discussed below. In order to provide a good picture of the study areas, each area will be discussed separately.

3.4.2 Bawku West District

The district is located in the Upper East Region of Ghana. Geographically, it lies roughly between latitudes 10^0 30'N and 11^0 10'N, and between longitudes 0^0 20'E and 0^0 35'E. The District shares boundaries with Burkina Faso in the North, Bawku Municipality to the East, Talensi/Nabdam District to the West and East Mamprusi

District to the South (GSS, 2014a). The area experiences a unimodal rainfall regime lasting between 4 to 6 months and a long dry period of 6 to 8 months in a year.

Two important tributaries of the Volta River namely the White and Red Volta ran contiguous to the Districts' Eastern and Western boundaries respectively. The District covers an area of approximately 1,070 square kilometers, which constitutes about 12% of the total land area of the Upper East Region. Based on its land area, it is the fifth biggest district in the Upper East Region (GSS, 2014).

Both the White and Red Volta and their tributaries drain the District. Though the presence of these rivers provides good sources of water for dry season farming, it has become a source of worry for farmers. The rivers over flow their banks during the rainy season (April-October) resulting in the flooding of farms and homes. The annual flooding of hectares of farms lead to significant loses of farm produce (Gyireh, 2011; Glazebrook, 2011).

Agriculture constitutes an important socio-economic activity in the Bawku West District. It provides income and employment for over 81% of the population. The total cultivable area is 58,406 Ha and uncultivable area of 33,687 (Sidibe *et al*, 2016; MoFA, 2018).

In spite of the heavy dependence on agriculture in the district, the activities of farmers are plagued with a number of challenges. These include, unpredictable weather conditions and dwindling soil fertility. The two most frequently deficient nutrients are nitrogen and phosphorus. Due to the combined effects of topography, human activities and vegetation, the build-up of any amount of organic matter is constrained by regular burning of crop residues and/or competitive use of these residues for fuel, animal feed or building purposes. The low vegetative cover during the dry season also renders most

of the soils susceptible to erosion during the rainy season. This, in turn, exacerbates the low fertility problem. The sustainability of good crop yields is therefore closely linked with careful management of the soils with the objective of preventing and controlling erosion, increasing organic matter content (compost, crop residues, farmyard manure, etc) and replacing and increasing plant nutrients lost through erosion, leaching and crop uptake (MoFA, 2018).

The Vegetation is Sudan savanna consisting of short drought and fire-resistant deciduous trees interspersed with open savanna grassland. Grass is very sparse and in most areas the land is bare. The district has a sparsely inhabited Oncho-freed woodland and forest belt and the uninhabited forest reserve along the eastern and southern portions of the Red and White Volta, stretching from Widnaba- Tilli area through Binaba-Kusanaba and Zongoyiri to East Mamprusi (GSS, 2014).

The natural environment is highly degraded by land clearing for farming, fuel wood harvesting, overgrazing, bush fire and harvesting of poles for construction. The gold deposits found in the rocks north of Zebilla and south of Sapelliga have increased the desire for mining by the youth. This is very clear in the Widna –Teshie zone where illegal surface mining and stone quarrying are prevalent resulting in serious land degradation and the pollution of surface water bodies.

The demographic characteristics of the Bawku West District are similar to the prevailing situation in Upper East Region. These characteristics include large household sizes, high illiteracy rates, that is, about 80 percent in the district, high birth and fertility rates. The district has a total usual resident population of 93,028 according to the 2010 Population and Housing with an average household size of 6.1 persons. About 79% of the population is economically active. Of the employed population, 81.0

percent are engaged as skilled agricultural, forestry and fishery workers, 6.1 percent in service and sales, 6.9 percent in craft and related trade, and 2.9 percent are engaged as managers, professionals, and technicians (GSS, 2014).

As high as 93.3 percent of households in the district are engage in agriculture. In the rural localities, 96.5 percent of the total number of households is into agricultural production while in the urban localities, 68.4 percent of households are into agriculture. Most agricultural households in the district (98.1%) are involved in crop farming. Chicken and guinea fowl are the dominant animals reared in the district (GSS, 2014). Major Agricultural produce includes maize, rice, sorghum, millet, groundnut soybean and cowpea.

3.4.3 Nkoranza South Municipal

Nkoranza South Municipal is located in the Bonno East Region of Ghana. It lies within longitudes 1^{o} 10'W and 1^{o}55'W and latitudes 7^{o} 20'N and 7^{o} 55'N covering a total area of about 920km^2. The district has about 105 settlements, which are mostly rural. It shares boundaries with Nkoranza North District to the North, Techiman Municipality to the West, all in the Bonno East Region and Offinso North District to the South and Ejura-Sekyeredumase to the Southeast, all in the Ashanti Region. The District has one political constituency, (Nkoranza South) and one traditional Paramount Authority (GSS, 2014).

The municipality forms part of the transitional zone between the savanna woodland of northern Ghana and the forest belt of the South. Savanna woodland and fewer areas of savanna re-growth largely characterized the eastern part of the district. The Southern part of the district is largely marked by forest re-growth, made up of shrubs and grasses with few original tree species, especially silk cotton trees. It is well drained by several

streams and rivers; notable among them are Pru, Tanko, Fanku, Abubre and Agyemfra. Most of the rivers and streams take their sources from the North–Eastern portion of the District, flowing South and Northwestwards (GSS, 2014).

Nkoranza South municipal lies within the wet semi-equatorial region, having a mean annual rainfall level ranging from 800-1200mm. It has its major rainy season from March to June, experiencing her minor rains in September to November. The month of August experiences a short dry season, with the prolonged one in the months of December to March. Though temperatures in the District are generally high, the average annual temperature is about 26^{o}C.

The Municipality according to the 2010 Population and Housing Census has a population of 100,929. Males constitute 49.6 percent and females represent 50.4 percent. More than half (52.9%) of the population in the municipality lives in rural areas. It has a total number of 26,930 households. The average household size in the municipality is 4.5 persons per household (GSS, 2014). Of this population 75% are economically active. About 75% of the economically active population are engaged as skilled agricultural, forestry and fishery workers, 8.0 percent in service and sales, 7.0 percent in craft and related trade, and 5% are engaged as managers, professionals, and technicians.

As high as 81.7 percent of households in the Municipality are engage in agriculture. In the rural localities, eight out of ten households (83.3%) are agricultural households while in the urban localities, 67.2 percent of households are into agriculture. Most households in the municipality (99.2%) are involved in crop farming. Main food crops cultivated are maize, yams, vegetables, cassava, groundnut, cowpea, cocoyam and plantain (GSS, 2014). Cotton and tobacco grow well in some parts of the district.

The prevalent farming practice in the district is the slash and burn method of clearing the land. This does not only leave the farm lands bare and exposed to erosion but it is gradually destroying the vegetation and changing the ecology of the district. In fact, the practice has changed the forest vegetation into savanna grassland in most parts of the municipality.

Incidence of bushfires is also high in the area. The activities of farmers, charcoal producers, game hunters and other human factors cause the bushfires. Charcoal production has been one of the major causes of environmental degradation in the district. The municipal Assembly has put in place stringent measures to overcome the challenge. However, charcoal production and unguarded bush burning persist in inaccessible parts of the district since enforcement agencies are not able to reach such places. (GSS, 2014)

Streams and rivers in the district dry up during the dry season. This is due to increased human activities in and around watersheds and riverbanks. Poor farming practices along water bodies, for instance, have led to exposure of riverbanks. The resultant effects of such activities are erosion and evaporation of streams, and the dwindling potential of dry season farming.

3.5 Justification for selection of study sites

The selection of the two different ecological zones and different socio-cultural context provides basis for comparison to determine how the different systems influence adaptation. This is especially in the case of smallholder farmers who diversify their livelihoods or intensify their production with the view of sustaining their households.

Additionally, a key motivation was the somewhat distinct decent or inheritance systems practiced in the two districts. Whereas the Bawku West district is predominantly

patrilineal, where the right to inherit is reckoned through the male line, the largely Akan Nkoranza South municipal is matrilineal. The key differences in inheritance systems offer basis for comparing how the differences in land access due to socio-cultural norms influence vulnerability to climate variability impacts.

3.6 Target population

For the purposes of this work, smallholder farmer households engaged in agricultural production constituted the target population from which the sample was drawn. Therefore household heads were selected as the main respondents for the study. The focus on smallholder farmers to analyse the socio-cultural influence on climate variability adaptation is due to their role in many economies in Africa. They possess great potential to safeguards food productions at both the household and national levels. In spite of the important contribution of smallholder farmers to food production in Sub-Saharan Africa (SSA), they face both personal and systemic challenges, which make them increasingly vulnerable to climate variability and change impacts (Chamberlin, 2007). Morton (2007) has noted that the greater of the burden of climate change impacts are faced by smallholder or subsistent farmers whose heightened vulnerability stem from the combined effects of location in the tropics, socio-economic, demographic as well as policy trends limiting their adaptive options and capacities.

Who a smallholder farmer is, has received attention from scholars. Their characterization has focused on the strength or size of their land holdings as well as the purpose of their productions. These criteria have influenced definition and identification. Smallholder farmers are defined in various ways depending on the context, country and even ecological zone. Using the land holding criterion for defining who a smallholder farmer in Ghana is has largely been accepted. For example, Ekboir,

Boa, Dankyi (2002) suggest that a small-scale farmer or smallholder farmer in any region of Ghana has less than 5 hectares on land. The Ministry of Agriculture (MoFA) of Ghana also maintains that, agriculture which is predominantly smallholder in Ghana is undertaken on land area less than 2 hectares by about 90% of farmers (MoFA, 2006). Following from the position of MoFA the land holdings of households was used as an objective criterion to identify and select respondents and participants for the study.

3.7 Sampling procedure and selection of respondents

A multi-stage sampling procedure was used in the selection of respondents and participants for the study. As a first step, each district was divided into four quarters based on the general outlines on the district map. This division was to ensure that the selection of communities was spread across the districts. After the first division, a community was randomly selected from each quarter. Before the random selection was done, communities prone to climate variability impacts within each quadrant were identified with the assistance of officials from the district assembly and the agricultural directorate of the Ministry of Food and Agriculture (MoFA). The sample of respondents was obtained at the household level. Four communities were selected from each district. Quota, systematic and purposive sampling techniques were used in selecting household heads in the study communities. Data from the Ghana Meteorological Agency (GMet) helped in selecting specific communities that show variability and change in climatic conditions. The criteria used in determining which communities to select for the study were:

a. Communities with a high degree of susceptibility to climate variability impacts. These include periodic long dry spells leading to droughts and crop failure as

well as a high propensity to experience flooding with devastating effects due to their location.

b. Communities with increased exposure to pest infestations in the recent past (not more than five years) due to long dry spells and prolonged experience of high temperatures. This consideration was made based on the increased cases of fall-army worm infestation with its devastating effects on food crops especially maize production.

c. Communities with considerable migrants/settlers' population engaged in agricultural production. The use of this criterion is due to its potential to provide the basis for understanding the dynamics of land tenure arrangements and resources access for indigenes and settlers, its implications for migrants/settler adaptation and influence of certain adaptation practices on migrants/settlers. This consideration was made especially in the case of the Nkoranza South municipal due to the high population of migrant farmers who have settled in communities to farms.

Having used these criteria; eight (8) communities were selected from each of the four (4) quadrants that each district was divided into. This resulted in the initial selection of thirty-two (32) within each district. After the initial selection of the 32 communities in each district, a random process was used to select 4 communities out of the 32 in each district. The resulting 8 communities, 4 communities for each district, were finally used as the study communities. The division of the districts into quadrants and selecting the study communities from each quadrant was meant to reduce bias in the sampling process and improve the scientific rigour of the study. After the communities were selected specific respondents were selected at the household to conduct the survey.

The selection of respondents for the survey followed a multi-staged sampling procedure. Like in the case of selecting the specific communities to use for the study, each community was divided into four (4) parts from a central point with the help of community assistants or agricultural extension officers. The division of the community was to ensure a good spread of the selection of households across each community. After the division, the total expected sample for each community was divided into four (4) and distributed equally across the four areas or sections of the community. The desired sample was increased to the nearest whole number where the division resulted in a decimal. The next stage of the sample involved a random selection of households for the survey. Due to the need for adequate gender representation, attention was paid to the sex of the household heads selected for the household survey. In this case the selection was purposively done to ensure that the number of male and female headed households were closely matched. Specifically, deliberate steps were taken to locate or obtain female headed households. This rule was observed more especially in the case of the Bawku West district where household heads were predominantly males.

Selection of participants for focus group discussions (FGDs) and key informant interviews was done using purposive and convenient sampling methods. For the FGDs, participants were drawn from the communities. Care was taken to ensure that different groups within the community were included. This process was facilitated by community leads. They ensured that the constitution of the groups was representative of all social categories and groups, that, famer groups, age categories, and migrants. The key informants were selected based on their roles of the position they occupy as well as their ability to provide insights for the study. Interviews were conducted with family heads, community leaders, and officials of the district assemblies and MoFA.

3.8 Sample Size Determination

To obtain a reliable sample frame, the researcher used the Ghana Statistical Service's (GSS, 2014), Population and Housing Census data on the proportion of people involved in agricultural production in the two districts selected for the study. The reliance on the PHC 2010 was due to the non-existence of independent data on farmers in the two districts. Based on the Ghana Statistical Service Population and Housing Census 2010 data, the population structure and proportion of households involved in agricultural production are provided in Table 3.1.

Table 3. 1 Population data on districts and proportions in agricultural production

District/Municipal	Population	No. of Households (HH)	Proportion in Agriculture	Proportion of HH in Agriculture
Bawku West	94, 034	15, 169	81%	93.3%
Nkoranza South	100,929	26, 930	81.7%	83.3%

Source: GSS (2014)

Table 3.1 indicates that the two locations have over 80% of households engaged in agricultural production. Though the data is not disaggregated to provide for the number of smallholder farmers and household in each area, MoFA's assertion as stated earlier, on the land area (less than 2 hectares) of most (90%) farmers in Ghana serves as a basis to treat all agricultural households as smallholder in relation to their agricultural production. Based on this assumption, the combined estimated number of agricultural households in the two areas is 42,099. For purposes of clarity the sample sizes for the two study areas were estimated separately to account for the differences in population and household sizes in the two districts.

To estimate the sample sizes for the selected districts Yamane's method (Yamane, 1967) for estimating samples for household surveys was used. The method for the estimation is provided as follows:

$$n = \frac{N}{1 + N(\mathrm{e})2}$$

Where, n = the sample

N = the size of the population/households

e = the error of 5 percentage points.

The specific values of the districts/municipalities are substituted:

Sample Estimation - Nkoranza South	**Sample Estimation - Bawku West**
Number of Households = 26, 930	Number of Households = 15,169
$n = \frac{26930}{1 + 26930\ (0.05)2}$	$n = \frac{15169}{1 + 15169\ (0.05)2}$

By applying Yamane's formulae of sample size with an error of 5% (0.05) and a confidence level of 95% (Yamane, 1967), the calculation of the estimated sample sizes for the two districts were 390 households for Bawku West and 394 households for Nkoranza South. This brought the total sample for the study to 784 respondents selected at the household level. Because care was taken to select communities with similar characteristics, the sample obtained from each district was evenly spread among the selected communities in each district. This is done acknowledging the likely variations in the population and household sizes of the selected communities. In this way

respondents were selected from 98 households in each of the four (4) communities selected in the Bawku West District and 99 households in each of the four (4) communities selected in the Nkoranza South Municipal.

Households were selected to participate in the study based on two essential criteria. First, they must be smallholder farmer households with land holding or farm size not greater than 5 hectares. The household heads may be involved in other kinds of economic activity however farming must be their main occupation. Secondly, all smallholder farmers selected for the study should have lived or stayed and farmed in the community for not less than six continuous months before the commencement of data collection for the study. This period was set to ensure that each respondent has cultivated for at least a single cropping season and therefore have had to go through the process of acquiring land for cultivation and also experienced the nature of climate conditions in relation to planning of farm activities and production.

Smallholder farmers working in out-grower schemes where land, farm inputs and other assistances are offered were not included in the study. Including this group of out-growers has the potential to confound the results obtained as their access to land and other resources are guaranteed, with limited or no influence of socio-cultural norms on access, use and control, by virtue of their membership of such out-grower scheme.

3.9 Data Sources

Two main sources of data were relied upon for this work. The main sources of data were primary data obtained through the Household Survey, Focus group discussions (FGDs) and Key Informant Interviews (KIIs). The primary data assessed the influences of socio-cultural factors on climate variability impacts on smallholder households.

Rainfall and temperature data were the main secondary data used for the study. The data was used to assess the nature and extent of climate variability over time and the possible effects such changes may have on farmer outputs coupled with the disruptions it may have on their income and livelihoods. In ascertaining the effects of rainfall on production output, yield information on maize from the district directorate of agriculture was used.

3.10 Instrumentation

Instruments for the data collection were designed with an underlying pragmatic approach. In that view, three separate instruments were developed to facilitate the collection of information close to the everyday realities of participants of the study. The instruments include, a survey questionnaire, a focus group discussion guide and an interview guide prepared for different categories of key informants. The instruments are attached as appendix to this thesis.

The questionnaire (see appendix 1), which was used for the household survey has eleven (11) parts. The questionnaire commences with series of questions to obtain general bio-demographic information on participants, household characteristics and farming activities. Further insights are sought regarding the types of crops they cultivate, sizes of their farms and the length of time they have been engaged in the cultivation of such crops.

The understanding of the phenomenon of climate change was sought from participants. This was to enable the researcher understand from the viewpoint of participants what climate variability constitutes. This need is occasioned by the fact that, the perceptions people hold about a phenomenon determine their responses and actions to address the challenges it poses. Other parts of the questionnaire explored the nature of norms on

access to land and the gendered issue relating to land access and land use arrangements. Adaptive practices and their outcomes were also examined by the questionnaire.

In order to examine the sensitivity and responses of participants to climate variability impacts, the final parts of the questionnaire assessed the extent and strength of the five capitals of the sustainable livelihood measures. This was to provide a basis to undertake a vulnerability assessment of households.

The focus group discussion guide (see appendix 2) was designed with the goal of capturing qualitative information, which the questionnaire could not assess. The focus was largely on the socio-cultural practices on inheritance and land tenure arrangements and how they are applied within the communities. An important focus was to assess the gendered differentiation in the application of norms on land use practices in general and inheritance practices in particular and how these influence adaptive options. Additionally, the guide was designed to help understand how the land use practices and inheritance pattern lead to the persistence of particular patterns of adaptation shaping exposure and sensitivity to climate variability impacts.

The in-depth interview (see appendix 3) was designed to guide conversations with community leaders, family heads, district assembly officials and officers of the district directorate of agriculture. The guide was designed as a composite document containing sections for the different categories of key informants anticipated and targeted for the study. The interview guide aimed at assessing the nature of inheritance and land tenure practices as well as rules governing their everyday practice. This information was collected from community leaders and family heads. The assessment of district level strategies and support systems extended to farmers during extreme climate events were targeted at district assembly officials and officers of the agricultural directorate.

3.11 Piloting of Questionnaire

The instruments for the study were piloted at Bueko in the Ada East district in the Greater Accra region of Ghana to test their validity and reliability. The pilot provided the opportunity to assess a number of things. These include the average time within which a questionnaire can be completed per respondent. Also, it was meant to check the appropriateness and the extent to which the questions are able to elicit the responses desired by the researcher. In addition to these the understanding of respondents of the questions were assessed to inform reframing of questions and use of familiar terms where necessary.

The pre-testing was conducted on 48 respondents with two focus group discussions. Due to the constraint of time the key informant interview could not be piloted.

3.12 Data Collection and Methods

Collection of data was done sequentially using a three-stage approach. Data collection commenced with the qualitative process. A series of Focus group discussions (FGDs) were conducted at the community level to better understand strategies for adaptation and how these are influenced by inheritance patterns, land tenure systems and norms guiding land access and land use arrangements within the communities. This process shaped, refined and focused the framing of questions for the design of instruments for the survey and in-depth interviews for subsequent stages of data collection.

The second stage of data collection involved a survey using a detailed semi-structure questionnaire to provide relevant data to determine connections, associations and influences of the key variables of interest to the study. In-depth interviews of key informants constituted the last stage of the data collection process. Respondents for this stage were gatekeepers of communities such as traditional leaders and family heads,

and leaders of farmer and community-based organizations. This group provided important data to triangulate how community and family specific rules and norms operate and influence adaptations to climate variability impacts. Additionally, district and municipal level officials and Ministry of Food and Agriculture (MoFA) were interviewed to understand formal measures undertaken to enhance people's ability to address the impacts of climate variability. Table 3.2 provides details on the instruments used, the type of respondents and number of respondents covered.

Table 3. 2 Instrument types, respondents and number of respondents covered

Instruments	**Respondents**	**Number covered**
Survey Questions	Household heads	789
Focus group discussion guide	Male and female focus groups	16
In-depth interview guide	Community leaders	6
	Family Heads	3
	District assembly officials	2
	District MoFA official	2
	FBO leaders	3

Source: Author

Climate data was obtained from the Ghana Meteorological Agency (GMET) in March 2018. Rainfall and temperature data from 1983 and 2017 were requested. This was augmented in February 2019 while the initial analysis was ongoing. The augmentation was meant largely to facilitate an assessment of the variability in rainfall on yield per hectare for the main staple crops in the two districts. Due to the unavailability of weather stations within the Bawku West district, two weather stations were proposed from which data could be used for the area. These were the Manga-Bawku and Binduri weather stations. Based on proximity and expert advice, the Binduri weather station was selected due to its nearness to the Bawku West district and the availability of both

temperature and rainfall data. Rainfall data from 2009 to 2011 was unavailable due to logistical – malfunctioning of monitors and gauges.

The Nkoranza South District on the other hand has a weather station with only rainfall recording equipment. In spite of this, data was unavailable for extended periods. These include, 1983-89, 2002-03, 2007, 2011-2013 and 2016-17. These omissions were considered in the computation of averages for the decadal analysis.

3.13 Data processing and Data Analyses

Data analyses was an on-going process. Themes drawn during the analysis of the Focus Group Discussions (FDGs) informed subsequent stages of data collection, leading to the deepening of understanding of the concepts- (adaptive capacity, vulnerability and adaptive options). Due to the design of the study, data collected was treated in two forms.

The qualitative data, which was in the form of audios, recorded from the Focus Group Discussions and Interviews, were transcribed and fed into the ATLAS.ti[2] software for analysis. The software eased the process of drawing themes and parallels from the different transcripts to establish similarities and differences in practices and experiences. The themes drawn facilitated the process of triangulation with the quantitative data.

[2] Research software used in the area of **qualitative** data, like ATLAS.ti, helps researchers to manage, shape and make sense of unstructured information. It is a workbench for analysis of large bodies of textual, graphical, audio and video data. (https://atlasti.com/product/what-is-atlas-ti/)

The Statistical Package for Social Sciences (SPSS) version 22 was used as the main statistical package to process the quantitative data. An initial template was designed for data entry based on the survey questionnaire. The software was further used for data cleaning and to transform as well as generate new variables to make certain kinds of analysis possible and meaningful. Once cleaning and transformations were completed, the data was saved in the Statistics Software for data Science (STATA) version SE13 to undertake further analysis.

Descriptive statistics, cross tabulations and comparison of means dominated the analysis, as the study sought to know the differences within the different districts, communities and the different social categories in the data especially the gendered differences. Also, regressions were carried out to ascertain the effects of context specific factors such as access, use and control of resources on adaptation.

Analysis of data was done in a complementary and integrative manner. Trends and themes were drawn from both the quantitative and qualitative data to obtain a complete picture on the influence of socio-cultural factors on the adaptation to climate variability impact of smallholder farmer households.

Climatic data collected from the Ghana Metrological Agency (GMet) and the survey were quantitatively analysed. The climatic data was analysed after which the results were presented using graphs and figures to observe the variability in climatic conditions especially rainfall during peak periods of the annual farming calendar with a keen attention paid to the onset and cessation of rainfall. The observations from the graphs and figures assisted to ascertain the specific impacts the observations made have on seasonality and planning, cultivation, output and other forms of livelihood activities beyond the farm. The rainfall data together with yield information collected from the

agricultural directorate of the two assemblies were used to plot trends of yield in order to observe the influence of variability in rainfall over the years on yield of maize per hectare.

Results from the survey constituted the main sources of quantitative analyses for the work. The analyses were carried out based on the nature of questions and objectives for the work. In order to understand the influence or effect of certain variables on others some variables were merged into composite variables. For example, a multi-dimensional vulnerability index was created from the five capitals assessed from participants. This allowed for an evaluation of the levels of sensitivity and response to climate variability impacts.

The AF approached by Akire and Foster (2011) for the constructions of multi-dimensional index was used as a guide in this process. Furthermore, the work of Gertz *et al.* (2017) provided an empirical template for the construction of a climate vulnerability specific multi-dimensional index. The sections that follow provide details on the how the multi-dimensional livelihood vulnerability index (MLVI) from climate induces impacts was constructed.

3.14.1 Constructing a Multi-dimensional Livelihood Vulnerability Index (MLVI)

The Multi-dimensional Livelihood Vulnerability Index (MLVI) was used in line with the work of Glitz *et al*. (2017) which used the index as a measure to explore and describe livelihood vulnerability to climate, environmental and socio-economic change in the Kush Himalayas region. The MLVI attempts to modify Hahn, Reiderer and Fosters (2009) Livelihood Vulnerability Index framework and combine it with Alkire and Foster (2011) AF method of multi-dimensional index construction.

Multi-dimensional vulnerability in this study is measured based on the methodology proposed by Alkire and Foster (2011). The conceptual definition of vulnerability of the IPCC Fifth Assessment Report (AR5) provides the basis for the evaluation. The report conceives vulnerability to consist of three main dimensions. These include sensitivity or susceptibility to harm, which is a function of the degree of exposure to social and environmental shock or impacts and the capacity to adapt or cope with the shock (IPCC, 2014:128).

The three dimensions of vulnerability shape the nature and form of vulnerability an individual or system experiences. Following from Glitz *et al*. (2017) exposure, sensitivity and adaptive capacity were incorporated in the MLVI to "address exposure to socio-economic shocks, which have the potential to increase a household's sensitivity to climate hazards, and undermine its adaptive capacity" (pp. 127). The unit of analysis of vulnerability in this study is the household. In this regard the intention is "to measure the current livelihood vulnerability status of households by determining households that have a high propensity to be negatively affected by climatic and other changes" (Glitz *et al*., 2017:126) as a result of the architecture of entitlement of their communities.

The use of this approach is important due to its assessment of the breadth, depth and severity of vulnerability in relation to climate variability and change. This approach builds on the Livelihood Vulnerability Index by Hahn et al. (2009), in addition to Scoones (1998) sustainable livelihood capitals to capture the socio-economic dimensions of vulnerability and adaptation. The use of the two approaches is augmented by the AF approach to facilitate the differentiation between vulnerable and less vulnerable groups around each component whiles decomposing the vulnerability across dimensions. The methodology involves two steps – identification and

aggregation. Identification involves two sequential steps. First, those who are deprived on each of the indicators are identified, defined by a vulnerability cut-off. In the second step, those who are multi-dimensionally vulnerable are identified by comparing individual vulnerability scores to a given vulnerability threshold. Aggregation on the other hand defines the overall level of vulnerability for the sample by summarizing the vulnerable and vulnerability profiles of different households. While the LVI and other vulnerability and poverty measures are "multi-dimensional" in the sense that they are based on several underlying indicators or components, " multi-dimensional" in the context of the AF method represents a process of identification and aggregation and tool of decomposition: The MLVI identifies vulnerable households by counting vulnerabilities across dimensions (identification), answers the question how vulnerable a given population is (aggregation), and – its main advantage – is able to describe in which way people are vulnerable (decomposition). The process of decomposition actually makes it possible to describe manifestations of vulnerability in an illustrative way thereby pointing to components to focus interventions and policy actions. The decomposition feature has thus led to the widespread use of the approach by scholars to construct indices (see Ura *et al*., 2012 on happiness; Hughes, 2013 on resilience).

First, in a dual identification process, the multi-dimensionally vulnerable households are identified by (a) determining a cut-off point for each vulnerability indicator and then, (b) deciding on the number of indicators in which the household has to be vulnerable in order to be considered multi-dimensionally vulnerable. The next step is to censor the data on the non-vulnerable household in order to calculate the vulnerability headcount -incidence, vulnerability intensity, and the actual vulnerability index through an aggregation of information on the multi-dimensionally vulnerable households. A vital step in the aggregation of the (number of) vulnerability indicators

is to assign weights to individual indicators. The process of weighting the indicators transforms the framework into an actual measure. The weights and cut-off points used in this study was based on Gerlitz *et al*. (2017) weighting process with some few modifications. This was based on the strength or significance of each variable in shaping the exposure and sensitivity to climate variability. Table 3.3 presents the dimensions, components, indicators, weights, and vulnerability cut-offs of the MLVI.

Table 3. 3 MLVI – Dimensions, components, indicators, weights and cut-offs.

Dimensions	Components	Indicator	Weight	Vulnerability cut-offs (HH is vulnerable if ….)/justification
Adaptive capacity	Socio-Demographic status	Dependency ratio	.042	A household with dependency ratio >1.5. A household is considered vulnerable if a person of labour force has more than one dependent due to the heavy burden of care placed on the economically active members
		Education	.042	HH head has no primary or formal education – the lack/no formal education decreases the potential to access and use information/new technologies and innovation to address changes observed and experience (Asfaw and Admassie, 2004)
	Resources and energy	Agricultural land	.083	Control of land under use. The ability to take decision on what land is used for facilitates adaptation to variability and environmental shock without delays. Lack of control can lead to landlessness and loss of primary livelihood for smallholders
		Electricity	.028	Primary source of lighting in household is not electricity (either solar or national grid). Lack of electricity adversely affects health and education outcomes, communication, use of technology and income (Kanagawa and Nakata, 2008)
		Cooking fuel	.028	Primary source of cooking fuel is solid fuel. The use of solid fuel such as charcoal and firewood has serious health, economic and environmental implication. Deforestations and degradation accruing from the felling of tress and burning of

			charcoal increases the carbon footprints with deepening consequence on climate variability (IEA, 2006)
Livelihood strategies	Non-Agricultural livelihood diversity	.083	No secondary or tertiary livelihood strategies or source of income <1 – HH has no non-agricultural livelihood strategies on which to rely on in instances of loss of or extreme effects to primary livelihoods. Increased livelihood portfolio spread risk (Glitz *et al.*, 2017)
	Agricultural livelihood diversity	.083	Number of crops under cultivation <1. Mono-cropping heightens the risk of yield loss from extreme weather events and changes in temperature and rainfall (Abramovitz *et al.*, 2001), broader livelihoods portfolios decreases vulnerability through the spread of risk
Social networks	Access to loans/credit	.042	Difficulties in borrowing money or finding financial support – this is used as a proxy inadequate potential support in times of stress with money representing an easily convertible resource
	Family support	.083	The lack of family support in times of social and climatic stress. Social support networks such as family and relatives constitute important relief and insurance for rural communities. Support are and could take any form
	Political voice	.042	Inability to influence decisions at the community level – proxy for inadequate social inclusion to facilitate the communication and of influencing one's own situation. This is closely linked to social inclusion (Sen, 2000)

Sensitivity	Health and Sanitation	Illness	.036	At least a member of the household has been unable to work over the last six months to one year due to a serious illness. A higher predisposition of people who have been seriously ill to be affected by climate related illness (Hales, Edwards and Kovats, 2003)
		Sanitation	.028	Has no improve toilet facility as defined by WHO, that is no toilet at all or in an open pit – it has a negative impact on health status of the household and the community (WHO and UNICEF, 2006). This increases sensitivity to water related diseases due to poor sanitation (Hales *et al.*, 2003)
		Drinking water	.042	Has no access to improved drinking water (WHO definition), perceived poor quality of water sources such as wells and river may be easily contaminated increasing sensitivity to water borne diseases (WHO and UNIFEC, 2006), This may affect the health of the household and the community
	Food security	Food self-sufficiency	.042	A household is not food sufficient if it is unable to feed all its members 3 daily meals. Households unable to ensure food sufficiency are those most likely to be sensitive to environmental and climatic changes with influence on food cultivation (Maxwell and Smith, 1992)
	Water security	Water sufficiency	.042	Has sufficient access to water throughout the year for agricultural activities or No. HH who are already facing water shortages are more sensitive to changes in temperature and rainfall patterns.
	Environmental stability	Dwelling	.048	Materials used in the construction of home/house/room is can only withstand extreme weather events with significant

				damage. These materials range from grass, leaves, thatch and straw
Exposure	Environmental shocks	Environmental shocks	.103	During the last 12 months at least one severe environmental shock experience. This includes failed-planting season due to erratic and short rains, intense sunshine and unpredictable seasonal weather patterns.
	Socio-economic shock	Socio-economic shock	.103	During the past 12 months at least one severe socio-economic shock experienced.

Source: Adapted and modified from Gerlitz *et al* (2017)

Regarding the weighting of indicators and dimensions, the MLVI has replicated the weighting approach of Gerlitz *et al.*, (2017). In this case different weights were assigned to the different indicators based on their influence and propensity to affect the three dimensions of vulnerability – exposure, sensitivity and adaptive capacity. Giving varied weights to the different components stem from the differences in weights of specific indicators within a certain component. This makes the index more robust and contextually relevant. This is in keeping with the five capitals of Scoones (1998), which suggest that though all the capitals may be relevant to guarantee sustainable livelihood, some capitals tend to be stronger and sometimes may lead to securing other capital within specific social and cultural settings. Overall, the different weights for the components meant that the dimensions sensitivity and adaptive capacity, weighted 56% and 24% respectively, were rated higher than the dimension exposure (20). This is justifiable for an index that focuses on the system "household" and aims to address policy makers and development planners: The "internal" characteristics are sensitive to policy change and indicate how well a household will be able to cope with "external" features (hazards), which are very difficult to influence.

Regarding the aggregated vulnerability cut-off, it was again decided to choose an aggregated vulnerability cut-off of 33%. This suggests that a household is multi-dimensionally vulnerable to climate variability if it is vulnerable in regard to one-third (1/3) or more of the weighted indicators. This equals vulnerabilities in regard to at least 6 out of the 18 indicators or 3 out of 10 components of the index.

The MLVI framework provided the basis for the calculation of the actual vulnerability measure following the AF method. Based on the cut-offs for each vulnerability indicator, it was determined in which regard a household was vulnerable to change or shifts in climatic variables; that is the first stage of the two-staged counting approach.

The second stage consists of adding up the number of vulnerabilities each household encounters. Based on the predefined weights and the second cut-off point – the aggregated vulnerability cut-off – it was then determined if a household is considered to be multi-dimensionally vulnerable to change. To aggregate the information and construct the index the focus was solely on the multi-dimensionally vulnerable households.

Data on the non-vulnerable households were censored, that is, vulnerabilities of those households were ignored during further analysis. Now, the multi-dimensional vulnerability headcount/incidence (H; the proportion of vulnerable households in the population) and intensity (A; the average vulnerability share in relation to the vulnerability indicators) could be calculated. The MLVI – the actual vulnerability index – is the product of the vulnerability headcount and the vulnerability intensity (MLVI = H x A) and ranges from "0" (no household is vulnerable in regard to any indicator) to "1" (every household is vulnerable in regard to all indicators). The index decomposition is presented in the form of the absolute and relative contribution of components to the index value and in the form of censored vulnerability headcounts, that is, the part of population that is multi-dimensionally vulnerable and vulnerable in regard to a specific vulnerability indicator

The decomposability property of the index made it possible to examine variations in household vulnerability across socioeconomic characteristics.

The two aggregate components of Household-MLVI are defined as:

$$\textit{Headcount (H): } H = \frac{q}{n} \qquad (1)$$

where, q is the number of multi-dimensionally vulnerable households and n is the total number of households sampled. The severity of vulnerability or vulnerability intensity is computed as:

$$A = \frac{\sum_{i=1}^{n} C_i(k)}{q} \qquad (2)$$

where, $C_i(k)$ is a censored vulnerability score or the average vulnerability score across vulnerable households. The censored vulnerability score is obtained as an additive function of the weighted indicators

$$C_i(k) = W_1 I_{i1} + W_2 I_{i1} + \cdots + W_d I_{id} \qquad (3)$$

such that $I_{ij} = 1$ if household i is deprived in indicator j and $I_{ij} = 0$ otherwise

W_j is the weight attached to indicator j, such that $\sum_{j=1}^{d} W_j = 1$

The multi-dimensional vulnerability index is obtained as

$$MLVI = H * A = \frac{\sum_{i=1}^{n} C_i(k)}{n} \qquad (4)$$

A snapshot of the approaches used in analysing data is presented in table 3.4.

Table 3. 4 Summary of Methods and Approaches of Data Collection and Analyses

Objective	Methodological Approach	Data/Data Collection technique	Data analysis method/Approach
To examine the nature of climate variability and its effects on the livelihoods of smallholder households	Quantitative and Qualitative Analysis	Yield and Rainfall data on the two districts. Secondary data from GMets and MoFA Primary data through Household Survey, Key Informant Interviews, Focus Group Discussions and Observations	Graphs and Charts, Descriptive Statistics and trend analysis, Coding and thematic analysis
To examine the gendered implications of inheritance and land tenure arrangements on access and use of land by smallholder farmers.	Qualitative and Quantitative	Focus Group Discussions, Key Informant Interviews, Household Survey Data	Coding and thematic analysis, Descriptive statistics
To investigate how differences in accessing land and other adaptive options influence vulnerabilities and resilience to climate variability impacts.	Quantitative	HH Survey Focus Group Discussions	Descriptive statistics Akire and Foster Approach – Multi-dimensional Livelihood Vulnerability Index Probit and Logistic regression models

Source: Author (2014)

3.15 Ethical considerations

In keeping with ethical standards, all participants were informed of the objective of the study which is to examine the influence of socio-cultural, inheritance and land tenure, on the adaptive capacity of small holder farmers especially women to climate variability effects. The explanation was done in Kusal for the communities in the Bawku West district and Twi/Bonno for the Nkoranza South municipal which is understood by all participants. Respondents were also informed that their participation in the study would enhance understanding of contextual adaption, especially regarding the influence of socio-cultural factors on adaptive decisions and vulnerability to climate variability impacts. Where there was the need to take written and audio records of conversations prior permission was sought before any recordings commenced. Besides stating the objective of the study, respondents were informed that information obtained from them will provide good basis for decisions on adaptation through the navigation of social systems to secure livelihoods to be made especially in relation to the growing effects of climate variability and change.

In order to ensure that respondents and participants understood the purpose of the work they were asked to explain the purpose of the study to the researcher. This helped to ensure that the conversations were focused and devoid of misunderstanding. After the purpose of the study was stated, respondents and participants were then asked if they were willing to participate in the study based on their understanding. All respondents and participants therefore stated expressly their willingness to participate. Respondents were made aware of their right to exit the study at any point. To protect the identity and rights of respondents, no names or anything that may be used to tie responses to persons was used in any part of the study. Names and identifications used in the presentation of results are merely pseudo names.

3.16 Limitations of thesis

Though care was taken to ensure adherence to scientific and methodological rigour, the process of undertaking the thesis was fraught with a number of challenges. The challenges include:

1. Gaps in climate data obtained from the Ghana Meteorological Agency (GMet) were one of the biggest challenges of the work. This was especially in the case of Nkoranza South municipal were several years of data was missing. The gaps thus meant that analysis could only commence from the early 1990s.
2. Inability to obtain extended yield data from district directorate of MoFA to undertake a rigorous analysis on the effects of rainfall on yields of main staple crops of the two assemblies. Challenges with data collection, data entering and data curating meant that in spite of the best efforts to obtain yield data at the district level, data could only be provided from 1993-2018 on maize and other crops. Based on that a trend analysis and correlations were done on maize yield per hectare and monthly average rainfall to observe the changes over the years as well as observe how shifts in rainfall pattern are matched by yield outputs per hectare. The choice of maize was because nearly all the households surveyed in the two districts produce maize.

3.17 Conclusion

This chapter presented the methods and approaches used to conduct the research and analyze the results. The chapter has indicated that data was collected from two districts, the Bawku West and Nkoranza South where four communities were selected from each district. In all data was collected from 798 smallholder households using the survey

with 16 focus group discussions held. The focus group discussions were held separately for men and women in all the 8 communities.

The analysis of data was also discussed in the chapter with further details given on the construction of multi-dimensional livelihood vulnerability to assess the influence of climate variability among smallholder households.

CHAPTER FOUR

CLIMATE VARIABILITY: EFFECTS ON THE LIVELIHOODS OF SMALLHOLDER HOUSEHOLDS

4.1 Introduction

This chapter focuses on climate change variability and its implications on the livelihoods of smallholder farmers in the Bawku West and Nkoranza South districts. It explores and discusses the changing patterns of rainfall and temperature over the last three decades with emphasis on the shifts as well as changes observed over the years at specific periods during the traditional (known) seasonal planting/cultivation in the two ecological zones. The chapter also presents the knowledge and perceptions of respondents on what climate change constitutes, the observed climatic changes experienced over the years as well as its perceived effects on different aspects of smallholder livelihoods. The analysis and discussions are done with reference to the specific communities where data was collected. The chapter uses rainfall data collected from the Ghana Meteorological Agency (GMET), household survey, and focus group discussions conducted in eight (8) communities in the Bawku West district and Nkoranza municipal. Key informant interviews conducted with district officials was also used to provide explanations and justifications for some of the trends observed. The chapter has a number of sections. Each section addressed a number of themes related to the core objective of the chapter. Sub-themes are used within the sections for meaningful reading.

4.2 Profile of respondents

As noted in the methodology of this work, effort was made to select respondents and participants for the study to reflect the population of each location. The 2010 population

and housing census of Ghana provided the basis for assigning specific sample sizes to each district and further selection of households at the community levels. While focus groups were composed of between 10 to 12 discussants per group within each of the eight communities, the household survey covered a total of 798 respondents across the eight communities. The distribution of samples in respective communities for the household survey is shown in Table 4.1.

Table 4. 1 Community and sex distributions of household survey

District /Municipal	Community	Total (%)	Sex (%)	
			Male	Female
Bawku West	Komaka	12.3	49.0	51.0
	Dagunga	12.9	53.4	46.6
	Kukuo	12.7	48.5	51.5
	Gbango	11.8	55.3	44.7
Nkoranza South	Donkro Nkwanta	12.4	53.5	46.5
	Jerusalem No. 1	13.2	60.0	40.0
	Ayerede	12.4	52.5	47.5
	Dotobaa	12.4	50.5	49.5

Source: Household survey 2018/19, N=798

In order to do a robust gendered analysis, care was taken to ensure that variations in the numbers of males and females respondents selected would not be so different to the extent of rendering any form of gendered analysis meaningless. In the selection of household head, deliberate attempts were made to find and select males and female household heads in turns. The process ensured a balanced assessment of the effects and outcomes of climate variability on households in each community. Tables 4.1 showed that the number of households sampled for each community constitute about 12% of the total sample size apart from Gbango and Jerusalem No. 1 where samples of 11.8% and 13.3% of the total sample were respectively obtained. The two communities stand out due to two community specific factors. These were the size of community and structures in relation to Gbango and the composition of migrants/settlers and indigenes

in the case of Jerusalem No. 1. The need to sample beyond the threshold for Jerusalem was largely due to its nature as a settler town driven by the presence of the Catholic Church. The church's relation with the community is one that can be described as symbiotic. The church offers land to settlers for farming and they in turn assist with the maintenance of the vast lands of the church together with other commitments towards it. Indeed, in the distribution of land access which will be discussed in later chapters, it will be observed that apart from Jerusalem no other community obtains land for farming from the church. Besides these differences the distribution across districts were more or less even with Bawku West having 49.6% and Nkoranza South having 50.4% of the total household survey respectively.

The full details of respondents' profiles based on communities are presented in Table 4.2.

Table 4. 2 Community profile of Respondents

Variables	Bawku West (%)				Nkoranza South (%)			
	Komaka	Dagunga	Kukuo	Gbango	Donkro Nkwanta	Jerusalem	Ayerede	Dotobaa
Sex								
Female	51.0	46.6	51.5	44.7	46.5	40	47.5	49.5
Male	49.0	53.4	48.5	55.3	53.5	60	52.5	50.5
HH Size								
1-5	30.6	38.8	17.8	19.1	37.4	40.0	68.7	36.4
6-10	35.7	58.3	59.4	57.4	49.5	53.3	30.3	63.6
11-15	28.6	2.9	19.8	23.4	11.1	6.7	1.0	-
16-20	1	-	3.0	-	2.0	-	-	-
>20	4.1	-	-	-	-	-	-	-
Marital Status								
Single	9.2	6.8	4	2.1	3	-	4	3
Married	65.3	75.7	90.1	93.6	66.7	80	83.8	61.6
Separated	4.1	-	-	2.1	19.2	6.7	5.1	24.2
Divorced	-	-	-	-	-	-	2	4
Widowed	21.4	17.5	5.9	2.1	11.1	13.3	5.1	7.1
Education								
No Education	60.2	64.1	69.3	74.5	30.3	26.7	6.1	20.2
Non-Formal	3.1	4.9	1	-	5.1	6.7	-	-
Primary	18.4	4.9	23.8	17.0	32.3	40	66.7	15.2
Mid Sch/JHS	8.2	13.6	4	8.5	32.3	26.7	23.2	46.5
SHS/Tech/Voc	10.2	12.6	2	-	-	-	-	14.1
Tertiary	-	-	0	-	-	-	4	4
Status in comm.								
Indigenes	96.9	100	97.0	100	70.7	46.7	39.4	56.6
Settler	3.1	-	3.0	-	29.3	53.3	60.6	43.4
Crop Farmed								
Maize	42.8	38.4	33.9	34.7	58.6	27.6	38.2	33.1
Yam	-	1.7	-	-	22.5	19.4	30.1	23.4
Millet	44.2	31.6	19.0	34.7	10.1	6.4	0.4	1.0
Cassava	-	1.7	-	-	7.7	17	0.4	12.1
Cocoyam	-	-	0.4	-	-	-	-	-
Tomato	1.9	2.1	-	-	-	-	1.5	1.0
Onion	4.3	-	-	1.7	-	-	-	2.1
Rice	6.3	20.3	16.5	0.8	1.2	-	25.9	1.4
Beans	-	5	21.0	14.9	-	4.2	2	5.5
Groundnut	-	2.1	4.4	1.7	-	14.8	1.5	9.0
Peper	0.5	-	1.2	0.8	-	4.2	0.8	-
Okro	-	-	-	2.5	-	-	0.4	-
Soybean	-	-	3.6	5	-	-	-	-
Sweet Potato	-	-	-	3.3	-	-	-	-
Cashew	-	-	-	-	-	6.4	-	9.0
Plantain	-	-	-	-	-	-	-	2.4

Sources: Field Work, 2018-2019 (N=798)

Table 4.2 showed that the ages of respondents (household heads) ranged from a minimum of 18 years old, usually a single member household, to a grand old age of 90 year as the maximum age. The average age of a household head was found to be 45.3 years with a standard deviation of 13.3. The mean age of household head suggest that all household head are within the economically active age bracket with the capacity to work and support their households.

The sizes of households surveyed shown in Table 4.2 ranged from a single member household to households as large as 25 members. The household had an average of 6.8, approximately 7 members with a standard deviation of 3.3. Communities in the Bawku West district tended to have large households due to the way living arrangements were organized as well as who household members identify as the head. This notwithstanding majority of the households surveyed across the two districts had sizes between 6-10 members. This composed of about 51% of the total number of household survey with households having less than six (6) members constituting about 36% of the total sample size. A greater portion of this group is found within the Nkoranza South Municipal. Single member households constituted 8% of the total sample.

Table 4.2 indicates that household heads of most of the households surveyed were married and stay with their spouses. This facilitated spousal support in varied forms to reduced strains on household heads in the provision of household needs especially in times of climate variability induced stresses. Results indicate that 77.1% of the respondents were married. Widowed household head constituting 10.5% of the total sample followed this. Separated, single and divorced household heads constituted 7.6%, 4% and 0.8% respectively. The married category was spread across the two districts and communities. For instance, Gbango has the highest proportion of married household heads (93.6%) and Dotobaa has the lowest (61.6%) proportion of married

household heads. For the purposes of further analysis, the marital status of household heads was recoded into three main categories, namely, never married, currently married and previously married. This was to ensure that in the case of regressions and other forms of multivariate analyses, the categories with fewer cases are not dropped due to iterations.

In terms of education, 53.6% of all respondents have had some formal education ranging from primary to tertiary levels of education as shown in Table 4.2. Of this number, 27.3% have ever attended primary school, terminating their education at different levels. Those who have either attended, to varying level or stages, junior high or the old middle school system follow this. They constitute 20.4% of the total sample. In order to make meaningful sense of the information collected the groups with senior high, technical, and vocational education were all captured as one form since in the educational ladder or progression they come after junior high or middle school. The group within this category constitutes only 4.9% of all respondents. The tertiary category constituted 1% of the entire sample. This composed of people who have had some form of formal post-secondary education or training. It included those with teacher training, nurses training and university training at different levels.

The distribution by districts and community showed that the educational levels of respondents from Bawku West were quite low compared to those from Nkoranza South. Considering those without any form of education, Bawku West had 66.9% compared to the 20.9% of Nkoranza South. Again, looking at those who have had some form of formal education, the percentages of Nkoranza South [Primary=38.6%, JHS/Middle=32.1%, SHS/Tech/Voc=3.5%, Tertiary=2%] were much higher than that of Bawku West [Primary=15.9%, JHS/Middle=8.6%, SHS/Tech/Voc.=6.3%, Tertiary=0%] apart from the case of those who have had senior high, technical, or

vocational education. Similar distribution is observed in the different communities within the districts and among males and females. Across all the educational levels males have higher percentage points except for the case of SHS/Tech/Voc, where the score for the females were slightly higher [21.8%] than that of males [19.2%].

Regarding migration status of respondents, the data showed that about 76% are indigene while the 24.3% of respondents are settlers (see Table 4.2) from other places in the district, region or from other regions of Ghana. The purpose for migration is varied. While some settlers moved from their places of origin in search of better farm lands to safe guard their livelihoods, others move due to marriage or transfers from their work. In the case of the study, it was found that most of the settlers, majority (96.9%) of which are within Nkoranza South hail from the Upper East, Upper West and Northern regions. Most of these migrants in the Nkoranza South municipal are largely distributed among Jerusalem (53.3%), Ayerede (60.6%) and Dotobaa (43.4%). This distribution fits with the pattern of north-south drifts observed in the migration literature. Besides the varied forms of conflicts that lead to forced migrations, the shift towards the south for better farm lands are largely due to the growing depletion of soil fertility in the northern parts of Ghana coupled with the growing effect of climate variability such as long dry spell, drought and seasonal destructive floods.

Since the work is focused on smallholder households, an assessment of the crops cultivated was made. It was found that households were engaged in the cultivation of several varieties of crops. These crops included maize, yam, cassava, millet, rice, sorghum, beans, groundnut, vegetables, soybeans and more recently cashew in the Nkoranza South municipal. Majority of households across the two districts and the eight communities produce more than one crop [85.2%] as shown in Table 4.2. Of this number, 39.5% of households cultivate more than one crop, 31.7% cultivate three crops

and 10.3% cultivate 4 different crops. The production of multiple crops is both socio-cultural in nature and a function of risk aversive behavior by farmers. As the weather has become more volatile and unpredictable, cultivating a single crop exposes household to greater threats of climatic shocks. Beyond the threat of climatic conditions, farmers engaged in multiple crop production and mixed cropping to ensure variety in terms of food as well as the need to maintain soil fertility through fixation of nitrogen in the soil by planting leguminous plants/crops (Altieri, 2004; Teklewold *et al*, 2013; Wood *et al*., 2014)

Majority of the household [91.9%] produce maize with an average farm size of less than 0.4 hectare (1 Acre). The size of farms suggests that besides maize cultivation general farming activities is at a very subsistence level with very little technological inputs and mechanization. Indeed, it was found that apart from few households who use tractors to plough their farms most households use basic mechanizations such as bullock ploughs, hoes and cutlass. Yields are thus low with an average of less than a third of a ton of output per hectare.

Observations, focused group and key informant interviews indicated that all communities in the two districts are undergoing rapid social and cultural changes. One clear sign of change is the softening of stance on what crop people were allowed to cultivate. This is especially in the Nkoranza South municipal where the differentiation between male and female crops have been diffused. The choice of crop to cultivate by a household is founded on its viability, profitability and the ability to make the needed investment once land has been acquired rather than social or culturally gendered categorizations. The case of Bawku West was a little different. Though some changes have taken place over the years regarding the cultural prescription of what crop men and women can produce, the change have not been sweeping as in the case of Nkoranza

South. The main reason according to a community leader in Komaka is the structure of land ownership where control is in the hands of men, therefore women can only cultivate certain types of crops as supplements to the main household farms which are usually owned by their husbands, fathers or sons. Details of the socio-cultural context of the two districts will be discussed in chapter Five (5) of this thesis.

4.3 Understanding on climate change

Understanding climate change is key to determining or estimating its effect on the lives and activities of people. Perceived effects or implications thus stem from the association of gains and losses in the lives and work of people on the climatic changes and variability observed and experienced. Again, a clear understanding of what the observed changes represent affords people affected the opportunity to identify the cause or sources of the observed changes and the best or possible ways of addressing the changes through effective adaptation (Ensor and Berger, 2009). In order to ascertain the understanding of climate change by respondents, five (5) key questions were posed to determine the levels of agreement with each statement in relation to their experiences and specific contextual climate related activities. The statements required respondents to rank their levels of agreement with each statement on a 5 item Likert scale, from a continuum of 1 representing “strongly disagree” to 5 representing “strongly agree”. Though literature points to a number of indicators of climate change, the work focused on five key aspects which were found to be closely related to the lives and work of smallholder farmers in the rural contexts. These include:

1. Heavy rains leading to floods
2. Shortening of rainy periods
3. Erratic rainfall patterns (Rain does not come at the time expected)

4. Intense and prolonged sunshine (with consequence on pest infestation and plant growth) and
5. Changes in the season (emanating from onset and cessation of rains)

The above statements provided the basis to assess how climate variability and changes is perceived and understood by respondents and participants.

Based on the data obtained, respondents have a very clear and extensive view of what constitutes climate change. This was also demonstrated in the focus group discussions in the communities. Due to the deep dependence on rainfall for agricultural productions, any shifts or variations in the expected patterns is noticed by smallholder farmers. Average scores of all responses from the eight (8) communities indicated that apart from the statement, "Heavy rains leading to floods", which had an average score of 3 suggesting "neither agree nor disagree", all other statements had an average score of 4 representing agreement with the statement. Importantly, the statement, "Erratic rainfall pattern (rain does not come at the time expected) recorded a mean score of 5 representing strongly agreed. This shows that climate change as "change in seasonality of weather conditions" also hold true for most respondents. This level of understanding shapes their ability to observe or note any kind of effect or implication livelihoods by such shifts or extremes. These responses corroborated Ensor and Burger (2009) findings that rise in temperatures and rainfall patterns constitute the key indicators by which most people understand and conceive climate change. Using these variables as basis for understanding help farmers especially to project and plan.

In order to ascertain the robustness of the result a principal component analysis (PCA) was conducted on the results obtained from the five statements. The analysis produced a KMO value of 0.57 indicating a sufficient adequacy of the sample used to undertake the analysis. The analysis extracted two components with an Eigenvalue greater than

one (>1). These were, “Rain does not come at the expected time” and “When the rainy period shortens”. The two factors combined to explain 60% of variance in responses. The specific distribution of the communities in relation to the statement shows similar patterns. This is backed by the observed climate events in the different communities.

Respondents indicated that, the observed changes are due to the combined effects of natural atmospheric changes and alterations to the natural environment by anthropogenic factors. While about 6% of respondents believed that changes observed are occurring normally and naturally, the overwhelming majority (94%) of respondents attributed the changes to human actions. They indicated that these actions have contributed significantly to deterioration of the physical environment and rural eco-systems. Across all communities, felling of tree, bush burning and use of agro-chemicals were rated very high, 90%, 93% and 76% respectively, in relation to their contribution to climate variability and the associated impacts.

4.4 Changing climatic conditions in Bawku West District and Nkoranza South Municipal

Shifts and variability are observed in climatic variables such as rainfall and temperature in the two ecological zones akin to global climatic changes. The observed variability has already shown its effects especially with the onset and cessation of rainy periods and the dry spells experienced by smallholder farmers.

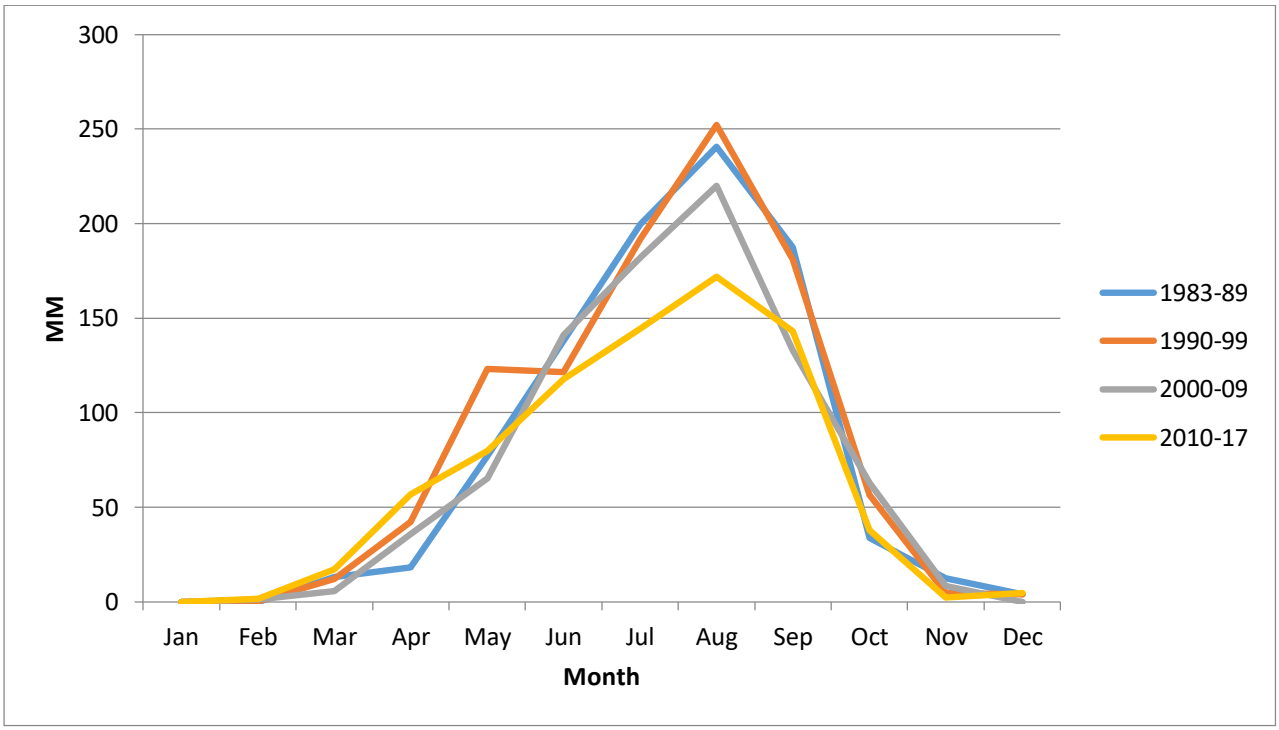
To construct the figures for trend analyses, the data, which was obtained as daily readings, was organized into months and monthly averages. The data was then structured in decades considering non-availability of data for some of the months and years especially for Nkoranza South. Therefore, while Bawku West had four (4) levels

of differentiations starting from 1983 and ending at 2017, Nkoranza South's analysis had three (3) levels beginning from 1990 to 2016.

4.4.1 Rainfall variability from 1983-2017

The analysis of rainfall data showed shifts in the amounts of rainfall recorded in both Nkoranza South and Bawku West at the annual and monthly levels. The variability observed based on the decadal analyses indicated changes during the on-set, sustained peak periods and cessation. This is shown in the Figure 4.1 and Figure 4.2.

Figure 4. 1 Decadal rainfall variability, Bawku West District – 1983-2017



Source: GMet 2018/19

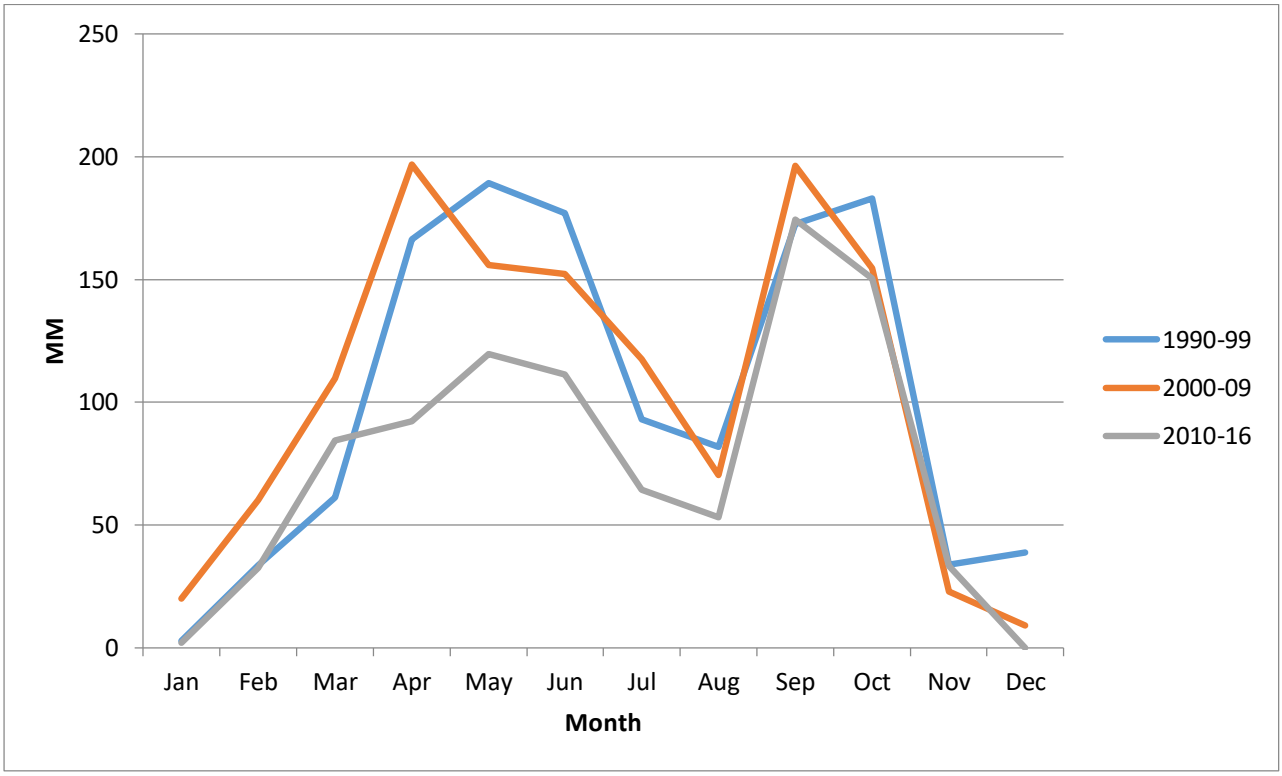
Figure 4.1 first shows that the area has a uni-modal rainfall thereby supporting only one rain-fed planting or cultivation regime. It also shows variability in rainfall in the Bawku West district from 1983 to 2017. These changes/variabilities are seen at both the commencement and cessation of the rains. Other studies in Savannah ecosystems in Ghana have found similar trends (Yiran, 2016; Yiran and Stringer, 2016). To properly capture the variations in quantity of rainfall over the period, data was organized in four

different cohorts to observe decadal variability. The shape of Figure 4.1 indicates slight variations in the on-set and cessation of the rains as well as peak rainy periods. In spite of these observed shifts, the sustained onset of rains up to an average of 50mm by the end of March maintained momentum for the decades, 1990-99, 2000-09 and the four (4) year period from 2010-17. This was however not the case for the four (4) year period from 1983-86 where the momentum collapsed around March to the middle of April before regaining momentum. The image of the peak rainy period however shows significant drops in quantities of rain over the last three (3) decades. The quantity of rain reduced from an average of 252.62mm for 1990-99 to an average of 220.18mm for 2000-09 with a further reduction to an average of 172.07mm for 2010-2017. These drops occurred after an increase in the quantity of rain recorded for the 1990s.

A noteworthy fact is that, despite the continuous reduction in the monthly average rainfall especially during June to October, the spread and distribution over time have remained relatively unchanged. The drop is very significant in this context as it follows a worrying downward trend with implication on food crop production especially staples such as maize and other cereals. This is even more significant as the area has only one planting season.

The case of the Nkoranza South municipal is similar considering the nature of variability of average monthly rainfall over the period 1990-2016. As stated earlier information on the period 1983-1989 was unavailable therefore analysis commenced from the 1990 through to 2016.

Figure 4. 2 Decadal rainfall variability, Nkoranza South Municipal – 1990-2016



Data source: GMet 2018/19

The bimodal rainfall pattern of the area is shown in the shape of Figure 4.2 as observed by Anaafo (2015). The rainy period for the first peak stretches from March to the middle of July where it drops sharply to an average of 53mm. The four wet months were however characterized by significant variations in the quantity of rainfall recorded over the periods of analysis. These variations were in the form of sharp increases in the quantity of rainfall as in the case of the 2000-09 (an average of 197mm) and drops during 2010-16 (an average of 119.8mm).

The second peak rainfall period on the other hand lasts for not more than two and a half months, commencing in the middle of August and breaking by the end of October. The usually sustained rains provide very good incentive for dry season farming.

Additionally, in spite of the observed changes/variability regarding the quantities of rainfall recorded for the first peak rains over the period of assessment, the second peak rains have seen very little variability. From the figure 4.2, though rainfall increased slightly during the major rainy season of 2000-2009, it has declined steadily over the years (2010-2016). Though there exist variations relating to quantity of rainfall recorded, the spread or distribution over time seem to be unchanged.

Looking at the nature of variability in rainfall over the two locations, it is striking to note that, Bawku West tends to have higher amount of monthly average rainfall recorded compared to the Nkoranza South area. Owusu and Waylen (2013) have noted that, the continued decline in the quantity of rainfall in the transition zone can potentially affect the cultivation of a second crop. This observation notwithstanding, both areas show significant drops in the quantity of monthly average rainfall between 2010 to 2016 and 2017 for Nkoranza South and Bawku West respectively. Nkoranza South in particular showed consistent reduction in the monthly average rainfall for the first peak periods over the period of analysis.

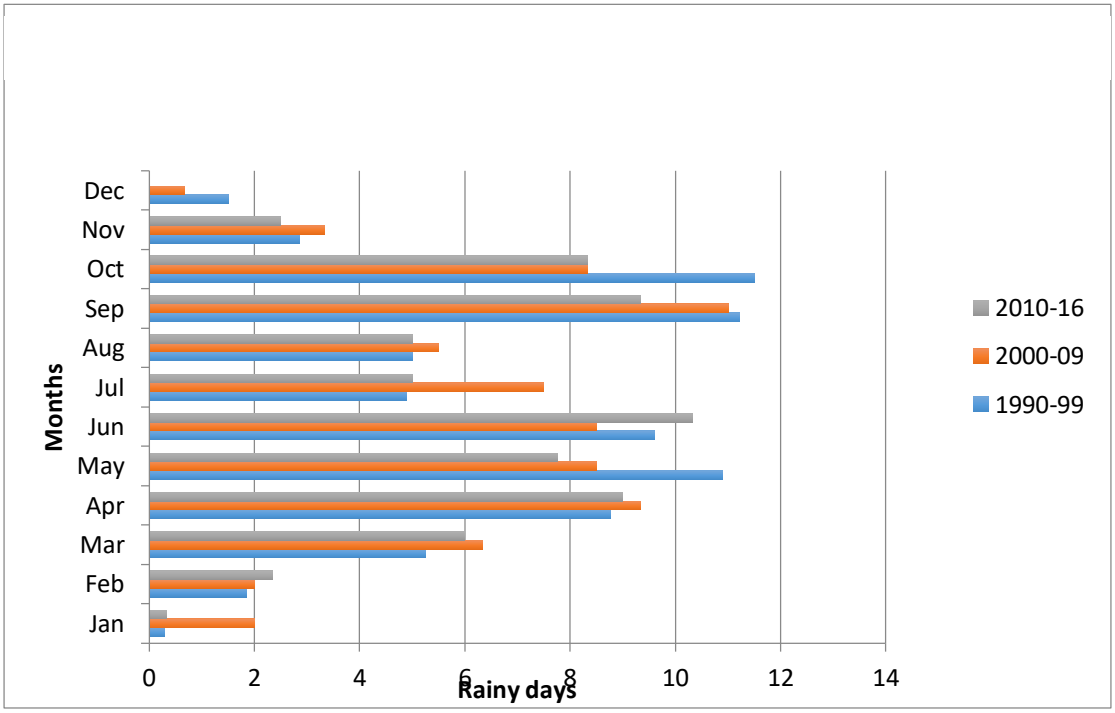
4.4.2 Distribution of rainfall:

How rainfall is distributed is key to determining how it influences rain-fed agricultural production through planning and outputs. The distribution is considered important, as the quantity of rainfall recorded should be appropriately spread for farmers to effectively and efficiently maximize its value (Addai and Owusu, 2014). Thus, when it rains successively within very short periods, usually within some few days, farmers are unable to take full advantage of it. These kinds of rains become destructive as they cause floods and high rate of run-offs and erosion. In the same way, very spare distribution where rainfall is interspersed with long dry spells are threats to successful

production. The distribution of rainfall is expressed in the number of rainy days for specific peak periods of rainfall.

For the purpose of this analysis the mean/average number of rainy days was computed for each month from 1983-2017 for Bawku West and 1990-2016 for Nkoranza South. Peak rainy periods are focused on in this analysis because farming activities tend to be planned and concentrated around such periods. The periods of expected rains compel smallholder farmers to plan in order to have the full benefit of the rainfalls. A good spread of rainy days thus suggests a better distribution of the rainfall and may affect the output of farmers. Farmers during the focus group discussions in the communities expressed concern about the changing distribution of rainfall over the years. They highlighted the undesired, erratic and shortening of rainy periods. The unexpected changes in the distribution of rainfall was negatively affecting crop maturity and output. The rainfall data collected from GMet are presented in the Figures 4.3 and 4.4.

Figure 4. 3 Nkoranza South - Average monthly rainy days from 1990-2017



Data source: GMet 2018/19

A clear observation from the rainy days of the Nkoranza South area indicates that throughout the period of assessment, 1990-2016, it has not rained beyond an average of 12 days in a month. The distribution and pattern follow the bimodal rainfall structure of the area. In this case, the number of average monthly rainy days gradually increases from January with a sustained ascendency till the end of June and then begins to drop. The drop plateaus by the middle of July through to the end of August maintaining an average rainy day of about 5 days and then rising sharply in September and October to an average of 12 rainy days with a sudden drop again in November through to December.

Also, with the exception of four (4) months, January, February, November and December, which recorded less than an average of 4 rainy days, most of the months in the year had average rainy days exceeding 5 days. April, May, June, September and October recorded an average number of rainy days exceeding 8 days for all the clustered years. This indicates that all thing being equal it rained at least every 4th day in a 30day month within those specific months. The nature of this distribution may be considered good as it allows for crop water absorption and siltation thus reducing the probability of flooding on farms due to excess water. It must be noted however that, the frequency of rainy days can be either extensively spaced or close such that their benefits cannot be fully harnessed. The crop officer of the Nkoranza South municipal directorate of agriculture pointed to the unbalanced distribution of rainfall when he noted in an interview that;

> It can sometimes rain continuously to the point that farmers constantly complain because the crops need the sunlight and some dry period. Like last year, in the middle of June, the rain was so much that they (farmers) couldn't even go to the farm. Then suddenly it (rain) just cut for almost three weeks. By the time it started raining again most of the maize was drying up. (District Crop Officer, Nkoranza South, 2018)

Regarding the minor or the second peak rainy period of the Nkoranza South area, a noteworthy point is the consistently high number of average rainy days recorded for September and October for all the cohort years under assessment. This consistency is comparable to the first peak rains months of April, May and June where the minimum average number of rainy days recorded was 8 days for the 2010-16 clusters.

The rainfall distribution of Bawku West is presented in Figure 4.4. The distribution follows a unimodal rainfall pattern. In this case, the amount of rainfall and rainy days increase gradually to a peak period and then drops gradually into a long dry spell. The nature of the distribution is however much gentler/more gradual in how it peaks and drops. The graph shows that the district's highest monthly average rainy days is comparable to the Nkoranza South district with a value of 12 days though the 1990-99 cluster recorded an average of about 15 days for the month of August. This notwithstanding, the months of June, July, August and September had an average of not less than 8 rainy days for the other clusters. This suggest that like in the case of Nkoranza South, the Bawku West area may have some rain on every 4th day in a 30-day month. This estimation gets better in the case of July, August and September where the rain falls every 3rd day within a 30-day month. It must be noted that in spite of a positive observation in terms of distribution, when rains fall in quick successions, with long dry spells the outcome may be detrimental. Farms may be flooded leading to lodging of and rot of plants. The outcomes of long dry spells between quick successions of rain may also result in stunting of crops and wilting as the moisture content required for plant growth may be inadequate.

Though the analysis of the distribution portrays a good picture in relation to plant life and yield, the timing of peak period is very essential in guaranteeing the full maximization of the rains. In this vain, a close look at figure 4.4 shows that the rainy

days for the 1900-99 are higher for every month per cluster apart from February, March and July. This suggests that expectations of rains for clusters like 200-09 and 2010-2017 may be greatly influenced by experiences from the 1900-99 period thus affecting planning, planting and outputs. This was found in some of the statement from participants from the Bawku West area on delays of rains or sudden cessation of rains.

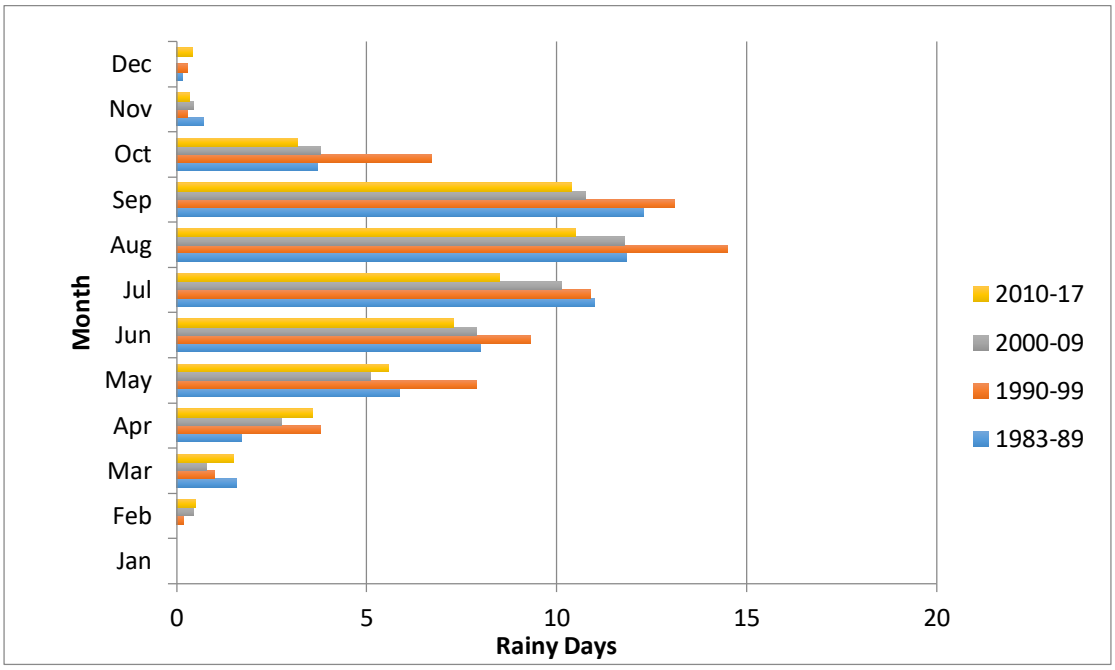
Challenges arising from poor distribution of rainfall were key issues raised in all the focus group discussions in the Bawku West district. Participants observed that significant losses have been incurred due to heavy destructive rains and long drought after first rains. Delayed onset and cessations of rains account for most of the losses incurred by farmers. The unpredictable patterns lead to a "shoot and miss" situation where farmers prepare their field and plant after successive rains only for the rains to cut for long periods before starting again. The case of early millet production was heighted by farmers. A visibly distressed participant of the female focus group discussion in Dagunga noted;

> The way the rain is behaving nowadays, it is very bad. We used to plant early millet with the first rains which helps to deal with the hunger at home but now that one (planting early millet) is not doing well because the rain will not come early. Sometimes we plant the millet after the first rain but they don't do well because the rain will stop for a long time. By the time the rain starts again the millet that was able to germinate with the first rain are almost dry without any fruits. (Female FGD participant, Dagunga, 2018)

Low precipitation has badly affected planning and early varieties of crops such as the early millet. Callo-Concha *et al*, (2012) for instant stress the implications on the production of early millet production by households in the Sudan Savanna ecological zone. They noted that early millet yields have been significantly affected by unusual climate events such as droughts and floods. Corroborating Callo-Concha *et al's* assertion, Antwi-Agyei *et al.*, (2012) note that crop production in the Upper East region

together with the other regions in the northern part of Ghana is highly vulnerable to the effects of extreme climate variability such as droughts and floods.

Figure 4. 4 Bawku West district - Average Monthly Rainy Days from 1983-2017



Source: GMet 2018/19

4.4.3 Assessing the influence of rainfall on production outputs of maize

Rainfall is very important in rural agricultural production due to its rain-fed nature. Scholars have thus highlighted the debilitating effects climate variability will likely have on rural agricultural production (Agyei-Antwi *et al*., 2012; Owusu and Waylen, 2009; Owusu and Waylen, 2008). In addition to the heavy reliance on rainfall for water, most farmers use very minimal amounts of improved inputs such as improved seeds, agrochemicals and fertilizers. They therefore rely enormously on the quality of soil and reliable rains. Disruptions in the patterns and quantity of rain thus present challenges of enormous proportions. This section discusses the influence of rainfall recorded over the years on the volumes of output of maize within the two districts of study. Though the two districts produce and have more than one staple crop, maize is an importance crop to all the eight communities studied as it constitutes about 80% of the composition

of meals consumed in households. Maize is considered important by households in both districts because it constitutes an essential part of household food consumption especially in the Bawku West district and an important source of household income due to the ready market for it (Tachie-Obeng *et al*., 2010).

An analysis of maize as an example presents a good impression of how the changing pattern of rainfall is likely to affect household food needs and community food cultures. Staple crops cultivated in the two districts include maize, yam and cassava for the Nkoranza South and maize, millet and sorghum for the Bawku West.

The analysis used rainfall data collected from the Ghana Meteorological Agency and yield information for maize from the district directorates of the Ministry of Food and Agriculture. Access to data on yield of specific crops over an extended period of time at the district level was quite challenging. The ability to retrieve data stretching over an extended period was plagued with data curating challenges such as loss of data on computers and damages to files. This to a large extent influenced the type of analysis that could be carried out. A regression model which could have made it possible to determine the effects of changing rainfall patterns and quantities on yield of specific crops could not be done due to the limitation of data that could be retrieved. The data available commenced from 1993 to 2018. The best form of analysis is thus to use graphs by plotting yield per hectare (in years) against annual rainfall for the same period. The outputs are presented in the figures 4.5 and 4.6.

Figure 4.5 shows the relationship between rainfall in years and maize out in metric tons per hectares (Mt/Ha) for the Bawku West district. It can be observed that just like the rainfall patter, yield of maize have been experiencing variability over the years with constant fluctuations. A negative relationship is observed between rainfall and maize

output per hectare in the Bawku West district. The graph shows that as volume of rainfall increases, maize output per hectare decreases. This relationship was confirmed by a correlation analysis undertaken to confirm the observation made. Though the result was not statistically significant it provided an indication of the direction of relation between rainfall and maize production in the Bawku West district.

A number of factors account for the observed relationship. The district Monitoring and Information Systems officer highlighted two main factors namely the types of seeds used and the ability of most lands in the district to absorb water. In an interview he stated:

> Most farmers use seeds that are unable to take high moisture. You can observe that once the rains become continues some of the maize begin to rot on the stalk. This is not very common but it happens. The thing is that even if you advise them to buy the proper seed they would not do it because of the price. They prefer to use their local seed. I am not saying the local seeds are not good, but some of them are very bad. The other thing is that the land itself cannot take a lot of water. Small rain then there is flood. Most farms get flooded when the rains get heavy. The rain is good but when it is too much it worries the farmers a lot. (MoFA MIS officer, Bawku West, 2018)

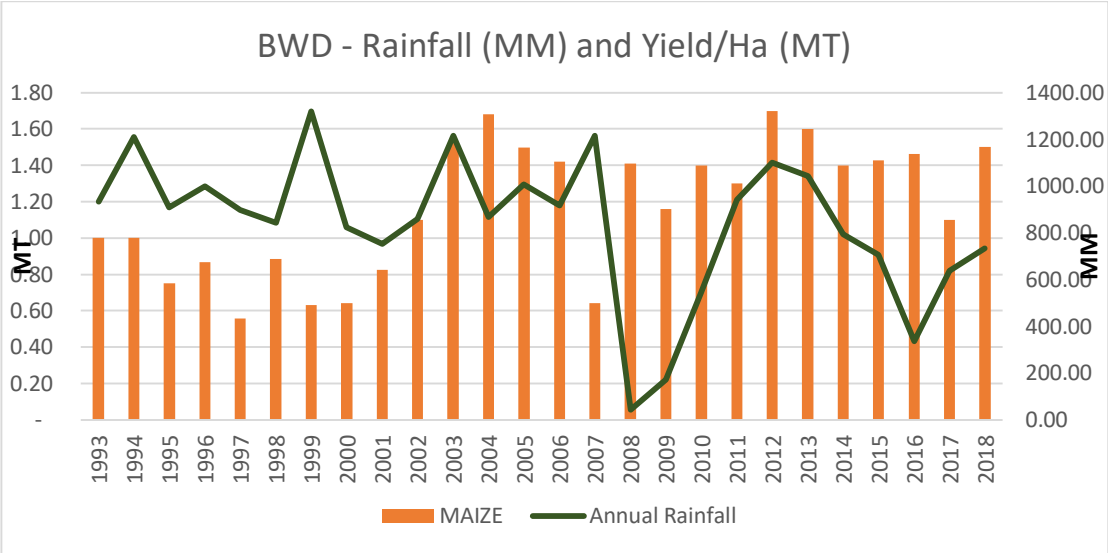
It must be noted that, outputs of maize over the years have somewhat maintained a steady increase with stable yields. Yields have remained close to or above 1.4Mt/Ha since the year 2003. This is instructive because rainfall has remained very erratic and extremely variable. Abdul-Rahaman and Owusu-Sekyere (2017) observing similar trends in the study of smallholder farmers in some districts in northern Ghana noted that emphasis on the relationship of rainfall and crop yield or production ought to be cautiously interpreted as the exertion of the effect of rainfall may not be uniform across all crops and times. The influence of other factors must thus be carefully considered. Such factors may include intensification of good agricultural practices, government and non-governmental interventions and a generally favourable environmental condition.

The observed stability may be accounted for by other factors that compensate for the variability in rainfall over the years. Some of these may include but not limited to the use of improved technology such as improved and drought resistant seeds and fertilizers by farmers in the municipality through both government and non-governmental interventions. Participants of the focused groups corroborated the use of improved and drought resistant varieties of seed as an adaptive strategy to ensure good and sustained output. In spite of the positive effects in terms of yields, farmers stated their inability to sustain the gains because of the cost of seeds.

> The extension officers help us a lot. ,…. (referring to the extension officer in the area) brought some seeds to us to plant. Pan 32 and another one. They were very good. Their stalks are short but the cobs are very big. Those ones need very little rain, once they germinate and tassels, they will do well even if the rain stops. ……The outputs are very good but the seeds are very expensive so we are unable to buy them. (Male FGD participant, Kukuo, 2018),

The seeds, which are usually supplied at subsidized prices by the district directorate of agriculture, tend to boost production for some time and then decline. This can be observed in the decline in yield of maize in the Bawku West district from 2004 to 2007 from 1.7Mt/Ha to a low of 0.6Mt/Ha. This tends to follow a four-year cycle consistent with electioneering years and the revamping of state or donor sponsored programmes to boost agricultural production and yields. Keeping to a similar pattern the yield per hectare started increasing from 2015 and peaked in 2016 at 1.5Mt/ha and dropped sharply in 2017. According to the district crop officer, the prolong effects of pest (fall army worm) was one of the key factors responsible for losses made by farmers. The infestation, which occurred between the 2016/17 production seasons, is reported to have resulted in the loss USD64 Million to Ghana (Business Ghana, 2018). The ministry of food and agriculture characterized the degree of damage as a threat to food security in Ghana (MoFA, 2017).

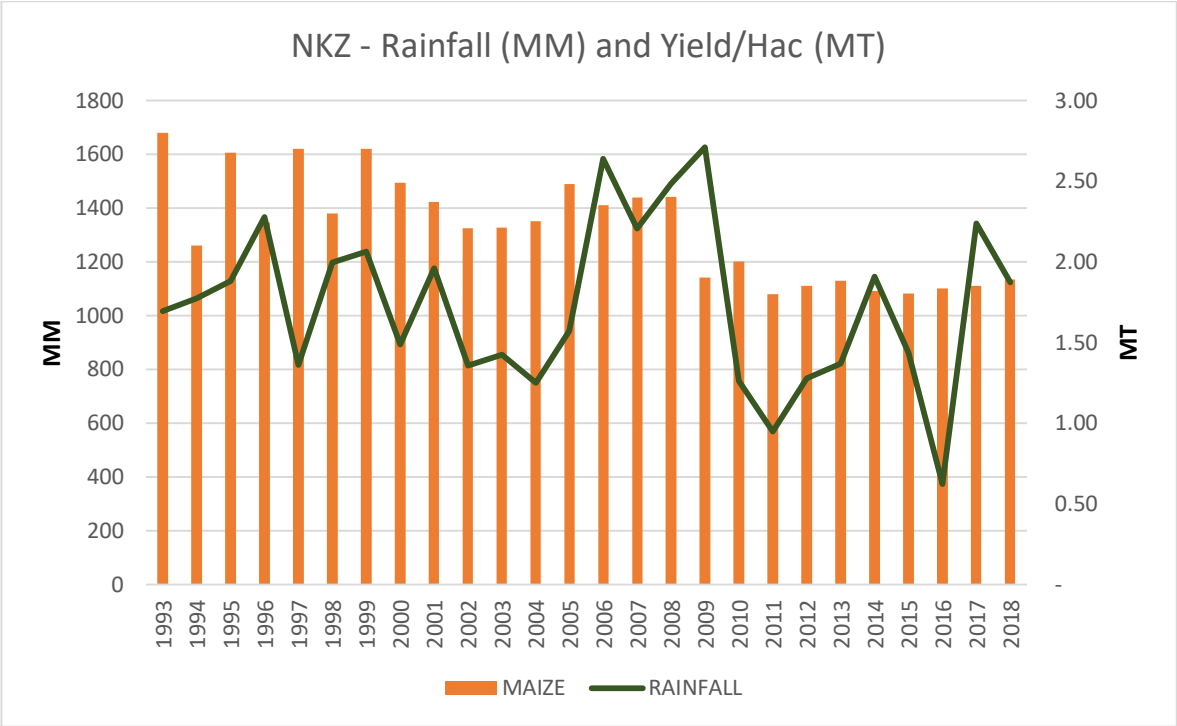
Figure 4. 5 Bawku West District, Maize Yield/Ha (MT) & Annual Rainfall (MM) – 1993-2018



Data Source: GMet & MoFA 2018/19

Unlike Bawku West, rainfall and maize yield (Mt/Ha) in Nkoranza South shows a positive relationship at the general level. Rises in rainfall is corresponded by rises in yield. There were however some instances where a negative relationship was observed. Examples of such instances include 1997, 2000, 2004, 2011 and 2016 where the maize yield increased despite drops in the quantity of rains for previous years. This is depicted in Figure 4.6.

Figure 4. 6 Nkoranza South, Maize Yield/Ha (MT) & Annual Rainfall (MM) – 1993-2018



Data source: GMet & MoFA 2018/19

The yield as observed in Figure 4.6 showed an unchanged yield for maize from 2011 to 2018 in spite of significant reduction in annual rainfall to between 600mm to 800mm from 2011-2013. Though the rainfall increased sharply in 2013 to nearly 1200mm from the previous year's amount of 800mm, the annual output in metric tons per hectare did not see a corresponding increase but remained the same. The trends observed point to two main things. First, in spite of the importance of climatic conditions, especially rainfall and temperature to agricultural production, they don't always exert the same influence, as there may be other intervening variables. Second, community specific factors such as soil types, stemming from relief and ecological features and fertility work together with climatic conditions to affect plant growth and output. Additionally, the types of seeds and vitality of such seeds may contribute to the final output even in situation where climatic patterns are favourable to crop production. Klutse *et al.* (2013) also observed that in spite of the reduction in rainfall, farmers continue to see increase

in general output due to the use of improved maize seed varieties and adoption of more efficient field management practices. Since the scope of this work did not cover such areas ascertaining the sources of differences and impacts could not be undertaken. In spite of this, conversations with the agricultural directorate indicated that farmers in the Nkoranza South district in recent times actively make use of improved seeds and reach out to extension officers for assistance on their farms.

> Now farmers don't do their own things anymore. Previously they will just buy any seed and plant without advice. When they have any problem, they will be asking their friends and neighbours on how they had solved similar problems, …. I'm not saying seeking information from friends and neighbours is bad, but sometimes they are misinformed. Now most of them have the phone numbers of the extension officers and they call them a lot. As you can see, some people come here to buy seeds, they just don't go and get some seeds. …...Some of the officers even stay in the communities so that they are accessible. (Crop Officer, Nkoranza South, 2018)

From the graphs presented on yield of maize (Mt/Ha) for the two locations, the highest outputs were 1.7Mt/Ha for Bawku West, which were recorded in 2004 and 2012 at points where rainfall reached close to 1500mm per annum and about 2.8Mt/Ha for Nkoranza South in 1993, 1995 and 1999 with rainfall ranging from a high of 1200mm to a low of 800mm. The trend in Nkoranza South has maintained a downward slump as rainfall figure reduce over times whereas Bawku West continue to undergo an annual variability with upward increases in yield in spite of reducing rainfall.

Though both locations seem to achieve an output a little above the national average output of 1.5Mt/Ha (MoFA-SRID, 2017), this is woefully inadequate to guaranteed food security at the household, district and national levels. The impact of climate variability on maize production cannot be over emphasized, Oseni and Masarirambi (2011) asserts that extreme forms of variability where a greater percentage of the annual mean rainfall is recorded in a short period can potentially affect the production of maize

which is a staple in many parts of Africa. Viewed in this manner annual average annual rainfall may remain unchanged or even increasing but its distribution may be greatly skewed resulting in very negative effect of rain-fed agriculture.

4.5 Experience of the effects of climate change/variability

Overall nearly all respondents in all the eight (8) communities indicated that they have observed and experienced the effect of erratic rainfall patterns on their farms leading to losses. Additionally, apart from Gbang, Donkro-Nkwanta and Ayerede, which recorded 42.6%, 78.8% and 79.8% respectively, the other communities had an average of 95% of the respondents indicating that they have experience the effects of shortening rainy period in their production cycle. The experience and effects of intense sunshine followed these two closely on the farming activities of respondents and their households.

The intensity of sunshine or intense heat is closely related to long dry spells and droughts especially in the case of communities in Bawku West district of the Upper East Region. Between the production years of 2016 and 2017, an attendant effect of the intense shine and long dry spell was the devastating effects of the fall armyworm infestation and destruction of large areas of maize farms across the country. Indeed, respondents at the community focus group discussions in both districts clearly noted the effects on their farms. For instance, in the case of Nkoranza South the experience of one farmer at Ayerede indicated the degree of loss incurred due to the infestation the fall armyworm on farms in the district.

> The fall armyworm situation was not easy at all, I planted about 5 acres of maize, they initially grew very well, and they had flowered very nicely. When the rain stopped and the heat started the worms started destroying my maize…. could you believe that I could not even get 3 bags (100kg/bag) of maize from

> the whole farm? It was very bad. Now I owe people a lot of money. (Male FGD participant, Ayerede, 2018).

Similarly, the helplessness of the situation was intimated by a middle-aged woman in Komaka;

> The way the worms ate the maize was sad. You wake up in the morning to realise the extent of damage. The sad thing was that we didn't know how to deal with the situation. We tried to use the pesticides which was difficult to buy but they didn't work. Other people were using *alata samina*[3] and other things. Nothing was working. We just stopped at a point because we were wasting money. The situation was not good at all. (Female FGD participant, Komaka, 2018)

The household survey showed that nearly all communities could relate to the experience of the farmer highlighted above. The intense heat does not only affect plant growth but introduces additional stress to farmers who already are plagued with challenges in relation to poor soil fertility and inadequate rainfall.

Changes in the season in relation to timing of planting and effects of prolonged rains leading to flood had mixed responses from respondents. For most (nearly 100% for all four communities) households in the Nkoranza South, floods and the associated consequence of high rate of run-off, erosion and storms were very minimal if not unusual. These tend to occur only in communities close to rivers courses or with soils with low absorbing capacity. The case however is different in communities in Bawku West. They reported that flood and storms constitute a big threat to both agricultural production and household livelihoods.

The flooding is not only limited to destruction of homes but also flooding of farms for days and death of animals. The perennial flooding results in the de-roofing and

[3] Locally made soap produced from plantain leave or cocoa pods

collapsing of buildings, lodging and in some cases total destruction of farms. At an FGD in Komaka, participants indicated that crops could be submerged in water for days with most of them getting rotten by the time the water dries up. The district crop and monitoring and information systems (MIS) officer of the Bawku West indicated that in the 2018 floods of the district, 26 communities were totally flooded affecting 596 households who had to be temporarily sheltered through the help of the National Disaster Management Organization (NADMO). A total area of 883 hectares of crops was affected. Crops destroyed include maize, soybeans, groundnut, rice and watermelons.

The consequences of such event are felt differently by different categories of persons. Women and migrant tend to be most affected, as their options to navigate the hardships imposed by extreme conditions are limited. Unlike most men, limitations on access to land, low resource and capital endowment affect the ability of women to swiftly change or secure new lands in order to relocate farms to rapidly readjust. Such limitation emanating from the architecture of entitlement tends to place women and sometime migrants in a disadvantaged position further deepening their exposure, sensitivity and vulnerability to climate impacts (Jost *et al*., 2016).

4.6 Aspect of livelihood with most impacts

Livelihoods of smallholder households have been affected in diverse ways. Whiles all aspects of livelihoods have been affected; some aspects have been greatly affected resulting in heightened sensitivity to future changes. In all the effect of climate variability was assessed on four (4) main aspects of smallholder livelihoods. These include, farming activities in relation to planning of work, household care relating to time taken away from responsibility towards household, nutrition and food as well as

income and revenues. Responses of households in all eight communities are tabulated in table 4.3.

Table 4. 3 Perceived Effect of Climate variability on aspects of smallholder livelihoods

Aspect of livelihood	Bawku West (%)				Nkoranza South (%)			
	Komaka	Dagunga	Kukuo	Gbango	Donkro Nkwanta	Jerusalem	Ayerede	Dotobaa
Farming Activities								
Lowest	8.2	11.7	-	-	-	-	19.2	-
Low	1	7.8	2	2.1	8.1	-	10.1	4
Moderate	2	9.7	12.9	40.4	4	26.7	30.3	33.3
High	35.7	9.7	78.2	46.8	37.4	53.3	31.3	43.4
Highest	53.1	61.2	6.9	10.6	50.5	20	9.1	19.2
Nutrition								
Lowest	1	3.9	-	-	6.1	-	7.1	20.2
Low	2	8.7	2	6.4	35.4	6.7	7.1	4
Moderate	14.3	26.2	32.7	34	48.5	26.7	17.2	27.3
High	30.6	24.3	61.4	55.3	2	46.7	33.3	29.3
Highest	52	36.9	4	4.3	8.1	20	35.4	19.2
Income								
Lowest	5.1	17.5	-	-	2	-	2	8.1
Low	7.1	12.6	2	6.4	-	-	-	4
Moderate	1	6.8	15.8	27.7	6.1	13.3	5.1	26.3
High	28.6	20.4	58.4	19.1	2	60	8.1	39.4
Highest	58.2	42.7	23.8	46.8	89.9	26.7	84.8	22.2
Household care								
Lowest	1	7.8	-	-	4	-	-	20.2
Low	5.1	11.7	-	-	9.1	-	3	4
Moderate	15.3	19.4	34.7	17	19.2	20	20.2	7.1
High	29.6	32	60.4	72.3	2	60	62.6	30.3
Highest	49	29.1	5	10.6	65.7	20	14.1	38.4

Source: Field Survey 2018/19 (N=798)

From Table 4.3 it can be observed that, all aspects of livelihoods of smallholder households across communities are affected. The rating of effects from low to very high presents a very bleak picture of the conditions of households in relation to the four (4) aspects of interest. In relation to farming activities, the impact of climate variability has been very high observing from the scoring of effects from moderate to very high by households. Each community averaged a cumulative score of 80% or above of the

intensity of climate variability between moderate to very high effect on their farming activities. This suggests that the effects on their farms and productivity levels have the potential to threaten the very base of sustenance for the household because the effects dovetail into other aspects. As has been noted by Morton (2007) the threat to the livelihood of smallholder farmers is one of the most important impact of global climate change as this group constitute the basis for subsistence to most developing countries especially countries south of the Sahara. Viewed from the perspective of the Ministry of Food and Agriculture of Ghana (MoFA), the threat posed to smallholder farmers in Ghana by climate variability impacts must be addressed to forestall a national food security crisis since nearly 90% of farmers actively engaged in agricultural production are smallholder farmers (MoFA, 2006).

The reported effects on nutrition, income/revenue and general household care follows in a similar fashion as the effect on farming activities. As note earlier, due to the intricate link between farm output and other aspects of smallholder farmers' livelihoods, any shift or shock to the farming activity leads to similar or stronger effects in other aspects of their lives. As shown in table 4.3, apart from some few exceptions, communities rated the effect of climate variability on household nutrition, income and general household care in very similar patterns as they rated the effect on their farming activities.

4.7 Conclusion

The chapter has examined and discussed climate change variability and its implications on the livelihoods of smallholder households in the Bawku West district and Nkoranza South municipal. To provide a background to the kinds of households sampled for the analyses, an overview of the sample was presented showing key household

characteristics such as the age, sex, educational distribution of household heads, as well as household sizes. An important variable presented and discussed was the kinds of crops households produced. This was viewed as very important as the crops produced determined the form of impacts a likely shift in climatic conditions may have on the household. It was established that almost every household surveyed produced maize in addition to other crops such as yam and cassava for Nkoranza South as well as millet and sorghum for Bawku West. On average, households produce a minimum of two crops showing very good agricultural diversity in case of crop failures.

In exploring the nature of variability using rainfall data obtained from the Ghana Meteorological Agency (GMet), it was found that there exists an inter-annual and decadal variability. In spite of the variability observed, a pattern of change could not be established though there a growing reduction could be observed in the amounts of monthly average rainfall over the years. Furthermore, the analysis indicated that compared to Bawku West, the Nkoranza South municipal has had significant reductions in the mean monthly and annual rainfall over the years especially during the peak rainy periods. The distribution of rainfall in mean average days per month was however observed to have remained more or less the same for both districts with some variability over time.

The observed variability in both rainfall and distribution have had mixed effects on the trends of output of maize (in Mt/Ha) over the year. An important observation made was that whereas Bawku West seems to have improved in yield from 1993-2018 with a negative relationship to rainfall, the outputs from Nkoranza South appeared to have dropped and plateaued at an average of 1.7Mt/Ha since 2011. The yield per hectare analysis shows a rather bleak picture on the performance of the two districts in relation to yields in metric tons per hectare in relation to the regional, African and global

average yield. The output of 1.7Mt/Ha for Bawku West and 2.8Mt/Ha for Nkoranza South are below the expected yield of 3Mt/Ha.

CHAPTER FIVE

INHERITANCE PATTERNS AND GENDERED ACCESS, USE AND CONTROL OF LAND IN BAWKU WEST AND NKORANZA SOUTH DISTRICTS

5.1 Introduction

This chapter examines inheritance and land tenure arrangements affect use of adaptive option by men and women to climate variability impacts. It evaluates the architecture of entitlement through as exploration of inheritance pattern and land tenure arrangement interrogating how different arrangements influence access, use and control of land for climate variability adaptation by different categories of smallholder farmers.

The focus is primarily on the gender relations and challenges, which either enhance or limit successful climate induced adaptation. The chapter uses primary data collected from four (4) communities each in the Bawku West district and Nkoranza South municipal with emphasis on the results from focus group discussions and key informant interviews.

Analyses and discussions on access to social and communal resources –with especial on emphasis land, control and management of resources and adaptive options relied on household survey data collected from the communities of study. The chapter is sectionalized to facilitate understanding and flow of arguments.

5.2 The architecture of entitlement: Inheritances patterns and practices

Inheritance constitutes an important mode of passing on or transferring property, titles, debts, rights, and obligations upon the death of an individual or persons. Inheritance is therefore governed by specified rules which are altered and changed over time. Inheritance therefore offers inalienable rights to the beneficiaries of such transfer to use

and control the resources handed over to them. The rights conferred on beneficiaries upon receipt of any form of estate/property vary from place to place and based on norms regulating use and onward bequeathal or transfer.

As noted by Fafchamps and Quisumbing (2005), inheritance provides the basis for the transfer, or exclusion from the transfer, of people's accumulated physical capital. The transfer of physical assets from one generation to the next can provide needed material start-ups for younger generations to secure their future livelihoods and boost their economic productivity. Exclusion from asset inheritance can therefore exacerbate vulnerability to chronic poverty and the intergenerational transmission of poverty (Bird, 2013).

In some countries, inheritance and customary practices can exclude individuals, specifically women and orphaned children, from inheriting the property (including land, housing and other productive resources) that they had access to while their husbands or fathers were alive (Cooper, 2008 and 2010). This was the case in Ghana prior to the enactment of the interstate succession law PNDC law 111 in 1985 when customary law held sway in such matters (Awusabo-Asare, 1990). In spite of the importance of the law in the administration of family inheritance when a property owner dies interstate, modalities for the administrations of a deceased person's estate on lineage lands were beyond its scope. Customary laws were therefore used in such cases. The use of customary law in the administration of such according to Awusabo-Asare (1990) was due to three related factors. These include

1. The customary governance of land
2. The limited reach of statutory structure

3. Requirement of the approval of customary governance bodies due to lineage group's ownership of land.

These factors provided the basis for the determination of such issues within the lineage especially regarding the estates of members who die interstate due to the non-applicability of PNDC Law 111 (Woodman, 2004).

Though PNDC Law 264 was enacted as an amendments to address the limitations of PNDC Law 111, traditional norms on inheritance practices retain significant influence on the transfer of properties (Awusabo-Asare, 1990). Ghana has two main cultural and normative inheritance systems or types. These are the patrilineal and matrilineal inheritance patterns. The two patterns are practiced throughout Ghana with cultural and location specific variations (Cooper and Bird, 2012). According to Cooper (2011) the practice of these two forms of inheritance dates back to pre-colonial era through to the last decades of the nineteenth Century. In her estimation, at that time and prior, customary laws had governed the practices of inheritance. These customary laws in most instances did not adequately reflect the changing realities of the day and therefore triggered customary and legal challenges and reforms.

Results from both the key informant interviews and focus group discussions indicate that the two districts practice the two main inheritance patterns. Bawku West practices the patrilineal system of inheritance and transfers of property while Nkoranza South practice the matrilineal inheritance system. The two practices have distinct features with different gendered implications.

The Patrilineal inheritance connotes the establishment of affinity through descendants of common male ancestors. This is achieved through the male bloodline due to the assumption of inheritance or conferment of the soul or spirit through the father

(Awusabo-Asare, 1990; Chukwukere, 1978). Children to a couple belong to their father's lineage. Relation and familial ties is thus struck through father's lineage (Kutsoati & Morck, 2014). The ownership of children born to the marriage belonging to the man has far reaching ramification on the naming, fostering, training, and major decisions on the life processes of children. A family's controlling spirit passes from generation to generation only through male bloodlines. These connections therefore define one's extended family. A family head from Kukuo in the Bawku West district stated that once a child is born all the relations of the father are fathers to the child and as such bears part of the responsibility for the welfare of the child. Uncles can take over affairs of the child if fathers are deemed to be incapable of discharging their fatherly responsibilities. He further indicated the intricacies of relationships stretching from parents to grandparents.

> Under patrilineal custom, one's extended family includes one's children as well as one's father, siblings, half siblings by a common father, aunts and uncles, and so on. One's sisters and half-sisters by a common father are members of one's lineage; but the sister's children are not considered family. This is because they belong to that sister's or half-sister's husband's family. Likewise, one's grandchildren through a son belong to one's family, but grandchildren though a daughter belongs to their father's family, and are thus not one's blood relatives. (Family head, Kukuo, Bawku West, 2018)

By implication the practice defines clear criteria for inclusion and exclusion. In spite of the cultural dictates and clear definitions of who is a relative, the practice does not follow such pristine and fine arrangements at all times. During the focus group discussion in Komaka, most of the men stated that strict adherence to such rules and expectations may result in challenges and lead to break down of marriages especially for men who marry women with other children.

> The way things are, when you marry a woman with a child or children your family will not allow her children to have the land you were working on if you

> die. Only the children (sons) you have with her will be allowed to have the land…. even if you give the land to her children before… when you are alive they will still take it from them because to your family they are your wife's children and not your children (Male FGD participant, Komaka, Bawku West, 2018)

Though this practice is uncommon they exist. Men in such unions consider the children of their spouse as their own though their families may not consider their wives' children as such. Taking a spouse' children or adopting them allows them to inherit the man's personal property but not the man's family assets or property in his possession.

The Nkoranza South municipal which is predominantly Akan practices the matrilineal system of inheritance. The practice perceives all descendants of all common female ancestors through female bloodlines as relatives and thus accord them rights to inherit and benefit from clan assets and properties. Children born to couples whether male or female belong to their mother's lineage as opposed to the patrilineal inheritance pattern. Relationships are thus with one's mother relations and lineage members (Kutsoati & Morck, 2014).

Under matrilineal tradition, a family's controlling spirit passes from generation to generation only through female blood lines, from whom Akan children are believed to inherit their "flesh and blood," i.e., their source of existence (Bleeker, 1966). Family ties, traced only through female ancestors, define one's extended family, lineage, or *matriclan*. In a matrilineal group as in the case of the Bonos of the Nkoranza South municipal, one is thus related by blood to one's mother, full siblings, and half siblings by a common mother (uterine half siblings), but not to one's father nor to any half siblings by a common father. Thus, children belong to their mother's lineage, but not the father's. A traditional Akan male thus feels blood kinship to his mother's brother (*wɔfa*), but at most a weak connection to his father's brother.

The strong appeal of the matrilineal inheritance system is waning in recent times as alluded to by the Chief of Dotobaa, Nana Gyasi Agyabaa. He intimated that the practice where men took care of their sister's children especially their nephews at the detriment of their children is waning due to a number of factors. He puts it this way;

> Now the wofa, wofa (uncle) thing is dying out because people have learnt.… they have realized the disadvantages of investing in their nephews at the expense of their children. These days when you inherit someone you only inherit in name, his property is for his children, now if you try to take your brother's property his children will fight you. (Community leader, Dotobaa – Nkoranza South, 2018)

The waning practice of matrikin inheritance is due to a number of factors. First the need to secure the future of both their children and spouses has led to greater investment by men in their own children's education. Secondly, deeply nucleation of the family has meant that reliance on the matrikin in old age cannot be guaranteed. In such cases any investments made in lieu of future support may result in disappointments. In recent times the strength of the matriclan is just in relation to the burial of relative and representations at community gatherings.

As was indicated in the previous chapter most migrants in the Nkoranza South municipal hail from the Northern parts of Ghana. The inheritance system in their places of origin is patrilineal. The inheritance practices of their places of origin was however irrelevant in the case of this study as the inheritance of their present location govern their access to and use of land for cultivation. Migrants' access to land was through shared cropping, rent or labour tenancy. It was noted that none of the migrants owned land which could be passed on to an offspring, spouse or any family member.

5.3 Applying inheritance rights: Implications on gendered access to resources

The different inheritance patterns have implication on gendered access to resources. Access and privilege to resources is based on the need for the lineage to consolidate its material wealth and enhance its social prestige. Assess to both moveable and immoveable assets or property is the ability to maintain and pass on within either the matrilineal or patrilineal clan.

An important note made in both the key informant interviews and focus group discussions in the Bawku West district indicated that women and girls are generally disinherited or exempted from inheriting landed properties from their fathers especially land for cultivation. Participants stated clearly that only sons are entitled to inherit. The access of both widows and female children to land are tied to their brothers or uncles who may inherit in the absence of a male heir. This observation appears that although in principle both sexes qualify to inherit in the patrilineal kinship system, the female child has fewer or no rights to her deceased male parent's property whereas the male child does.

This finding is opposed to Robertson (1984) study among the patrilineal Ga in central Accra. Though he pointed to similar arrangement in terms of the lines of inheritance and tracing of lineage patrilineally, inheritance rights do not flow unilaterally, that is only from fathers to son. He indicates that some properties pass from mothers to daughters, while certain transmissions are from fathers to sons. There are also certain things passed on, without gender discrimination (Robertson 1984: 45-67). In the case of the Bawku West area, mothers are largely unable to pass on any form of landed properties to their daughters acquired through the husband due to the fact that they are immediately disinherited from their father's household where they may have access to land for farming once they marry. Apusigah (2009) views this structural and cultural

process of female disinheritance as creating an unequal gender relation based on the men/boy as super-ordinates and potential heirs and heads of household and women/girls on the other has as subordinates who depend on males for resources provision.

The male focus groups and some family heads though acknowledged the disproportionate access to resources and its potential to limit female contribution to household provisions remained intransigent on the need to modify cultural norms and practices to enhance female access and control of resources especially land. The need to safeguard the social good was one of the strong bases for the non-inheritance of women and girls. The association between land, social and group identity also gives credence to this position of male dominated administrative system and structure (Apusigah, 2009:55). A participant succinctly put this point thus

> The reason why society allows men to have more rights than women to inherit land, as mentioned earlier, is that men are supposed to cultivate the land and use its proceeds to support and maintain their wives and children. As a result, women are not supposed to inherit land. Similarly, a house as an estate passes to the male child when the father dies. The female child may reside in the house but leaves as soon as she is married. Sometimes, a male child may give some portion of an estate to his sister, but often his wife will object since the latter expects her own male children to inherit the estate. This is important to ensure that the property stays in the family. (Male FGD participant, Dagunga, Bawku West 2018).

The limited access to land greatly curtails women's role and contribution to household decision-making and care. As noted by Kevane and Gray (1999), access to and control of material resources such as right to own land as well as control the use of land shapes household decision-making. Therefore, the absence of such rights influences the ability of women to partake in such processes. This was strongly felt when women in the focus group discussions were asked about their participation in household production practices. One of the most poignant response was;

> As for this place it is the man who makes the decision. For us the women we just follow what our husband will say. The land we use is given by the man. If the family land is too small you work with him on the small land. …. Sometimes if your husband needs your land for other things…. he can take your land. As you can see, we only farms around the compound, that one they leave it to us (Female FGD participant, Gbango, Bawku West, 2018)

The response suggests that the dependence on men for land and other inputs for cultivation of crops such as groundnut, soybeans and beans renders women docile. As Apusigah puts it, "they are more likely to persuade and plead than to claim rights" (Apusigah, 2009:60).

Limited resource access and control have potentially debilitating effect on household nutrition, provision and expenditures. This is imperative as most of the women's production goes directly to supporting the needs of children and the household. Doss (2006) who studied women access to land and other resources in Ghana found that the more women are allowed access to farmland the more they are better able to positively affect the quality of household expenditures. Allendorf (2007) corroborating this finding suggests that woman's land rights facilitate their ability to have a say in the organizations of the household leading to improvements in the nutritional needs of children.

The case of Nkoranza South is quite different considering the comparatively high level of access to land by women and girls. The right to properties and family assets especially land for farming are available to all members of the matrilineal clan. The difference however is that the administration of family property and resources tend to favour women and their off-springs as they are considered family. Children of men, whether male or female have no or limited access to family property. Despite the cultural and social advantage for women and girls in relation to the right of access and

use, their control and management of both moveable and immoveable assets and properties is limited.

Though land seems to be available and accessible to women with guaranteed usury rights, control and management lies in the hands of family heads and specific patriarchs. The influence of men in the administration of community and family assets like land deepens the control of men over women. Valdivia and Gille (2001) have explored the intricate linkage between control of resource and power. They contend that, the marginalization of women in the structure of agricultural production stem from their lack of control of resources. In the view of Valdivia and Gille (*ibid*) the control of resources in itself engenders power and voice. This highlights the patriarchal realities of matrilineal societies where control of social institutions and social arrangements put men in a super-ordinate position in spite of guarantees on rights and privileges of women. This is poignantly expressed in the sentiments expressed by one woman in Ayerede

> In this community everyone can get land either from their family or the chief. Unless your parents have their own land, you have to depend on what the family has or the chief. But the situation is such that women sometimes get overlooked when another man comes for the same land. This is happening because it is the men who make and take all the decision. The women are like helpers. They are sometimes not considered. Both men and women can get land once they ask for it, but men have more power when they want the land. (Female FGD participant, Ayerede, Nkoranza South, 2018)

The statement above suggests that though perceived as a system which guarantees place more power and control in the hands of women, matrilineal inheritance does not in itself deny the influences of patriarchy and control of men. It is a system of male inheritance through female lines.

5.3.1 Using cultural/normative rights as security of access, use and control of land

In order to navigate the limitations and constraints on access, use and control of land women have evolved ways of ensuring continues access, use and control of family assets. These strategies are however peculiar to women in the Nkoranza South municipal where their access to land is not curtailed by cultural or other inheritance inhibitions. Three (3) main strategies were noted in relation to the use of family or community land. They include the establishment of cashew plantation through the support and help of husbands; work together with husband on land allocated to them by the family and rent unused lands to settlers or engaged in a shared cropping arrangement.

Due to the inability of most women to cultivate several acres of seasonal crops such maize, portion of land allocated to then are mostly taken over by men who have access to more financial resources to cultivate larger areas at a time. In order to ensure that their share of land remains under their control, most women have begun investing in tree crops. Cashew has thus become a means to guarantee control of land by some women who have the ability to make the initial investment. Those without the resources to unilaterally establish the plantations, work together with their spouses to setup the farm under a profit-sharing arrangement. In establishing the farm, other matrikins will not have any justification for taking over the land. Also, the property established on the land enables the off-strings of the women to derive lasting benefits from the land.

Closely related to the establishment of cashew plantation is joint use of land by women with their spouses. It was observed that most women who have access to significant sizes of land work together with their spouses. This strategy facilitates the injection of resources in to the land and its continued usage. Participants of the women's focus

group discussion in Dotobaa noted that it was better to team up with the husbands to work on woman's land. This was in spite of the tendency for the men to usually take over revenues from the farm. They noted that maintaining independent farms become not only burdensome to them but create an enabling environment for other family members to take over excess land she is unable to use. Working with their spouses therefore affords them the time, energy and right amount of resources to put the land to good use.

For some women, a way of ensuring control over their land is through the extension of use to settlers and settler farmers. Since the Nkoranza South district constitutes an important destination for migrants and settler farmers from the Northern parts of Ghana, there is no shortage of people seeking for land for farming. Most women take advantage of this situation by either renting or entering into shared cropping arrangements with settler farmers. It must be noted that in some cases the settler farmers are initially engaged as labour tenants who are later given the lands to work on. This arrangement has ensured that old women who lack the physical strength to work a large area of land can reliably depend on the services of the settler farmer for some form of income and food.

5.4 Practices and considerations: Assess use and control of resources

Degrees of access and control of resources are varied across communities and conditioned on the nature of inheritance and norms of allocations. Results from the household survey indicate that of the different sources of land used for farming by household, family land constitute the most relied upon source of land acquisition for farming. A total of 47.37% of the total number of household survey use family land for their agricultural production. A significant proportion (75.51%) of this number is within

the Bawku West while 19.65% are within the Nkoranza South municipal. The data still point to the high levels of access to family resources by men as a result of the inheritance system and the increased control of men over land. From the survey, where only 36.97% of women have access to family lands 56.64% percent of men have access and control over family lands. Similarly access to community lands followed such patterns.

The ability to obtain family land for farming is hinged on a number of factors which were gleaned from in-depth interviews and focus group discussions

1. The availability of unused farm lands within the family.
2. The absence of any person requesting for the same piece of land or lands with a stronger appeal to family heads or elders
3. The willingness of family heads and elders to release the land to the seeker
4. The ability to invest in the entirety of land a person is desiring to be allocated
5. Cultural and normative rules on gendered land access

The factors listed were compiled based on the different the experiences shared by participants of the focus group discussions in Bawku West and Nkoranza South districts.

The factors operate within both the Bawku West and Nkoranza South districts to determine access to family lands. In the case of Bawku West where the patrilineal inheritance system is practiced however, factor number five tends to have a greater sway. Due to the clear rules on female access to land, women cannot by themselves request for the use of family land or have independent use of them. Their access is thus connected to males who they are related to by blood or marriage such as fathers, uncles, husbands and sons. It must be noted in this regards that the reported use of family lands

by females in Bawku West area is rather portions of lands allocated to them by a male super-ordinate whose right to access and use of family lands extend to either their daughters or wives.

Unlike women in Bawku West, women or female headed household in the Nkoranza South regardless of their age were entitle to portions of family lands and are capable of accessing family lands independent of men. The right to access and use land for the women constitute a means of economic empowerment thereby reducing their dependence on their spouses for support. Though most women establish farms together with their spouses, the case of widows and women who have separated from their spouses were less precarious since they are better able to engage in farming activities without hindrance emanating from cultural or social inhibitions.

Apart from the use of family land, land can be obtained from a person with whom there is no blood or marital affinity through a formal request. The case in Bawku West is that apart from the use of family land, lands can be sought from other persons. The process of seeking land to use is very similar to processes in the Nkoranza South area with the exception that the cultural inhibition to the ownership is applied. Therefore, a woman's requests must be routed through a male family member who fronts the process of obtaining the land on her behalf. Women who go directly to seek land either from the chief or any other person in the community were viewed as deviants. It was indicated at the male focused group that, women were hardly successful in obtaining lands through other sources for farming apart from household or family lands.

> If a woman on her own goes to ask for a land from another person she will never be given. The arrangement is that if the woman wants to farm but there is no land for her in her household, another male leads her to a person who has unused land to beg the use of the land. When it is done that way, the woman will be given the land to work on. (Male FDG participant, Komaka, Bawku West, 2018)

Access to other resources such as fuel wood, water and economic plants such as dawadawa and shear are however not governed strictly by such rules in the two areas. A common rule found at both Bawku West and Nkoranza South is the need to seek prior permission from landowners before collecting resources from their farms. Seeking permission is meant as a social process of allowing the landowners' family first right to such resources. It must be noted that the rules on access to wild economic plants like dawadawa and shear have become more restrictive recent times. The women's focus group in Gbango observed that, ones the tree is placed on a family's land even in the wild it is only women from that family who can go and pick the shear for commercial purposes. Asked why this arrangement has become necessary, one of the participants stated:

> When we were children you can just go around picking shear everywhere whether they are on your land or not, but now if you do that it will bring confusion. Now the trees don't bare as much as they used to do and the crops are failing very often so everybody has shifted their attention to what they can get from the shear. There have been so many quarrels because people have gone to other people's farm to collect shear fruits. (Female FGD participant, Gbango, Bawku West, 2018)

A key consideration made in granting access to the use of land is the quality of social relations with family members. This is noted in both Nkoranza South and Bawku West. The difference however is in relation to how it is applied in the case of a widow. Whereas in Nkoranza South widows may have access to lands from their matrilineal clan, widows in Bawku West have to depend on the benevolence and favour of the family of the deceased husband or sons. In the case where widows have no sons, it is the quality of the relationship with the rival's son (s) who become heirs in the case of a polygynous union for access to land and upkeep. Where widows are viewed unfavourably or has quarrels with the rival or the husband's family, she is totally

disinherited. According to participants, there are cases where widows seen as "stubborn" are evicted from the land though this is rather rear.

The analysis of data showed that though migrants are not bared in any way from engaging in agricultural production which may require the need to seek land in the Bawku West there has not been any practice or experience from which to speak. The migrant in such communities were not engaged in Agricultural production. The Nkoranza South on the other has a large migrant farmer population. The rule on family lands in the area is such that only family member can access the land. Migrants or settlers can therefore only get access and use family lands through shared cropping, labour tenancy or annual or seasonal land renting arrangement.

The case of migrants is therefore precarious since their ability to obtain land is premised on their ability to pay. Apart from the residents of Jerusalem No. 1, who obtain their lands directly from the church without payment, most migrant rent land for agricultural production.

5.5 Inheritance patterns/practices and Land tenure/use arrangements

Access to land for farming within the two study districts can be acquired through a number of ways. The existing land tenure arrangements govern the type of land and terms of use a smallholder farmer may have. The different land tenure and use arrangement discovered in the study areas include free use without any demand of compensation for use of land by the land owners, land rental arrangement which may be either for a duration of a year or for a season for areas with double planting season, and shared cropping arrangements of varied forms, freehold use through first clearance which largely applies to family and community lands, outright purchase or long lease ownership and a wide range of labour contract arrangements.

It must be noted that the forms of tenures or land use arrangements are largely influenced by the norms on access and use of land and ownership structure of the community and the district. Whereas Bawku West seems to have a uniform land ownership structure with land owed largely by families and households, Nkoranza South has varied forms ranging from community lands vested in the chief or stool, family or clan lands, lands acquired through first clearance and individual ownership of lands. The different ownership structures therefore influence who and how land could be used and under what specific terms of use.

5.5.1 Forms of land tenures and land use arrangements

Households' use of land is based on different land tenure and use arrangements. For most households, access to family land is vital due to their relatively secured tenure and the reduced burden of dealing with the demands of landowners. In spite of this desire, not all households have access to family and community land or virgin forest to clear as first users. Lands acquired are thus under various use arrangements.

From the survey it was observed that majority (47.4%) of respondents use family lands. Of this number 75.5% of them are within the Bawku West district while 19.7% are within the Nkoranza South municipal. As indicated above, the challenges with security of tenure or continued use of the land makes access to family land for households in Bawku West area very important. Table 5.1 presents the distribution of types of land access by households in Bawku West and Nkoraza South for farming.

For the 27.8% of households who obtain land access through annual rent or hire, more than half (53.7%) are in the Nkoranza Area with only 1.5% of them in the Bawku West district. The data also suggest that for all households surveyed in the Nkoranza South municipal, 53.7% of them rent land for their agricultural production. The wide difference in the proportions of people renting land for production in the Nkoaranza

South municipal compared to the Bawku West area indicates the degree or extent to which land access has been commoditized within the Nkoranza area. In spite of this landowners are not ready to release land on long-term leases. The percentage of outright purchase of lands shows that only 1% of households in Nkoranza South have permanently acquired the land on which they work.

Table 5. 1 District and source of land for farming

Source of land	District		
	Bawku West (%)	**Nkoranza South (%)**	**Total (%)**
Family	75.5	19.7	47.4
Rent	1.5	53.7	27.8
Chief	0.5	1.7	1.1
Outright purchase	-	1	0.5
Spouse	18.4	1.2	9.8
Inherited	3.8	15.7	9.8
Shared cropping	0.3	1.7	1
Church	-	5.2	2.6

Source: Household Survey 2018/19

The association between source of land access and status in community (see table 5.2 below) shows that whereas it is expected that family lands will be occupied by indigenes an observation, which is striking, is the good share of indigenes within the Nkoraza South area that also rent land for farming. A Farmer Based Organization (FBO) leader who gave an extensive insight into land use and land tenure dynamics in Donkro-Nkwanta pointed that in spite of the availability of family lands in the community for people to farm, most people have to rely on rented land in order to expand their farms. Also, some indigenes tend to use their own land to cultivate plantations (cashew) whiles relying on other people's land for cultivation of seasonal crops.

> Now the cashew has become very appealing to people but that can only be done of your own land, so what people are now doing is to do the cashew farm on the one they have from the farm as their own land. Before the cashew grows they

> continue to do maize of ground and other things on the farms. When the trees grow and they cannot do the other crops anymore they go and look for land to plant maize every season. As we are sitting here all of us are renting land for maize but we also have cashew. (FBO leader, Donkro-Nkwanta, Nkoranza South, 2018

In such a case both indigenes and settlers compete over access to and use of land. This situation has resulted in the high rate of land rental for farming and a consequent rise in the cost of the annual land rents.

Table 5. 2 Status in community and source of land for farming sorted by district

Source of land	Status in community					
	Bawku West (%)			Nkoranza South (%)		
	Indigene	Settler	Total	Indigene	Settler	Total
Family	75.4	83.3	75.5	32.7	4.8	19.7
Rent	1.3	16.7	1.5	27.1	84	53.7
Chief	0.5	-	0.5	-	3.7	1.7
Outright purchase	-	-	-	-	2.1	1
Spouse	18.7	-	18.4	2.3	-	1.2
Inherited	3.9	-	3.8	28	1.6	15.7
Shared cropping	0.3	-	0.3	-	3.7	1.7
Church	-	-	-	9.8	-	5.2

Source: Household survey 2018/19

The arrangements for the use of land are varied. While some of them are standard community rates agreed upon by all, others are based on individual level agreement between landowners and tenants or users. There is a fixed rate paid for the use of land for either the season or the entire year. The rate for the communities in the Nkoraza South municipal ranges from GHC50-GHC70 per acre for each production season. According to farmers at the FGDs the rate is usually revised based on demand and scarcity of land. Besides the payment of cash for the use of land some landowners and farmers sometimes agree to pay or receive payment in bags of produce. The bags are charged in relation to the number of acres under use. It was noted by participants that usually a farmer pays between two to three bags (100kg) per acre for the total number of acres of land under use. This arrangement tends to place enormous burden on

farmers, as periods of crop failures are not accounted for. One farmer during the FGD in Jerusalem noted his experience

> Last two years when the pest was destroying the crops, my landlord came to ask for her bags of maize at the end of the season. It was very tough for me. I had to go to the market to buy six (6) bags of maize for her. As for them (*the land lords*) they don't care what you get; they will still take their maize. (Male FGD participant, Jerusalem No. 1, Nkoranza South 2018).

Though the rent arrangement, either cash or with produce, helps to enforce a level of certainty regarding the use of land by tenants, the nature of arrangements sometimes constitute sources of conflicts between landlords and tenants. These conflicts arise from non-payment on the part of tenets leading to the forcible demand of agreed form of payment by land lords. Conflict may also arise in cases where land lord takes over rented lands without prior notice or information. The case of forcible occupation or use of land already rented lands was a strong issue that arose during the focus group discussion is Donkro-Nkwanta in the Nkoranza South district. One farmer noted:

> Some of the people give you land, you will be paying for the use of the land but they still want to use the same land for doing other things. My former land lady came to plant okro on the same land I had planted maize. It was very bad. When I complained that the okro will spoil the maize she started fighting me with threats of eviction. Just imagine ooo, I am an indigene ooo, the case of the migrants is even worse. (Male FGD participant, D-Nkwanta, Nkoranza South, 2018).

Based on the experienced shared by the farmer the researcher sought to ascertain the experiences of migrants present at the FGD. Though they (3 present) hesitant in sharing their experiences due to fear of retribution from other indigenes one spoke of an experience he had in the previous season.

> I had been working on that land for three years without any serious challenges until last year. Because of the way the armyworms destroyed my crops I decided to plant some water melon [farm is close to a river]. After I had spent money and time to prepare the land, this woman came to tell me she is taking the land

> for tomatoes farm. It was not easy. The issue went to the chief, everybody here knows about it. I was demanding the money I used for the land preparations, but eventually I had to leave it (Migrant farmer, D-Nkwanta, Nkoranza South).

In spite of these experiences, participants maintain that, since it was difficult to purchase land due to customs and amount involved they have to learn to endure some of the challenges that arise. The terms of land access use arrangements were seen as better as they at the minimum, enable landless individuals especially settlers to gain access to farmlands for cultivation.

Table 5. 3 Land tenure and land use arrangements

Tenure/ use arrangement	Form of Access						
	Family (%)	**Rent (%)**	**Chief (%)**	**Spouse (%)**	**Inherited (%)**	**Shared Crop (%)**	**Church (%)**
Annual Payment	5.1	92.7	-	2.1	-	-	-
Share output	10	60	6.7	-	-	23.3	-
No planting of tree crops	83.3	16.7	-	-	-	-	-
Use land till needed	50	50	-	-	-	-	-
Contribute to church activities	-	-	-	-	-	-	100
Intercrop with cashew/care for cashew	-	100	-	-	-	-	-
Give part of produce to mother	-	-	-	-	100	-	-
Annual payment/care for cashew	-	100	-	-	-	-	-

Source: Household survey 2018/19

Table 5.3 presents other forms of land use arrangements such as shared cropping, free use of land till required by owner, intercropping planted field with tree crops such as cashews and provision to family for the use of land. Most of these terms or use arrangement were found in the Nkoranza South municipal because the communities tended to have a more relaxed land used arrangement compared to the Bawku West district. For most households in the Bawku West district, the land used for farming are

usually lands which belong to the family or household and therefore users are not obliged to make any payment either cash or kind.

Besides the use of household or family lands, land can be borrowed from neighbours or other persons in the community or adjoining communities in the Bawku West district. The process of borrowing a land for farming purposes require a formal request to be made to a land owner after an unused land has been identified. Requests are usually granted though under certain circumstances requests are turned down. Due to nature of the practice and the customary norms regulating this practice, the persons to whom lands are granted are not formally obliged to make any form of payment to the land owner. Nevertheless, beneficiaries of such arrangements show appreciation for the use of the lands. The demonstrations of gratitude are meant to ensure continues usage. The process of granting and continuous use of lands are therefore based on the strength and quality of relationships landowners and tenants.

5.5.2 Changing land use arrangements and land commercialization

Land tenures like all other cultural and social arrangements and practices undergo changes over time as society develops and change. It was observed that some practices have evolved in the areas in response to climatic changes and dwindling land access. The changes observed include land use practices, which involved intensification as well as diversification of crop production through the introduction of tree crops such as mangos and cashew.

Cashew has gained prominence in the Bonno-East region due to its high commercial value and availability of ready market. Additionally, its resilience to the variable climate has made it a preferable crop to farmers compared to the more volatile seasonal crops such as maize and others. Furthermore, cultivation of tree crops guarantees a stronger security of tenure (Otsuka *et al*, 2003). In spite of these seeming advantages

emanating from cashew production it presents several challenges rural livelihoods especially in relation to foods crop production and access to as well as the use of family lands. Scholars such as Evans *et al* (2014) have noted the food security and poverty alleviation concerns arising from the growing expansion of cashew plantations in the region. They further pointed out that besides the unequal relations between the producers and buying firms, the exhaustion of family and other lands meant for food crop production may comprise food security and land accessibility in the long run.

Again, the expansion of the cashew plantation tends to place the use and control of both community and family lands and other resources in the hands of men thereby depriving women and girls who usually engage in food crop production access to arable family lands. This corroborates Evans *et al*. (2015) assertion that women and girls are more likely to lose out in the long run as there is a higher likelihood for men to control the land, the plantation as well as the monies realized from the work. Besides the labour demands for such plantations, it is likely to deny young people and women the ability to undertake the production of food crops, which are important source of sustenance and income for the household.

Farmers who participated in the focus group discussion especially in Ayerede and Donkro-Nkwanta shared these concerns. They noted that though settlers are the most affected, indigene might be the eventual losers as the setters may leave once they are overly stretched. One of the main challenges with the expansions of cashew farms as noted is the new labour tenancy arrangement it is giving rise to. In this arrangement landlords allow tenants, who are usually settler farmers, to intercrop newly planted cashew plantations with maize or any other seasonal crops. The tenant is then charged with the responsibility of care for the cashew till they begin to develop canopies at which point the tenant vacates the land.

The arrangement according to the farmers disadvantages the tenant in a number of ways. First their labour for working on the plantation is not paid for rather they bare enormous cost for pruning and weeding. Secondly, the tenant farmers are unable to use any form of pesticide or weedicide due to the damage they may cause to the young cashew plants. The tenants are thus left with very little ways of controlling weeds and pest on the farm. The arrangement though mimics labour tenancy arrangements in a number of ways, does not fit the contractual embodiment of obligations and expectations of both parties as observed by William (1996). The landlord does not assume or take any obligation for the maintenance of the tenant. The landlord takes the use of the land as payment for the work undertaken on the plantation by the tenant.

Some farmers noted that similar practices are mated out by landlords to tenants who pay for the use of the land. In the words of one participant

> I was in the farm one day when the landlord just came with some boys. They had cashew seedlings. He simply told me that he will be planting the cashew in the farm. I was not happy about the situation so I protested. He simply told me that if I don't understand or won't allow him to go ahead and plant I should vacate the land. He even told me that he will get someone else to come and occupy the land. The situation is really bad. (Male FGD participant Donkro-Nkwanta, Nkoranza South, 2019)

The growing profitability of cashew production is gradually leading to a revision of norms governing the transfer of land and titles to non-natives in a number of communities within the Nkoranza South area. The increasing demand for land for the establishment of plantation by investors is leading to the commercialization of land through joint ventures with indigenes or outrights sales of lands by family heads and chiefs. Anaafo (2015) who observed a similar trend in the study of land reforms and land right change in the Nkoranza South noted that though internal cultural changes

and reforms may be accounting for current practices, the "global resources consumption and transnational land deals" are contributing enormously to the growing trends.

5.6 Conclusion

This chapter has explored the inheritance systems of the two study districts and how they influence access to land and land use arrangements. The chapter further discussed the gendered implications of both matrilineal and patrilineal inheritance patterns. The changing patterns of inheritance and land tenure arrangement were also brought to the fore.

The gendered implications of inheritance rights and access to land for females have far reaching ramifications for household expenditure and consumption. While it was noted that women in Nkoranza South could obtain and use land independent of their spouses or male relatives, the case of women within Bawku West is quite precarious if not dire. The rights of women from Bawku West to lands, which are intricately connected, or woven to males (fathers, husbands, and sons) increases their sensitivity to any socio-economic or climatic shocks. This high level of resources dependence limits their contribution to the household and deepens their subordinate place in the organization and decision making of the household.

To strengthen their control and management of lands, women in the Nkoranza South municipal establish cashew plantations through spousal support and extend their frontiers of land through joint ventures with spouses. They also rent excess uncultivated lands to settler farmers. These arrangements help women to protect their rights to family lands thereby ensuring access not only for themselves in the future but also to their off-springs.

Family lands constituted an important source of land for farming in both Bawku West and Nkoranza South. Nearly half of the total sample use family land for cultivation with a significant proportion of them accounted for by Bawku West. The use of family land in Bawku West was largely due to the nature of land ownership arrangement and the low levels of commercialization and commodification of lands in the area. Additionally, the continued use of family or household lands further strengthen the super-ordinate place of men and maintains their control over women in relation to resource access and use. Due to the disadvantages and vulnerabilities the arrangements place women in, it is important to carefully consider cultural and social reforms on inheritance and land rights that considers the different layers of needs in the community. These reforms can be undertaken without compromising the cultural heritage and customs as well as social stability of the people.

The Nkoranza South municipal however presented a myriad of land use and ownership arrangements. The municipality had in operation rental, shared cropping, and outright ownerships through long leases and even labour tenancy arrangement. The more relaxed and evolved land tenures and use arrangements have provided bases for migrant farmers usually from the northern parts of Ghana to move and settle in the municipality to work as settler famers, labourers or labour tenants to secure a stable livelihood. The rapid evolution of the land use arrangements has been in response to a combination of local land use reforms and a global drive of commodification and large-scale land acquisition deals.

The changes relating to land use and the need for robust means of adapting to the influences of climate variability and impacts on important seasonal crops such as maize has resulted in intensifications and diversifications on farms. The establishment of cashew plantation in the municipality has witnessed massive growth. The increasing

lands devoted to cashew production have implications for land use and food crop production as food crop farms are continuously being converted to cashew farms. The concerns for food crop production and changes in food cultures are implications that require further exploration. Additionally, the gendered effects of cashew production relating to resource access, use and control especially for households who commit collective household resources in such ventures require thorough interrogation.

CHAPTER SIX

INFLUENCE OF CULTURAL FACTORS ON CLIMATE ADAPTIVE OPTIONS AND HOUSEHOLD VULNERABILITY

6.1 Introduction

The chapter explores the differences in adaptive options of households to climate variability impacts. The exploration highlights the gendered differences in adaptive options and investigates how the differences in adaptive options influence vulnerabilities and resilience to climate variability impacts. The chapter essentially uses data from the household survey conducted in the eight communities selected from the Bawku West district and Nkoranza South municipal. The first section discusses the differences in exposures to climate events such as floods and other extreme weather conditions in the form of long dry spells and drought as well as intensification of pest on farms looking at adaptive options and their outcomes. A multi-dimensional livelihood vulnerability index based on the work of Glitz *et al* (2017) is used to estimate as well as understand the nature of vulnerabilities different categories of people faces especially women within the two ecological zones. The impacts of the three dimensions of vulnerability to climate varibility - Adaptive Capacity, Sensitivity and Exposure – on households were assessed. A multiple logistic regression was used to examine the determinants of multi-dimensional vulnerability of households to climate variability impacts.

6.2 Experience and nature of climate variability impacts:

The variability in climatic conditions has contributed to extreme weather conditions. These conditions have affected farmers in a number of ways. The household survey indicated that besides the effects of climate variability felt on farms, households are

faced with challenges arising from extreme weather conditions such as droughts, floods and storms with destructive effects on properties.

Regarding the impacts of climate variability on farms, households indicated that delays in rainfall and intense heat have had the strongest effects. They reported that loss of seeds, low yields, wilting or stunting of plants and pest infestations constitutes important challenges to their productive activities. The effects of these impacts are shown in Table 6.1. The table present the responses based on community. For instance, wilting of plants and pest infestations, arising from long dry spells or droughts were consistently reported by most households (an average of 71%) in all communities within the two districts. Mutekwa (2009) who had similar findings in an assessment of climate change impacts on smallholder farmers in Zimbabwe concluded that, the effects of droughts and floods, which are occurring more frequently in recent times, have potentially catastrophic outcomes for rural farmers who have very low adaptive capacities. The case of most households in the Bawku West district are even more challenging as most of the households in the four communities use very little improved or efficient farming methods. Women in this case are at greater risk of exposure and repeat exposures due to their reliance on male relative to adjust their livelihoods to the impacts. Consequently, their lack of capacity to independently and swiftly adjust to climatic shocks increases their likelihood of becoming vulnerability.

Specific to the effects of pest, the fall armyworm has had devastating effects across Ghana in recent times. The impacts as noted in chapter one of this thesis has led to significant losses in terms of yields and resources invested in controlling the pest. Georgen *et al*, (2016) and Cook et al, (2017) have documented the spread and infestations of the pest in West and Central Africa and the consequent effects the pest has on smallholder livelihoods. The period of infestation coincided with the period of

the year when temperatures increased and maize cultivation begun. This confirms Nagoshi (2018) findings on the timing and migratory pattern of the pests.

As a consequence, the effect of climate variability on farms led to other general effects on household living conditions. Effects on household income and income sources due to low yields and output threaten the general livelihoods conditions of households such as availability of meals and care for the needs of children. This is very evident in the data especially in the Bawku West district compared to the Nkoranza South municipal as shown in Table 6.1.

The differences in the two districts may be accounted for by the ability of farmers in Nkoranza South to cultivate a second crop after an unsuccessful crop in the major season due either to poor weather or pest infestation. Similar window of planting to reduce the hardships of the effects of climate variability is however not open to households in the Bawku West district who have a single season. Therefore, crop failures due to extreme weather conditions have the potential of plunging households and entire communities into deep vulnerabilities and poverty. Though the production of a second crop is viewed as an advantage for households in the Nkoranza South municipal over households in the Bawkus West district, declines in annual mean rainfall and the increasing inter-annual and decadal variability can potentially threaten the second crop and erode this advantage (Owusu and Waylen, 2013).

Table 6. 1 Nature of climate variability effects on household

Nature of effect	Komaka	Bawku West (%)		Gbango	Nkoranza South (%)			Dotobaa
		Dagunga	Kukuo		Donkro Nkwanta	Jerusalem	Ayerede	
Loss of seed (Delayed rain)	88.8	74.8	100	95.7	75.8	46.7	3	24.2
Low Yield	50	20.4	32.7	34.1	74.7	40	96	10.1
Wilting of planted crops	78.6	52.5	56.5	40.5	88.9	86.6	85.8	79.8
Pest infestation	83.7	67	64.3	36.2	75.8	86.6	98	100
Lodging of plants (Floods)	81.6	67	74.2	61.7	13.2	6.7	78.8	7.1
Reduction in income	51	37.9	52.7	10.6	77.8	6.7	61.6	8.1
Inability to purchase inputs	87.7	66	100	89.4	77.8	26.7	89	60.6
De-roofing of home due to storm	83.7	84.5	99.1	97.9	2	0	0	0
Provision of daily males	88.8	58.2	68.4	46.8	9.1	6.7	81.8	46.4
Difficulty in paying school fees	85.7	58.3	73.3	48.9	6	33.3	89.9	40.4
Borrowing	81.7	60.2	64.4	42.5	46.5	0	92.8	24.2

Source: Field Data 2018/19 (N=798)

The gendered analysis showed that apart from few variations relating to some of the effects, the impact on both males and female headed households in the two districts were very similar. The interesting observation is that for most of the effects the number of male headed households had higher percentages. The observed differences relating to climate variability effects on farms may be accounted for by the relatively larger farm sizes of males headed household thus any shock in climatic condition will be felt highly.

Table 6. 2 Climate change effects – gender and resident status

Climate change Effect	Sex/Gender				Res. Status in Community			
	Bawku West		Nkoranza South		Bawku West		Nkoranza South	
	Female	Male	Female	Male	Indigene	Settler	Indigene	Settler
Low Yield	98	78	86.2	92	96	-	98.3	97.4
Wilting of planted crops	100	85	43.7	67.3	92.5	-	84.7	85.4
Pest infestation	97	84	98	93	91.9	-	88.3	91.8
Lodging of plants (Floods)	74.6	69.2	-	2	75.2	2.3	2.9	8.2
Reduction in income	92.3	78.4	23.4	13.8	88.4	-	8.5	15.3
Inability to purchase inputs	62.7	54.1	34.5	43.5	87.8	-	16.2	7.9
De-roofing of home due to storm	57.3	54.2	2.7	-	65.1	-	2	0
Provision of daily meals	79	86.7	10.6	8	73.6	-	5.3	12.9
Difficulty in paying school fees	94.2	88.1	23.5	10.9	76.5	-	17.8	26.5
Borrowing	67.9	54.8	32.5	28.7	71.6	-	7.8	67.3
Loss of seed (Delayed rain)	86.7	91.2	73.4	74.6	90.4	-	79.4	68.3

Source: Field Data 2018/19 (N=798)

As shown in Table 6.2, the experiences of climate variability and change effects by migrants and indigenes are similar in terms of percentage of households being affected. This notwithstanding, the levels of exposures and experiences tend to be lower among migrant households compared to indigenous households. Cases in point are the incidence of de-roofing of buildings by storms and lodging of plants on farms due to floods. The reason for the low incidence of these effects among migrant household is that, migrants' households are largely found in the Nkoranza South district where storms and flooding are not felt greatly.

6.3 Gendered difference in adaptive options

Climate change affects different people in different ways. The levels of effects felt are founded on the degrees of exposure and sensitivity as well as the ability to deal with the consequences of the impacts felt. An important consideration in the differentiated climate impacts is its gendered outcomes. Organizations such as the UNFCCC, IPCC and the FAO have noted that climate change impacts are not gender neutral. The differences in impacts are as a result of contextual factors that define limits to resource access and use (Sultana, 2012). Consequently, adaptive options to address the challenges arising from the impacts will be differentiated.

The data showed that households used different adaptive options. In order to put the different adaptive options in the right perspective, the adaptive options were categorized into farm specific adaptive options and general adaptive options.

6.3.1 Farm specific adaptive strategies

Households' farm specific adaptations observed include changing timing of planting, use of drought resistance seed varieties, use of organic fertilizer, use of chemical fertilizers, use of pesticides, seeking advice from the agricultural directorate of the district and relocation of farms. Households' farm specific adaptive options by genders and locations are shown in Table 6.3.

It was observed that at the broader level, that is, without disaggregating the data by gender or location, households mostly used three of the seven farm specific adaptive options. These include change in timing of planting (91%), use of drought resistant seed varieties (75.81%) and seeking advice from agricultural extension officers from the district directorate of agriculture (80.53%). The use of all three main farm specific adaptive options showed very little differences between males and females. Use of drought resistant and early maturing seed varieties as well as the careful timing of

rainfall pattern to obtain maximum outputs have been found by Franks *et al*. (2007) as an efficient and important means for farmers to adjust to the changing climatic patters. Taking these steps together with the assistants of extension officers enhance the possibility of achieving positive results.

Besides the three (3) main farm specific adaptive options, farmers also use fertilizers to boost the levels of yields. The use of fertilizers has become very important and necessary especially in the Bawku West district due to the growing depletion of soil fertility. Participants of the focus group discussions in all the four communities of Bawku West noted the poor state of soil fertility. They stated that soils have become so poor to the extent that without the application of fertilizer yield will drastically reduce.

The two forms of fertilizers or soil enrichment additives used in the study areas are the organic manure, which are usually animal droppings such as cow dung. The chemical fertilizers usually used are NKPs and Ammonia Phosphates. Because most households in the Bawku West keep animals, the droppings are dumped on the fields to replenish soil nutrient in the off-seasons. The results from the household survey show that while overall only 27.94% of household use organic manure as an adaptive strategy, 47.22% of households in Bawku West use this strategy.

The use of chemical fertilizers is however widespread. Of the 50% of household that indicated they use chemical fertilizers, 67.41% of households in the Nkoranza South municipal and 35% of households in Bawku West use chemical fertilizers. Due to the cost of chemical fertilizers, most households are unable to afford them. Largely, households tend to depend on subsidized fertilizers distributed under government programmes such as the planting for food and jobs programme, which is usually unsustainable. Though these programmes are meant to improve farmer outputs through

the promotion of improved seeds and fertilizer considered vital for food security purposes, Crawford, Jayne and Kelly (2005) have argued that such programme are usually inimical to private sector investments and exercise of agency by farmers.

They stress that the use of price controls and rationing promote hoarding, unwanted price hikes and unsustainable dependence on the state for individual and household needs. These assertions are corroborated by Jayne and Rashid (2013) who stated that fertilizers subsidies usually provided for farmers by African government tend to be ineffective at best, only accounting for total fertilizer usage with very little effect on yields. The positions and sentiments of the scholars cited above was echoed by farmers who noted that the process of distribution of the subsidized items is fire with corruptions and rent seeking. In such case inputs are diverted from the target populations.

Table 6.3 which presents the distribution of adaptive options sorted by community and sex indicates that apart few differences observed between male and female households in relation to the use of some of the farm specific adaptive options, there is generally very little gendered difference on the use of adaptive options at the community level.

Table 6. 3 Farm Specific Adaptation sorted by community and gender

Strategy/ Community (Sex)	Change timing of planting	Drought resistant seed	Organic manure	Fertilizer	Pesticide	Advise from MoFA	Relocate Farm
Komaka: Male	100	91.7	95.8	83.3	87.5	93.8	87.5
Female	84	82	80	72	80	76	72
Dagunga: Male	78.2	92.7	21.8	12.7	20	76.4	29.1
Female	77.1	87.5	37.5	33.3	47.9	91.7	56.3
Kukuo: Male	98	98	61.2	8.2	-	91.9	2
Female	100	100	63.5	13.5	2	96.2	5.8
Gbango: Male	100	77	7.7	30.8	15.4	92.3	19.2
Female	95.2	90.5	9.5	38.1	14.3	90.5	23.8
D-Nkwanta: Male	62.3	-	-	-	40	1.9	11.3
Female	71.7	6.5	0-	-	32.6	8.7	6.5
Jerusalem: Male	100	889	-	100	100	88.9	11.1
Female	100	83.3	16.7	83.3	100	83.3	16.7
Ayerede: Male	100	100	17.3	82.7	98.1	100	11.5
Female	100	100	3	78.7	100	93.6	10.6
Dotobaa: Male	94	50	-	94	100	100	2
Female	100	63.1	8.2	939	100	100	-

Source: Household Survey 2018/19 (N=798)

6.3.2 General Adaptive strategies

The use of general adaptive responses across the two districts show differences in the options used by male and female headed households across all the types of adaptive measures used. The survey revealed that across the board, households in the two districts of the study used ten (10) different general adaptive measures with some

households combining the use of all ten (10) approaches to address the effect of climate variability on their households.

The adaptive strategies were essentially non-farm, off-farm work, self-denial, sale of asserts and reliance on other sources such as savings or loans to maintain the household. The off-farm strategy was particularly on the sale of labour to other farmers. In this case, members of the household worked as farm labourers for other farmers to raise money for household up keep and reinvestments in farming activities. The non-farm adaptive strategies were the dominant general adaptive strategies used, these include, artisanal work such as carpentry or masonry, engagement in children in economic activities such as sales of items or hawking. Some households rely on support networks and assistance from relatives, associations and friends for loans or other forms of handouts such as food and money.

Apart from Gbango, which used nine (9) of the approaches, the other three communities used all ten (10) approaches in the Bawku West district. The case of Nkoranza South was different. Only Donkro-Nkwanta had households combining the use of all ten adaptive strategies. The rest of the communities in the municipality had households using a maximum of 9 adaptive options identifies with significant variations between male headed and female headed households. Jerusalem No. 1, Ayere and Dotobaa recorded 8, 9 and 4 adaptive strategies respectively.

As can be observed in Table 6.4, the differences at the community level concerning the percentages of male headed and female headed households and the use of specific general adaptive strategies across the two districts are worthy of note. The use of adaptive options as has been illustrated in the previous chapter are founded on social and cultural allowable limits of access and use of resources. Additionally, forms of

social contacts and networks enable the use of adaptive options. Some of these social sources of reliefs include reliance on familial networks, borrowing and attracting help or assistance from associations and other groups. A gendered analysis of the different adaptive option shows that with the exception of some few cases the differences in the proportions of male-headed households using specific adaptive options in each community as against the proportions of female-headed household use of adaptive options does not seem to follow a particular pattern. The only adaptive option that is worthy of note is the Non-Farm Work. It can be observed that apart from Komaka in the Bawku West district and Jerusalem No. 1 in the Nkoranza South municipal where the proportion of male-headed households engaged in other forms of economic activity as an adaptive measure was higher, female-headed households in the community tended to be the ones that used different strategies to address the effects of climate variability impacts.

The domination of women in through their engagement in non-farm activities such as trading has been found by scholars such as Apusigah (2009) as a strategy used by women to free themselves or break out of the control of men especially in patrilineal inheritance systems through the control of resources and their labour. Besides the need to break free of culturally limiting practices that make use of socially and culturally available resources, the socialization process tend to place women at an advantageous position to easily venture into "buying and selling" of different kinds items including food. Though culturally gendered occupations are undergoing changes, there still exist strong reservations for engaging in gendered defined occupations especially in the rural context. This may lead to the labelling of men especially who deviate from or ventures into "female work" such as selling of food.

Table 6. 4 General Adaptive Strategies

Strategy/ Community (Sex)	Borrow	Farm Laborer	Non-Farm work	Reduced daily meals	Sell assets	Reliance on family	Asso. help	Use savings	Take a loan	Children work
Komaka: Male	87.5	93.8	89.6	87.5	95.8	87.5	91.7	87.5	81.3	85.4
Female	88	80	86	70	74	76	80	88	68	66
Dagunga: Male	49.1	61.8	81.8	61.8	873	49.1	72.7	72.7	23.6	85.5
Female	66.7	66.7	87.5	54.2	79.2	48	66.7	75	35.4	75.1
Kukuo: Male	12.2	22.5	57.1	69.4	6.1	59.2	4.1	55.1	-	4.1
Female	7.7	5.8	59.6	82.7	11.5	76.9	7.8	38.5	1.9	-
Gbango: Male	3.9	15.4	11.5	50	-	23.1	3.9	-	7.7	-
Female	14.3	23.8	19.1	62	9.5	19.1	4.8	4.8	4.8	
D-Nkwanta: Male	18.9	98.1	49.1	3.8	11.3	5.7	54.7	96.3	88.7	9.4
Female	41.3	87	50	6.5	4.4	4.4	43.5	100	93.5	15.2
Jerusalem: Male	-	77.8	33.3	-	-	-	-	100	-	-
Female	16.7	16.7	-	16.7	-	16.7	16.7	83.3	-	-
Ayerede: Male	63.5	5.8	3.9	-	-	1.9	3.9	96.2	-	-
Female	14.9	25.5	53.2	49	36.2	25.5	19.2	48.9	31.9	-
Dotobaa: Male	6=	12	2	-	-	-	-	62.	-	-
Female	-	-	32.7	-	-	-	-	69.4	-	-

Source: Household Survey 2018/19 (N=798)

Some of these adaptive strategies were confirmed during the community focus group discussions. The number of quotes is provided in these regards.

> When things get hard expecially when the rain stopped for a long time and all the maize were drying I went to Kintampo to work (head porter in the station). It is difficult work but it was important so that I can pay the fees of the children. If you say you are not going to do it you will be in trouble. Sometimes I go Sefwi to carry cocoa too (Male farmer, Ayerede, Nkoranza South, 2018)

A participant from Bawku West also intimated:

> As for me I sell porridge in the school so that is what helps, but last year because the early millet didn't do well, … I went to Zebilla to help my sister to sell so that I can make some money (Female farmers, Gbango, Bawku West, 2018).

6.4 Determinant of adaptive options

A household choice of adaptive option is founded on a combination of household, social, cultural, and economic conditions (Grothmann and Patt, 2005). These factors which are context specific shape the outcomes of the approaches used address the effects of climate variability impacts. Based on this fact, O'Brien *et al* (2004) have stressed that the use of adaptive options is based on the extent to which an individual or groups of individuals have to access resources based on their status. Consequently, use of weak adaptive approaches and options produced vulnerabilities which are reproduced and reinforced through repeated exposure to extreme climatic events. Carr (2008) found that, the continued use of specific forms of adaptive strategies and their outcomes are founded on social dynamics and arrangements, which reinforce unequal social relations.

In estimating the determinants of adaptive options (farm level) a probit regression model was used to predict how household specific characteristics determine the use of particular adaptive options. Following from Below *et al.,* (2012) household characteristics focused on include age, sex, educational level, and marital status, number of years the household head has stayed in the community and migratory status of the household head as well as the size of the household. In order to account for differences in community relating to social and cultural practices which influence inheritance and access, use and control of land variable "district" was added to the predictors.

Three different models were ran in this respect. There is a combined model which explores the effects of all the predictors listed above and other two models which are gender specific, one for male and one for female and district specific models for Bawku West and Nkoranza South. An effort was made to introduce a forth model which was

to isolate “status in community” (indigenes/migrants), however that could not be done due to the low number of migrants in the Bawku West district. The adaptive options are each presented as a binary variable. Each variable can have only two possible outcomes denoted as 1 and 0. The value 1 represents the use of a particular adaptive strategy and 0 represents the non-use or absence of an adaptive strategy.

The model used is mathematically expressed as

$$\Pr(Y = 1 \mid X) = \Phi(X_t\beta),$$

Where

Pr is the probability of the present of an adaptive response (Y being 0 or 1)

Y is the outcome variable or the adaptive strategy

X is the vector of the explanatory variable (demographic characteristics of HH head)

Φ is the cumulative distribution function (CDF) of the standard normal distribution

β is the vector of parameter estimations.

The general model is discussed first followed by the two gender specific models which are discussed together to facilitate understanding.

The results of the models on the determinants of farm level adaptive options (marginal effects) are presented in Tables 6.5, Table 6.6, Table 6.7, Table 6.8 and Table 6.9. Observation from all the models indicate that the use of adaptive options is influenced by the different characteristics of the household head in varied ways. From the combined model (Table 6.5) almost all the predictors of adaptive option show significant results across the adaptive strategies apart from the marital status.

Table 6. 5 Combined Model - Determinants of farm level adaptive strategies

VARIABLES	Drought resistant seed	Use of organic manure	Use of fertilizer	Use of pesticide	Seek MoFA advice	Relocate Farm
Age	-0.014**	0.004	0.019***	0.006	0.010*	-0.018***
	(0.006)	(0.006)	(0.007)	(0.006)	(0.0060	(0.005)
Age SQ	0.015**	-0.007	-0.019***	-0.006	-0.004	0.010*
	(0.006)	(0.006)	(0.007)	(0.006)	(0.006)	(0.005)
Female	0.026	0.112***	0.039	0.054*	0.023	0.054*
	(0.031)	(0.03)	(0.036)	(0.032)	(0.029)	(0.029)
Non-Formal education	0.026	0.064	-0.133	0.187**	-0.04	0.284***
	(0.078)	(0.0790	(0.10	(0.086)	(0.086)	(0.11)
Primary school	0.128***	0.091**	0.02	0.03	0.021	0.054
	(0.037)	(0.036)	(0.047)	(0.042)	(0.037)	(0.034)
Middle Sch./JHS	0.098**	0.016	0.098*	0.036	0.072*	0.048
	(0.043)	(0.045)	(0.053)	(0.048)	(0.038)	(0.044)
SHS/Tech/Voc>	-0.057	-0.05	0.038	0.141**	0.012	-0.043
	(0.074)	(0.055)	(0.074)	(0.064)	(0.068)	(0.052)
Currently Married	0.047	0.004	0.047	0.008	0.113	0.033
	(0.082)	(0.069)	(0.089)	(0.07)	(0.083)	(0.063)
Previously Married	0.011	-0.06	-0.065	-0.031	0.063	0.027
	(0.093)	(0.079)	(0.102)	(0.083)	(0.098)	(0.071)
HH size	0.032**	-0.038**	-0.024	-0.035**	-0.005	0.027*
	(0.013)	(0.017)	(0.017)	(0.015)	(0.013)	(0.015)
HH size SQ	-0.183***	0.284***	0.101	0.163**	-0.011	-0.072
	(0.06)	(0.089)	(0.083)	(0.074)	(0.059)	(0.079)
Settler	0.096**	0.168***	0.208***	0.226***	0.124***	0.223***
	(0.039)	(0.054)	(0.057)	(0.05)	(0.0350	(0.061)
Length of stay in community (Yrs)	0	0.004***	0.003*	0.003**	-0.001	0.009***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Nkoranza South	-0.365***	-0.416***	0.209***	0.408***	-0.253***	-0.270***
	(0.038)	(0.042)	(0.052)	(0.049)	(0.037)	(0.045)
Observations	798	798	798	798	798	798

Standard errors in parentheses |* p<0.01, ** p<0.05, * p<0.1|**

The age of the household head was shown to influence the use of drought resistant seed variety, use of chemical fertilizer, use of pesticide and relocation of farm. Age as a predictor is considered important due to its effect on access, use, control and

mobilization of physical, financial and social resources. The effect of age of household heads on the use of the adaptive options was positive for use of fertilizers and reaching out to MoFA for advice whiles it effect on use of drought resistance seed variety and relocation of farms was negative. This suggests that the probability for households to use fertilizers and seek the support of MoFA officers on their farms increases with age, while the probability to use drought resistant seeds and relocation of farms reduces with age. Age squared which suggest a non-lineal relationship or effect of the age of the household head on the use of specific adaptive option shows that household decisions and needs are adapted as the household head ages. In this way access to and use of adaptive resources either improves or wanes with the advance in age of the household head in both Nkoranza South and Bawku West. Age of the household head is therefore associated with the level of access to adaptive resources, household's eventual use of the available adaptive resources and the timing of the use of the available resources.

The statistically significant and negative marginal effects of age on the use of drought resistant seed variety suggests that for every increase in the age of the household head the probability of using a drought resistant variety of seed reduces. This is the same in relation to the probability of relocation farms. The age squared, which is positive, indicates that after a threshold age, the probability of using drought resistant seed variety begin to increase. The observation on the use of drought resistant seed variety is similar to Tambo and Abdoulaye (2011) work on the use of improved technologies among maize farmers in Nigeria. They found that age influenced the use of improved farm inputs. The initial resistance to change in they suggested is accounted for by farmers' experience with failed technologies and the need to maintain the old order of things, however over time, the growing effects of climatic conditions on old technologies and proven efficacy of the new technologies compel a change in approach

and eventual use of improved technologies.

The use of fertilizers shows positively significant result while relocation of farms produced a significant but negative response. Age squared show a significant but opposite result for the fertilizer use and relocation of farms. In relation to the use of fertilizer, the result suggests that, for every additional year in age for the household head, the probability to use fertilizers on the household farm increases. The observation is very tenable akin to observations made during the focus group discussions especially in the Bawku West district. The increasing need for fertilizer use was heighted due to the low soil fertility and its effects on yield. A farmer intimated the situation as follows;

> Now if you don't use fertilizer you will not get anything. Somethings you even use the fertilizer and the yield is low. Just imaging that you don't use it at all…. The challenge is with the price…. (Male farmer, Komaka, Bawku West, 2018)

The challenges with price as noted in the quote is expressed in the non-lineal effects the age square show. The negative age squared in relation to fertilizer use suggests that after a threshold age the probability of using fertilizer and begins to reduce. The reduction the probability of fertilizer use in relation to age is accounted for by two factors. These factors are largely associated with the experiences of farmers and households in Bawku West. They are succinctly captured in a works of a female farmer in Dagunga.

> Sometime the agric people help us with the fert (*fertilizer*) but when the ones they have get finished we can't but because of the price. It is expensive. We don't make much from the farming. For the young people they can do some other work in the big market at Zibilla or Bolga to make money but the old people, as for us we can't do that. If you don't get any support to buy the fertilizer you just use the animal droppings like that.

From the quote, the two factors cited were the cost of fertilizer and the effects of age on the ability to use monies from other sources of income to purchase them. At old age

access to some resources such as land (expressed in relation to the need to relocate farms) grows while the ability to engage in multiple income generating activities reduces.

The disaggregated analysis for both gender and district also showed that results for males show significance for the use of pesticide and relation of farms in relation to the age of male headed households. It indicated that age increase the probability of a male headed holds use of pesticide by 3.8% while decreasing the probability of relocation of farms by 17%. Results for female headed households indicated that age was significant in determining the use of five out of the six farm specific adaptive options. These were use of drought resistant seed variety (positive influence), use of organic manure (negative influence), use of fertilizer (positive influence), use of pesticide (positive influence) and relocation of farms (negative influence).

In relation to districts, age has positive predictive influence on the probability of using fertilizer (3.2%), pesticide (1.9) and seeking the advice of MoFA (1.1%). However, there is a decreasing probability of age on the use of drought resistant seed variety (2.3%) and relocation of farms (2.7%). The analysis of Nkoranza South on the other hand indicated that age has significantly positive influence on the probability of using organic manure (2.4%). The probability of using pesticides (3%) and seeking advice of MoFA to address the effects of climate change (2.4) were however negative. Table 6.6 and Table 6.7 provide more details on the gender specific models on the determinants of farm level adaptive strategies.

Table 6. 6 Male Model – Determinants of farm level adaptive strategies

VARIABLES	Drought resistant seed	Use of organic manure	Use of fertilizer	Use of pesticide	Seek MoFA advice	Relocate Farm
Age	-0.006	0	0.015	0.014	0.038***	-0.017**
	(0.01)	(0.007)	(0.009)	(0.009)	(0.008)	(0.008)
Age SQ	0.012	-0.004	-0.009	-0.009	-0.032***	0.012
	(0.01)	(0.007)	(0.009)	(0.009)	(0.008)	(0.008)
Non-Formal education	-0.009	-0.097	-0.143	0.183*	-0.117	0.325***
	(0.087)	(0.098)	(0.105)	(0.106)	(0.106)	(0.123)
Primary school	0.090*	0.039	0.007	0.066	0.026	0.035
	(0.05)	(0.045)	(0.06)	(0.054)	(0.047)	(0.043)
Middle Sch./JHS	0.145***	0.04	0.084	0.052	0.130***	0.176**
	(0.053)	(0.069)	(0.082)	(0.073)	(0.049)	(0.072)
SHS/Tech/Voc>	-0.131	-0.119*	0.088	0.118	0.107	-0.015
	(0.083)	(0.061)	(0.091)	(0.082)	(0.073)	(0.064)
Currently Married	-0.208***	0.167**	0.133	0.112	-0.086	0.009
	(0.05)	(0.065)	(0.108)	(0.091)	(0.066)	(0.101)
Previously Married	-0.283***	0.171**	-0.061	0.033	-0.172*	0.108
	(0.093)	(0.087)	(0.135)	(0.12)	(0.099)	(0.124)
HH size	0.031	-0.059***	-0.059***	-0.080***	-0.018	0.028
	(0.019)	(0.021)	(0.02)	(0.017)	(0.015)	(0.018)
HH sizesq	-0.205***	0.360***	0.203**	0.318***	0.047	-0.084
	(0.078)	(0.11)	(0.088)	(0.08)	(0.06)	(0.084)
Settler	0.168***	0.215***	0.314***	0.304***	0.232***	0.225**
	(0.055)	(0.078)	(0.087)	(0.074)	(0.042)	(0.089)
Length of stay in community	-0.002	0.006***	-0.001	0	-0.002	0.007***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Nkoranza	-0.427***	-0.451***	0.139*	0.303***	-0.360***	-0.264***
	(0.049)	(0.061)	(0.075)	(0.073)	(0.046)	(0.064)
Observations	422	422	422	422	422	422

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 6. 7 Female Model – Determinants of farm level adaptive strategies

VARIABLES	Drought resistant seed	Use of organic manure	Use of fertilizer	Use of pesticide	Seek MoFA advice	Relocate Farm
Age	-0.026***	-0.026***	0.015*	0.023**	-0.002	-0.023**
	(0.008)	(0.008)	(0.008)	(0.009)	(0.008)	(0.01)
Age SQ	0.020**	0.020**	-0.018**	-0.031***	-0.002	0.031***
	(0.008)	(0.008)	(0.008)	(0.009)	(0.008)	(0.012)
Non-Formal education	-0.046	-0.046	0.474***	-0.255	0.137	-0.081
	(0.156)	(0.156)	(0.1440	(0.208)	(0.156)	(0.166)
Primary school	0.102*	0.102*	0.158***	0.003	-0.02	-0.015
	(0.055)	(0.055)	(0.0570	(0.072)	(0.065)	(0.056)
Middle Sch./JHS	-0.002	-0.002	0.025	0.08	-0.014	0.01
	(0.065)	(0.065)	(0.06)	(0.075)	(0.07)	(0.058)
SHS/Tech/Voc>	-0.082	-0.082	0.137	-0.066	0.228**	-0.217*
	(0.13)	(0.13)	(0.103)	(0.138)	(0.092)	(0.131)
Currently Married	0.246**	0.246**	-0.190*	-0.059	-0.142	0.224**
	(0.115)	(0.115)	(0.108)	(0.141)	(0.091)	(0.112)
Previously Married	0.264**	0.264**	-0.278**	-0.097	-0.143	0.156
	(0.121)	(0.121)	(0.118)	(0.149)	(0.098)	(0.124)
HH size	-0.009	-0.009	0.009	0.005	0.03	-0.029
	(0.026)	(0.026)	(0.029)	(0.034)	(0.031)	(0.028)
HH sizesq	0.099	0.099	0.095	0.032	-0.114	0.09
	(0.153)	(0.153)	(0.162)	(0.195)	(0.177)	(0.156)
Settler	0.078	0.078	0.171**	0.078	0.170**	0.043
	(0.055)	(0.055)	(0.072)	(0.081)	(0.068)	(0.052)
Length of stay in community	0.002	0.002	0.002	0.007***	0.007***	0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Nkoranza	-0.314***	-0.314***	-0.355***	0.261***	0.483***	-0.214***
	(0.057)	(0.057)	(0.059)	(0.07)	(0.063)	(0.055)
Observations	376	376	376	376	376	376

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Gender was a positive predictor of the use of organic manure, pesticide and relocation of farm. The marginal effect shows a significant and a positive result for all three predictors. The results indicate that the probability of females headed households are 11.2%, 3.9% and 5.4% more compared to male headed households to use organic,

pesticides and relocate farms respectively. These results point to a clear indication of the influence of the architecture of entitlement on the access to resources of all kinds and its influence on the adaptive options households use.

The significant results for the two specific farm level options –use of manure and relocation of farms- shows the degree of access to other forms of resources to enable an alternative technology use. This is more especially in the case of Bawku West district where female access to resources is especially constrained due to the architecture of entitlement. As shown in the quotation above, the lack of financial resources force women to resort to the use of animal droppings to rejuvenate their lands. Though the use of animal dropping is environmentally friendly and sustainable, the sentiments express shows a clear preference for the quick fix remedies of chemical fertilizers. Additionally, the need for female-headed households to relocate their farms shows their degree of vulnerability and disadvantage considering the lands they have access to. The high sensitivity of lands used by this groups place them under constant threat of exposure to extreme climate events that requires relocation due largely to floods. A female farmer who lives in Komaka but farms close to the White Volta around Azum Sapeliga in the Bawku West district stated that

> "…. My farm gets flooded all the time, every year I have the same problem, but what can I do?... I have to manage like that".

The case of women in Nkoranza South are much different because women's access to land is not constrained by cultural limits and barriers.

The district analysis of the influence of gender on adaptive options showed that though women in Nkoranza did not indicate explicitly their use of organic manure during the focus group discussions, female headed households showed a probability of 14.6% of using organic compared to men as an adaptive strategy.

The different levels of education for the household heads produced varied results. The mixed results shown in relation to educational levels of heads of households implies though education has an influence on the choice of adaptive options a household use in addressing the impacts of climate variability effects on their livelihoods. The choices made are not wholly founded on education, but are premised on contextual intricacies of access to and control of important and viable lands. The assembly of Gbango who is also a teacher noted that,

> "over here though who have the land are the chiefs and some big men, they have not gone to school before but they are very powerful, education is very good, it can help you do other things but because in this community they don't sell land you have to go and beg for land from those who have" (Assemblyman, Gbango, Bawku West)

Of all the levels of education, middle school or JHS levels of education showed significant results for three of the six farm specific adaptive strategies compared to the other levels. The three adaptive strategies were use of drought resistant seed, use of fertilizer and consulting MoFA for advice. All these results were positive. The results on primary level of education showed positively significant values for the use of drought resistant seeds and organic manure. Household heads with secondary/tech/vocational education show a significantly positive result in the use of pesticide. The result also showed that compared to households' heads with no education the probability of them using pesticide is 14.1% more. Similar observations were made with respect to the gender and district specific models. The Nkoranza South model in this context makes a strong case for education as an important driver for positive adaptation. Table 6.8 high lights this point.

Table 6. 8 Nkoranza South Model – Determinants of farm level adaptive strategies

VARIABLES	Drought resistant seed	Use of organic manure	Use of fertilizer	Use of pesticide	Seek MoFA advice	Relocate Farm
Age	-0.002	0.024***	-0.003	-0.030**	-0.024*	-0.002
	(0.011)	(0.009)	(0.01)	(0.013)	(0.014)	(0.008)
Age SQ	0.006	-0.027**	0.006	0.040***	0.044***	-0.001
	(0.011)	(0.011)	(0.011)	(0.015)	(0.016)	(0.009)
Female	0.007	0.146***	-0.051	-0.027	-0.03	0.029
	(0.054)	(0.035)	(0.051)	(0.043)	(0.049)	(0.029)
Non-Formal education	0.11	-	0.048	-	-0.222**	0.574***
	(0.141)	-	(0.144)	-	(0.104)	(0.15)
Primary school	0.277***	0.110***	0.197***	0.165***	0.151**	0.041
	(0.066)	(0.033)	(0.068)	(0.056)	(0.061)	(0.028)
Middle Sch./JHS	0.232***	0.062*	0.203***	0.120**	0.211***	0.018
	(0.069)	(0.032)	(0.071)	(0.059)	(0.061)	(0.03)
SHS/Tech/Voc>	0.101	-	0.383***	-	-	-
	(0.128)	-	(0.088)	-	-	-
Currently Married	-0.056	0.025	0.101	-	0.1	
	(0.141)	(0.083)	(0.143)	-	(0.137)	-
Previously Married	0.012	-0.093	0.073	-	0.125	-
	(0.156)	(0.082)	(0.156)	-	(0.14)	-
hhsize	0.133***	-0.005	0.052*	0.064**	0.132***	-0.012
	(0.039)	(0.019)	(0.031)	(0.031)	(0.046)	(0.016)
hhsizesq	-1.078***	-0.052	-0.582***	-0.581***	-1.329***	0.160*
	(0.271)	(0.134)	(0.203)	(0.219)	(0.348)	(0.084)
Settler	0.035	0.052	0.015	-0.008	0.135**	0.015
	(0.067)	(0.052)	(0.064)	(0.046)	(0.055)	(0.042)
lengthofstayincomm	-0.007***	0.002	-0.005**	-0.005***	-0.004**	0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)
Observations	402	368	402	361	380	373

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The results from the levels of education of household heads though mixed from the general model suggest that the probability of using specific farm adaptive strategy increases with education. This observation is confirming a-prior expectation of the study, that education is a positive predictor of the use of adaptive option in spite of the influence of inheritance and land tenure and land use arrangements due to the proper

use of information and the enhanced ability to mobilize adaptive resources of all kinds.

Marital status for the purpose of the analysis was merged into three main categories, never married to include the single and cohabiting group, currently married for those presently in a recognized marital union or relationship and previously married for those separated and widowed. This applied to districts, communities, gender and resident status in community. The merging of the different marital status was because initial analysis dropped some of the categories due to the low number of observations needed to undertake the analysis.

The result of the combined model did not show significant results for any of the groups. This suggests that in reference to the general model marital status has not influence on adaptive option of the household. The gender specific models as will be show in Tables 6.6 and 6.7, indicate significant results for some variables. A similar observation was made regarding the district specific model (Tables 6.8 and Table 6.9).

The size of the household showed significant results for four (4) of the adaptive strategies. These include use of drought resistant seed variety, use of organic manure, use of pesticides, and relocation of farms. The result was negative for use of organic manure and pesticide while it was positive for the use of drought resistant seed and relocation of farms. The household size squared for both use of organic manure and pesticide use were positive indicating that after a threshold household size, the probability of using organic manure and pesticides increases. The reverse is shown for use of drought resistant seed.

The results of the combined model on households' size influence on use of adaptive strategies are quite interest, however conversations with the district agricultural MIS

officer hinted at why some of this rather counter intuitive approach may be taken by farmers. He stated;

> "The farms' approach is not always bad, we discovered that some of the local seed varieties were better at withstanding the stressed of the terrain. Some farmers rather prefer to buy fertilizers and pesticides than to buy the improved seed. Some of the hybrid seeds get attacked by diseases easily. What we have doing for sometimes now is to show them the best practices in seed selection on their own farms rather than to force them to purchase the hybrid seed". (MoFA MIS Officer, Bawku West, 2018)

Table 6. 9 Bawku West Model – Determinants of farm level adaptive strategies

VARIABLES	Drought resistant seed	Use of organic manure	Use of fertilizer	Use of pesticide	Seek MoFA advice	Relocate Farm
Age	-0.023***	0.001	0.032***	0.019**	0.011**	-0.027***
	(0.008)	(0.009)	(0.009)	(0.009)	(0.005)	(0.008)
Age SQ	0.022***	-0.004	-0.036***	-0.025***	-0.010*	0.011
	(0.008)	(0.009)	(0.009)	(0.008)	(0.005)	(0.008)
Female	0.041	0.06	0.087*	0.097**	0.009	0.107**
	(0.031)	(0.052)	(0.05)	(0.049)	(0.031)	(0.048)
Non-Formal education	0.015	0.262*	-0.244**	0.035		-0.095
	(0.046)	(0.159)	(0.12)	(0.182)		(0.139)
Primary school	0.027	0.044	-0.087	-0.039	-0.009	0.048
	(0.039)	(0.069)	(0.063)	(0.06)	(0.041)	(0.061)
Middle Sch./JHS	-0.062	-0.05	0.12	0.036	-0.046	0.097
	(0.064)	(0.092)	(0.092)	(0.091)	(0.062)	(0.091)
SHS/Tech/Voc>	-0.053	-0.035	-0.154	0.04	-0.203**	-0.073
	(0.064)	(0.113)	(0.108)	(0.115)	(0.103)	(0.099)
Currently Married	0.012	0.034	-0.098	0.012	0.017	-0.011
	(0.055)	(0.114)	(0.125)	(0.108)	(0.065)	(0.107)
Previously Married	-0.083	0.065	-0.133	0.075	-0.035	0.106
	(0.082)	(0.137)	(0.141)	(0.13)	(0.091)	(0.127)
hhsize	0.036***	-0.064*	-0.011	-0.074***	0.01	0.027
	(0.011)	(0.036)	(0.023)	(0.024)	(0.014)	(0.021)
hhsizesq	-0.156***	0.515***	0.081	0.397***	-0.029	-0.058
	(0.047)	(0.198)	(0.107)	(0.12)	(0.071)	(0.098)
lengthofstayincomm	0.002**	0.003	0.007***	0.009***	0	0.016***
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
Observations	396	396	396	396	387	396

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The gender specific model showed that has a negative influence on male households' probability to use organic manure, fertilizer and pesticide. Female headed households showed not significance relating to the household size and use of adaptive strategies. Bawku West in relation to the district specific models indicated a negative of household size on the probability of using organic manure and use of fertilizer while showing a positive probability for the use of drought resistant seed variety (3.6%). An interesting observation from the analysis on Nkoranza South shows that the square of the household size has significantly negative influence on the use of five of the six adaptive strategy. These influences are quite large and strong (see Table 6.8 on Nkoranza South model).

Migratory status shows significant and positive results for the use of all six farm-level adaptive strategies to the climate variability impact. The result suggests that compared to indigenes the probability of migrants/settler farmer household to use the farm level adaptive strategies are greater. The male specific model showed the same result. The use of all forms of adaptive option have been noted by Adger *et al*., (2013) who stress that the propensity for farmers to move to areas that are already at risk predispose them to extreme climate events. Their desire to reduce the effects of their already sensitive livelihoods force them to adapt or perish.

6.5 Multi-dimensional Livelihood Vulnerability Index: Dimensions, indicators, vulnerability cut-offs and weights

The dimensions, indicators, vulnerability cut-offs and weights used in the estimation of the multi-dimensional vulnerability to climate variability impacts index for in the Bawku West and Nkoranza South have been presented in chapter three of this thesis. The choice of indicators and deprivations cut-offs have been selected to reflect various aspects of climate change induced livelihood vulnerability based on the IPCC

conceptualization. Weighting of the dimensions were based on their importance and role in determining vulnerability and ability to deal with the effects of extreme, moderate and low climate conditions. Varying degrees of importance are thus assigned to the different dimensions of the climate induced vulnerability. The dimensions are adaptive capacity, sensitivity and exposure.

The indicators for the adaptive capacity dimension are dependency ratio of the household, educational of the household head, agricultural land, electricity, cooking fuel, non-agricultural diversity, agricultural diversity, access to loans and credit, family support and political voice. Six main indicators capture sensitivity; they include illness, sanitation, drinking water, food self-sufficiency, water sufficiency, and dwelling. The third sensitivity dimensions are measured using two main indicators; the environmental shock and socio-economic shock.

6.5.1 Measuring multi-dimensional livelihood vulnerability to climate variability impact in Bawku West and Nkoranza South districts

Table 6.6 provides the data on community-based vulnerability scores per indicators in relation to climate variability impacts. It shows that communities in the Nkoranza South municipal have higher dependency ratios compared to the communities in the Bawku West district. Donkro-Nkwanta shows the highest dependency ratio per household with 34.34% of households in the municipality having dependency ratios higher than the vulnerability threshold. Ayerede and Jerusalem closely followed with 29.3% and 26.7% of households above the vulnerability threshold respectively.

Regarding education larger proportions of households in Bawku West were vulnerable. The percentages of households vulnerable in terms of education were above 60% across all communities. Gbango had the highest proportion (74.5%) of its households vulnerable. Donkro-Nkwanta again was the community with the highest percentage

(35.4%) of its households vulnerable in educations. Concerning access to farm lands. The proportion of vulnerable households seems to cut across the two districts though Bawku West had more vulnerable households in this respect. From the table, it can be observed that Jerusalem No.1 of Nkoranza South had the lowest proportion (20%) of household facing challenges with securing farmlands for agricultural purposes.

Access to electricity shows that apart from Gbango where all households were vulnerable no other community in the Bawku West district has a single household vulnerable in that regards. The case of Nkoranza South municipal was quite different. Two communities, Donkro-Nkwanta and Jerusalem No.1 had 6.1% and 21.9% of households deprived on the indicator respectively. The indicator on cooking fuel showed vulnerabilities across the two districts. The case of Bawku West is however more precarious compared to Nkoranza South though there are also high proportions of households vulnerable. Non-agricultural diversity and agricultural diversity show somewhat similar patterns across the two districts. It can be observed that higher percentage of households in Bawku West are vulnerable in the two indicators. Ayerere in the Nkoranza South municipal also show very high proportions of its households vulnerable in the two indicators.

In a similar manner, Bawkus West had more households being vulnerable in relation to access to credit or savings. Kukuo and Gbango have more than 80% of their households vulnerable in this respect. Again Donkro-Nkwanta remains the only community in the Nkoranza South municipal with more than 50% of the total households surveyed being vulnerable in relation to access to credit or saving. Again, the results on family support indicate that the Nkoranza South municipal had three communities with more than 50% of their total household surveyed lacked family support. The Bawkus west district has only Dagunga with more than 50% of its households vulnerable on family support. The

indicators on political voice shows that largely most households in Bawku West were vulnerable on political voice, that is, having very little say in the affairs of the community. Komaka and Dagunga had more than 50% of households deprived on this indicator.

Illness and sanitation, which tend to go hand in hand, show vulnerabilities across the two districts. In fact, apart from Dotobaa where the proportions of households vulnerable on the illness indicator was below 50% all the other communities had more that 50% of households vulnerable on the illness and sanitation indicators. Drinking water show lower vulnerability across communities in the two districts. The communities in the Nkoranza South municipal showed no vulnerability on drinking water. Komaka which has 22.5% of its household deprived recorded the highest vulnerability headcount on this indicator followed by Gbango with 17% of its households vulnerable. The indicator on food sufficiency showed that Ayerede and Dotobaa of the Nkoranza South municipal have 81.8 and 46.5 percent of their households vulnerable on food sufficiency respectively. Also, three communities in the Bawku West district have more that 50% of households vulnerable on the food sufficiency indicator. In relation to water sufficiency one community each from Bawku West and Nkoranza South has more than 50% of household vulnerable on it. These were Komaka and Jerusalem No.1. Dwelling which is the final indicator under sensitivity showed that all the communities in Bawku West have more than 50% of their households vulnerable. This is largely because of the use of clay and thatch for the construction of homes. There is however a changing trend as was observed in most of the communities. Most of new structures been constructed now used aluminium roofing sheets.

The indicators for exposure, environmental shock and socio-economic shock show vulnerability across the two districts albeit Bawku West has more of its households being vulnerable. The indicators, unreliable rain, short rain and intense sunshine show more or less the same levels of vulnerabilities across the board for all communities. The differences in the proportions of households prone to vulnerability under floods and changing planting time are more in the Bawku West district with Ayerede showing high (97%) proportions of its households vulnerable to changing planting times. The levels of households vulnerable to socio-economic shocks are very low in the Nkoranza South municipal except for Donkro-Nkwanta where 45.3% of households were vulnerable to socio-economic shocks. Two communities, Komaka and Kukuo, in the Bawku West district had more than 50% of households vulnerable to socio-economic shocks.

Table 6. 10 Multi-dimensional Livelihood Vulnerability Index (MLVI) –raw vulnerability headcount by district (Communities) in %

	Bawku West				Nkoranza South			
	Komaka	Dagunga	Kukuo	Gbango	Donkro Nkwanta	Jerusalem	Ayerede	Dotobaa
Dependency ratio	12.3	17.5	13.9	6.4	34.3	26.7	29.3	14.1
Education	63.3	68.9	70.3	74.5	35.4	33.3	6.1	20.2
Agricultural land	94.9	92.2	91.1	74.5	93.9	20	66.7	54.6
Electricity	-	-	0-	100	6.1	21.9	-	-
Cooking fuel	100	100	100	100	58.6	85.7	98	86.9
Non-Agric. diversity	81.6	81.6	95.1	83	54.6	66.7	96	38.4
Agric. Livelihood diversity	98	97.1	86.1	83	100	53.3	95	79
Access to credit	39.8	38.6	83	80.9	68.7	20	15.2	18.2
Family support	25.5	53.4	4	27.7	1	66.7	92.9	50.5
Political voice	51	70.9	39.6	23.4	-	6.7	12.1	-
Illness	64.3	50.5	60.4	72.4	61.6	63.8	58.6	42.4
Sanitation	85.7	90.3	94.1	91.5	77.8	83.8	81.8	87
Drinking water	22.5	3.9	6.9	17	-	-	-	-
Food self-sufficiency	88.9	58.3	68.3	46.8	9.1	6.7	81.8	46.5
Water sufficiency	51	48.5	21.8	40.4	18.2	50.5	7.1	4
Dwelling	83.7	100	79.2	95.7	11.1	10.5	19.2	4
Environmental shock								
Unreliable rain	89.8	59.2	100	92.6	98	93.3	100	100
Short Rain	84.7	66	90.1	75.5	92.9	93.3	100	91
Flood	81.6	55.3	60.4	71.3	8.1	-	12.1	1
Changing planting time	77.6	59.2	66.3	78.7	38.4	20	97	41.4
Intense sunshine	81.6	62.1	84.2	93.6	98	80	79	85.9
Socio-economic shock	57.1	42.7	72.3	36.2	45.3	-	2	-

Source: Author's computations (N=798 HH)

The indicators used in measuring the multi-dimensional livelihood vulnerability of the smallholder households in Nkoranza South and Bawku West each contribute to the nature of vulnerability households. Table 6.11 shows the contribution of each indicator to the multi-dimensional livelihood vulnerability index (MLVI) and the proportion of the entire sample that are vulnerable on each indicator. In terms of contribution of the dimensions and indicators to the multi-dimensional livelihood vulnerability to climate variability impacts, the results show that adaptive capacity has the largest share contributing 59.9% to vulnerabilities to climate variability impacts. The contribution of the sensitivity and exposure dimensions to vulnerability to climate variability impacts were 20.2% and 20% respectively.

Table 6. 11 Vulnerabilities and Contribution of each indicator to MLVI of smallholder farmer households

Indicator	Vulnerable (%)	Contribution (%)
Adaptive		***0.599***
Dependency ratio	19.469	0.015
Education	49.018	0.038
Agricultural land	72.946	0.115
Electricity	15.550	0.009
Cooking fuel	91.403	0.046
Non-agric. livelihood diversity	74.716	0.121
Agric. livelihood Diversity	86.094	0.133
Access to credit/savings	45.259	0.037
Family support	40.582	0.063
Political voice	25.411	0.021
Sensitivity		***0.202***
Illness	59.039	0.040
Sanitation	86.473	0.044
Drinking water	6.195	0.005
Food self-sufficiency	50.695	0.041
Water sufficiency	30.088	0.024
Dwelling	50.316	0.048
Exposure		***0.200***
Environ. Shock – Unreliable rain	91.403	0.034
Short rains	86.852	0.032
Flood	35.777	0.015
Change in season	59.418	0.024
Intense sunshine	82.807	0.031
Socio-economic shock	31.479	0.065

Source: Author's computations

Table 6.11 indicates that, under the adaptive capacity dimension, more than 50% of all households were vulnerable on agricultural land (73%), cooking fuels (91.4%), non-agricultural (74.7%) and agricultural diversities (86%). These indicators show vulnerabilities for very high proportions of households across board. Under the same dimension, education, and access to credit or saving and family support were the indicators with the next highest proportion of households being vulnerable.

An observation of the indicators within the sensitivity dimension shows that illness and sanitation had the highest number of households vulnerable in them. The proportion of households showing vulnerability in the two indicators were 86.5% for sanitation and 59% for illness. The proportions of households vulnerable on both food self-sufficiency and dwelling were almost the same at 50.7% and 50.4% respectively.

On the exposure dimension the proportions of household vulnerable to environmental shocks are quite significant. Households who were vulnerable to unreliable rains was 91.4%, those vulnerable to short rains 86.9%, flood 35.8%, change in planting time 59.4% and intense heat 82.8%. A total of 31.5% of household were vulnerable to socio-economic shock as indicated by Table 6.11.

The higher sensitivity to environmental shocks especially was a key highlight the focus group discussions. Participants stressed the extent to which their livelihoods are affected by the variability in rain and long dry spells.

> The weather has really changed … it is really affecting us. Previously we could tell when the season is about to change. You see the birds and all, but now those birds are not even around anymore. Sometimes it rains at the same time the sun would be shining. You just don't know anymore. This is really affecting our work. We are here in Dodobaa, it can rain at the roadside when a single drop would not fall here at all. Things have really change. (Male FGD participant Dotobaa, 2018)

A woman in a focus group discussion at Gbango had this to say,

Sometimes we cry for the rain, especially when the dry season takes a long time. We are all happy when it rains but the rains always destroy things. Just last year I lost all my maize and guinea corn because the rain was just too much. Not just the rain but the wind was so much …. Everything was on the floor. (Female FGD participant, Gbango, 2018)

6.5.2 Decomposition of multi-dimensional livelihood vulnerability to climate variability

Analysis of the decomposition of the multi-dimensional index generated is undertaken in this section. The multi-dimensional livelihood index is interacted with the socio-demographic characteristics of the household head including sex, marital status, and migratory status in community as well as community specific inheritance patter, district and communities. Generally, the result show very high incidence of multi-dimensional livelihood vulnerability across the different categories of the variables assessed.

By the sex of the household head, the index shows very high incident of multi-dimensional vulnerability between both male-headed and female-headed households with very little difference in the incidence of vulnerability between them. Whereas the headcount shows slightly more male-headed households as multi-dimensional vulnerable with 90.6% as compared to 90.1% of female-headed households, the severity or intensity shows the opposite. Table 6.8 shows that female-headed households are vulnerable in 55.9% of the weighted vulnerability indicators whiles males are vulnerable in 55.2% of the vulnerability indicators. Both types of households have multi-dimensional vulnerability index greater or equal to 0.5 (>/=0.50). The result thus indicates that in terms of multi-dimensional livelihood vulnerability to climate variability there is no significant difference between the experiences of males headed households and female headed households in the two districts under investigations.

Table 6. 12 Sub-group decompositions of multi-dimensional livelihood vulnerability to climate variability

	H	A	MLVI
Sex of household head			
Male	0.906	0.552	0.500
Female	0.901	0.559	0.504
Marital Status			
Never married	0.969	0.552	0.534
Currently married	0.908	0.559	0.507
Previously married	0.872	0.542	0.403
Migration Status			
Indigene	0.928	0.581	0.539
Settler	0.830	0.466	0.387
Inheritance Pattern			
Matrilineal	0.812	0.466	0.379
Patrilineal	0.997	0.630	0.628
District			
Bawku West	0.997	0.629	0.628
Nkoransa South	0.812	0.465	0.378
Communities			
Komaka	0.990	0.650	0.643
Dagunga	1	0.620	0.620
Kokuo	1	0.628	0.628
Gbango	1	0.620	0.620
Donkro Nkwanta	0.926	0.473	0.438
Jerusalem No. 1	0.733	0.430	0.315
Ayerede	0.990	0.519	0.514
Dotobaa	0.606	0.411	0.249
H=Head count /incidence	**A= Severity/Intensity (% of indicators)**		

Source: Author's computations

Marital status also shows very high vulnerabilities across the categories in spite of the marginal differences in relation to incidence and intensity of multi-dimensional climate induced vulnerability. The incidence of multi-dimensional vulnerability was 96.9% among households whose heads have never married, 90.8% for households whose heads are currently married and 83% for households whose heads had previously married. The intensity of the vulnerability ranged from vulnerability in 55.9% (currently married) of the weighted vulnerability indicators to 54.2% (previously married) of the weighted indicators. The multi-dimensional vulnerability index is

estimated at 0.534 for the never married, 0.507 for currently married and 0.403 for the previously married group.

The result on migratory status shows that, the incidence of multi-dimensional vulnerability is higher among indigenes (92.8%) as compared to settlers or migrants (83%). The indigenes are furthermore multi-dimensionally vulnerable in 58.1% of the weighted indicators as the settlers are vulnerable in 46.6% of the weighted indicators.

The inheritance patterns which also showed high incidence of multi-dimensional vulnerability to climate induced impacts had 81.5% of household within areas where matrilineal inheritance is practiced as multi-dimensionally vulnerable as compared to a much higher (99.7%) incidence for patrilineal areas. The relatively higher rate of incidence of multi-dimensional vulnerability in patrilineal areas may be accounted for by norms on access and control of adaptive resources. The intensities of the vulnerability show 46.6% for matrilineal areas and 63% for patrilineal areas. The MLVI for matrilineal areas was estimated at 0.379 while that for patrilineal areas is estimated at 0.628.

The decomposition of the multi-dimensional vulnerability index by district shows that the two districts have very high incidence of vulnerability. Furthermore, Bawku West is shown to have a relatively higher (99.7%) incidence of multi-dimensional climate induced vulnerability compared to Nkoranza South (81.2%). The results indicate that Bawku West is at least ten percentage points higher in the rate of incidence. The incidence of multi-dimensional vulnerability in Bawku West is due to vulnerabilities in 62.9% of the weighted vulnerability indicators while the intensity of the vulnerable households in Nkoramza South is 46.5%. The higher incidence and intensity of Bawku West compared to Nkoraza South is further observed in the communities within the

district. The results show that three (3) – Dagunga, Kukuo and Gbago - out of the four (4) communities in the Bawku West district had 100% incidence of multi-dimensional vulnerability to climate variability impacts with associated higher levels of intensities. The very high incidence rates and intensities require well fashioned, targeted and focused community-based interventions to improved conditions especially in relation to the vulnerability indicators to reduce the intensity and severity of vulnerability which will eventually lead to a reduction in the incidence of multi-dimensional vulnerability in households.

6.6 Determinants of Multi-dimensional Livelihood Vulnerability

Multi-dimensional vulnerability to climate change is influence by contextual, socio-economic and demographic factors of individual and groups. The outcomes of the effects of vulnerability are therefore shaped by strength of individuals and groups characteristics. Fussel and Klien (2006) have therefore argued that changes in non-climatic factors such as societal conditions and shifts in social and economic findings are sometimes solely responsible for the exposure and vulnerabilities of people to climate change impacts. Corroborating these assertions, Cardona *et al.* (2012) stressed that exposure and vulnerability to extreme climate events and hazards are founded on context specific factors strengthen or weakens people's ability to cope or adapt.

A logistic repression model was used to model the effect the socio-demographic and household characteristics have on the multi-dimensional vulnerability status of the household. Multi-dimensional vulnerability was thus the dependent variable denoted as (y).

The vulnerability (y_i) is specified as a dichotomous variable and modelled as a linear function that depends on household demographic and economic characteristics and the

personal characteristics of the head of the household. Household demographic and economic characteristics include migration status and household size. The group of personal characteristics of the head of the household includes age in years, level of formal educational attainment, current marital status and sex of the head of household.

The vulnerability of a household is defined as

$$y_i = x_i'\beta_i + \varepsilon_i$$

Where x_i is a vector of the explanatory variables; $\beta_i$is a vector of estimated parameters including a constant term and ε_i is a random error term that follows the standard normal distribution.

In this case, the work examines household vulnerability status in relation to climate variability impacts. The dependent variable is defined as

$y_i = 1$ if Household multi-dimensionally vulnerable

$y_i = 0$ if Household is not multi-dimensionally vulnerable

The probability that a household multi-dimensionally vulnerable to climate variability impact, given the set of explanatory variables, is obtained as

$$Pr(y_i > 0) = \Phi(x_i'\beta_i)$$

where Φ is the cumulative density function of the standard normal distribution.

To assess the partial effects of the explanatory variables on the household's vulnerability, the marginal effects are estimated as $\frac{\partial E(y_i=1|x)}{\partial x_i} = \Phi(x_i'\beta_i)\beta_i$.

The results obtained from the regressions analysis are provided in table 6.9 below.

Table 6. 13 Marginal effects of the determinants of Multi-dimensional Livelihood Vulnerability

VARIABLES		Marginal Effects
Age	Age	-0.0106**
		(0.0044)
Sex	Female	0.0079
		(0.0238)
Education	Non-Formal education	-0.1772**
		(0.0688)
	Primary school	-0.1490***
		(0.0304)
	Middle Sch./JHS	-0.1704***
		(0.0298)
	SHS/Tech/Voc>	-0.1483***
		(0.0517)
Marital Status	Currently Married	-0.1834**
		(0.0821)
	Previously Married	-0.2420***
		(0.0846)
Household size	HH size	0.0372***
		(0.0128)
	HH sizeSQ	-0.1061*
		(0.0572)
Migration Status	Settler	-0.1185***
		(0.0308)
Length of stay in community (Yrs)	Length of stay in community	0.0035***
		(0.0011)
Observations		791

Standard errors in parentheses |*** p<0.01, ** p<0.05, * p<0. 1|

Results obtained indicate that apart from sex, which was not significant, the other variables showed significance at different levels. The non-significance of sex indicates that in spite of the contextual barriers to women's access to land and other community-based resources for adaptation, the effects of exposure to climate induced impacts has general implication for all types of households. Community level impacts are thus felt by all. This point was echoed in both Nkoranza South and Bawku West at the focus group discussions. Two quotes will be offered to demonstrate the collective effects of climate variability impacts.

> The last flood was very bad, it affected a lot of people those of us who are farming close to the river because the land around were all occupied were not the only ones affected. The entire community suffered. The way the things happened, everybody was affected. This house we are sitting in got flooded. You see that guinea corn over there (*pointing to a planted field*) my father had maize there, they were all on the ground. (Male FGD participant, Komaka, Bawku West, 2018)

This quote from Bawku West shows the collective effects of flooding. Another from Nkoranza South shows the devastation of the fall armyworm.

> When the whole thing started, people were complaining, but most those farms were far in the bush so I didn't think we will be affected (those nearer to town). In some few days things became serious. Even maize by the road side were attacked by the worms. (Male FGD participant, Ayerede, Nkoranza South, 2018)

Age was found to be significant at 5%, however the effect on vulnerability was negative. The result suggests that as age of the household head increases likelihood of the households becoming multi-dimensionally vulnerable decrease. This decreasing effect of age on climate-induced vulnerability is contrary to findings, which highlight how old age tends to increase exposure, and sensitivity to climate change due to reduces financial resources and failing health. Bambrick, Capon and Barnett (2011) for instance found that the health implications for the aged tend to be dire as their levels of sensitivity increases. Contextually, however, age tends to work in the favour of people as it guarantees social support and quick assistance in times of need especially in rural areas. The provisions provided for by children and extended family relations ensure that increase exposure and sensitivities are forestalled.

All the categories of education showed significant results with negative effects on multi-dimensional vulnerability of households. The results imply that as household heads educational attainments improve, the likelihood of being vulnerable reduces. The result shows that household heads with non-formal education are 17.7% less likely to

become multi-dimensionally vulnerable compared to household heads without any form of education. In a similar manner household head with a minimum of primary education are 14.9% less likely to be multi-dimensionally vulnerable to climate variability. Those household heads with middle school or JHS education are also 17.1% less likely to be multi-dimensionally vulnerable as compared to those household heads without education. The SHS/Tech/Vocational group also show a 14.8% less likelihood of becoming multi-dimensionally vulnerable compared to those without education. The link between education and multi-dimensional vulnerability cannot be over emphasized. Education has been found to very key to empowering people and communities to plan and mitigate the effects of climate change. Formal education has thus been found to have a positive effect on reducing vulnerability to climate change impacts through the strengthening of adaptive capacities even in climate sensitive terrains (Muttarak and Lutz, 2014; Lutz, Muttarak and Striessnig, 2014). This finding thus stresses the need for education to be enhances at all levels to enhance the capacity to plan and use adaptive resources effectively and efficiently.

Marriage has been found work as a limiting and enhancing factor. It can confer rights and privileges and at the same time can unfavorably affect people especially women where their labour is appropriated (Apusigah, 2009). Marital status was shown to be significant and with negative influence on the multi-dimensional poverty status of the household. The results indicate that household with heads who are currently married where 18.3% less likely to be multi-dimensionally vulnerable compared to households with unmarried heads. Also, households with heads who were previously married were 24.2% less likely to be multi-dimensionally vulnerable compared to households with unmarried heads. The influence of marriage on multi-dimensional vulnerability is quite interesting as it shows that married households can better mobilize resources to

facilitate positive adaptation to climate variability impacts. Usually the influence of marriage tends to influence women's access to adaptive resources and the use of adaptive options tend to be mediated by gender and marital status in some contexts (Apusigah, 2099; Van Aelst and Holvoet, 2016). Furthermore, because most women tend to engage in non-farm activities as adaptive strategies households with marriage couples will better be able to escape vulnerability as their livelihoods may be less reliant on climate sensitive economic activities.

Household size showed a significantly positive effect on the vulnerability of households. The result indicates that as the household size increases the probability of becoming multi-dimensionally vulnerable increases by 3.7%. The positive sensitivity to household size suggests that households with larger sizes are more likely to be vulnerable. The greater risk of multi-dimensional vulnerability may be prevented if a large household has the resources to cater for the needs of its members. The household size squared, which is negative (10.6%), indicates that after a threshold household size, the likelihood of becoming multi-dimensionally vulnerable begins to decrease. The result on effects of household vulnerability shows that initially household with large dependent population might struggle until a point when the dependent population begins to thin up and therefore begin to contribute towards the upkeep of the household. The contribution to the household could be in the form of labour, food or financial support. The positive effect of household size on climate vulnerability of the house has been found by a number of studies. For instance, Thorlakson and Nuefeldt (2012) discovered that household size negatively impacts on the adaptive capacity of households. The impact is especially felt in the diversity and quantity of food available to the family. The threat to food quality and sufficiency far outstrip the seemingly

advantageous values of larger household sizes (Bryan *et al.*, 2013; Dumenu and Obeng, 2016)

Migratory status also showed significant but negative effects on household's climate induced vulnerability. The result indicates that settler households are 11.85% less likely to be multi-dimensionally vulnerable to climate induce variability compared to indigenous households. The findings suggest that due to the challenges settler farmer households are likely to face in accessing land and other socially based resources for adaptation, they are more likely shift less climate sensitive sectors. Use of non-farm and off-farm activities like trading, day labourers or simply working as labour tenants enable settler farming households to escape vulnerabilities from climate variability.

Length of stay in community shows a significant and positive influence on household vulnerability. This suggests that for every additional year a household stays in the community it was 0.35% more likely to be multi-dimensionally vulnerable. The relationship between length of stay in community and vulnerability to climate-induced vulnerability has not been adequately explored in literature. The expectation was that length of stay in community would be negatively related to climate induced vulnerability as the household might have established strong networks and improved its access to lands which is an important resource for smallholder livelihood. The need to further explore this relationship is necessary to understand how length of stay in community influences vulnerability.

The lack non-significant of effect sex on multi-dimensional vulnerability may be accounted for by the intersecting of combined effects/influence of other factors on the sex or the gender of a person in determining exposures, sensitivity and the adaptive capacities of a person. The intersecting impact of factors such as education background

of household head, the education background of the spouse of the household head, the marital status of the household head, residential status (Indigene or Migrant) and length of stay in the community on the gender of the household head has the potential to result in varied outcomes.

An intersectional analysis therefore is provided in table 6.14. One the sex was interacted with education and marital status, sex showed a significant values. Female headed households were in this case showed to be less likely to be multi-dimensionally vulnerable to climate variability impacts. The interactions also showed negative vulnerability outcome for both male and female headed household were the household head is in a marital relationship and have attained primary or JHS level of education.

Table 6. 14 Determinants of Multi-dimensional Vulnerability to climate variability – interaction of sex, education and marital status.

VARIABLES		MARGINAL EFFECT
Age	Age	-0.0526*** (0.0187)
Sex	Female	-3.1338*** (1.1311)
Education	JHS	-1.5406** (0.6920)
	SHS or higher	-3.1430*** (1.1531)
Marital Status	Currently married	6.2516*** (2.0413)
	Previously married	6.5501*** (2.0243)
Migratory Status	Migrant	-0.7895 (0.4947)
Years in community	Years in community	-0.0240* (0.0139)
Inheritance system	Patrilineal	3.4790*** (1.0955)
Interactions	Male#Primary#Currently married	-4.6662***(1.6760)
	Male#JHS#Currently married	-2.9681** (1.2603)
	Female#Primary#Currently married	-2.4853* (1.4175)
Constant		2.8806 (1.9418)
Observations		444
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1		

The negative and significance effects of the interactions are relevant in light of the intersectional approach use as the analytical framework to piece the theories and argument made in this thesis together. The result therefore showed that the intersectional approach to analysing a complex phenomenon such as climate change and climate variability adaptation is helpful in examining the intersecting influences of

factors that enhances or limit the capacities of different social groups. More specifically, the approach helps to better address the adaptation needs of women (female headed households) to climate extremes and impacts as their lives and experiences are a product or summation of the intersecting social and cultural relationships.

6.7 Conclusions

In conclusion this chapter has explored the different adaptive options and strategies used by households. It further examined how adaptive options are varied and the factors that influence the use of specific adaptive options. In analyzing the determinants of farm level adaptive options, it was established that gender influence the use of organic manure as a means of enriching soil nutrients and relocation of farms due to increased exposures. The positively significant result suggests the low adaptive capacity of female headed household compared to male -headed households in terms of access, use and control of resources. Settlers' heightened susceptibility to climate vulnerability required that they apply all available means to adapt so as to shield their households and livelihood from the impact of climate variability.

Additionally, the multi-dimensional livelihood vulnerability index has established that there is a very high incidence of vulnerabilities among households in Bawku West and Nkoranza South due to climate variability impact. These high levels of vulnerabilities are associated with increased severities regarding the vulnerability indicators. A need for an intervention to address the specific indicators such as education, which has been proven to positively enhance adaptive capacity, is urgently required to decrease exposures and heightened sensitivities to climate variability impacts.

CHAPTER SEVEN

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

This chapter concludes the thesis. The chapter consists of the summary of key findings of the study and conclusions drawn. Relevant recommendations for policy considerations, social and cultural transformations are also given. Additionally, the chapter provides suggestions on areas for further research.

7.2 Summary of Key Findings

The study examined how inheritance patterns and land tenure arrangements influence the adaptive options of smallholder household adaptation to climate variability impacts in the Bawku West district and Nkoranza South municipal. Additionally, it interrogated the effects of adaptive options used to address the impacts of climate variability on the vulnerability of households. The analysis took into consideration the gendered differences in experiences and how the different levels of access to adaptive options shape the vulnerability status of the household.

The work was designed using a mixed method approach, combining both qualitative and quantitative methods and techniques in sampling, data collection and analyses. The different approaches were complementary ensuring that the objectives of the research were attained. The study was conducted in eight (8) communities in the two districts. In all 798-smallholder households were surveyed using a semi-structured questionnaire in four (4) communities each from the two (2) districts. Additionally, 16 focus group discussions (FDGs) were conducted, eight (8) in each district. The focus group discussions were held separately for men and women in each community of study. A

total of 15 key informant interviews were held with district officials, officials from the district directorate of agriculture, community and family leaders. The thesis had three empirical chapters based on the number of specific objectives. The key findings of the study are discussed in the sections that follow.

7.2.1 Deepening Climate Variability Effects on Smallholder Livelihoods

The first empirical chapter examined the nature of climate variability in the two districts and its effects on the livelihoods of smallholder households. Using rainfall data from 1983-2018, the study found that there has been significant variability in rainfall based on the decadal analysis. Though these changes were not consistent, a clear observation was the reduction in the average monthly rainfall overtime. These changes were usually at the onset, peak and cessation of rainfall for both Bawku West and Nkoranza South districts. The reduction in rainfall was especially drastic in the case of Nkoranza South for the first planting seasons between March and May from 1990-2016. The changing rainfall patterns and variability have had severe consequence on production planning and yield. The analysis on yield showed that Bawku West showed that there is a negative relationship between the yield of maze in tons per hectare and rainfall. Periodic flooding in the district posed significant threat to maize production. Though the determinants of yield are beyond rainfall, the variability in the patterns of rainfall has affected farming activities and yield. Also, the period flooding has had its toll added to the long dry spells usually experienced in the district.

The ecological differences in the two districts are instrumental for soil fertility and types of crops which could be grown. Added to the ecological differences, the number of annual peak rainy periods influence production outputs and farmer planning. In this case, the two planting seasons of Nkoranza South though under threat as a result of changing climatological patterns, offer smallholder households in the district windows

of opportunities to better deal with losses in previous seasons for readjustments. These factors account for the large number of migrants and settler farmers in the district. This was not found in the Bawku West district.

These observations are in line with the conceptualization of the study. Climate induced impacts are not only influencing ecosystems but have dire consequences for agricultural production for the resource poor in communities. The effects are not only felt on farms as a result of decreased yields through droughts and pest attacks, but on the organization of households as floods and other extreme climate events like storms lead to loss of properties and in extremes cases lives through diseases and accidents.

7.2.2 Limitation of women's access, use and control of land through inheritance and land tenure arrangements

The study examined inheritance and land tenure arrangements practiced in Bawku West and Nkoranza South and how they influence gendered access to and use of land for agricultural production. It was found that the inheritance practices in the two districts, matrilineal and patrilineal, have clear gendered implications for land access and use. Women or female headed households in Bawku West where patrilineal inheritance is practiced are greatly disadvantaged in relation to their access and use of land compared to women or female headed households in Nkoranza South where land access and use is guaranteed for women due to the matrilineal inheritance. The inability of women in Bawku West to independently access lands curtails their ability to innovate during periods of climate extreme events such as floods. The architecture of entitlements therefore consigns women to a cycle of exposure to climate variability impacts and maladaptation.

Though the situation of women or female headed households in Nkoranza South was relatively better. These households were constantly in the process of bargaining with

the social and cultural systems through the use of innovative strategies to keep control and use of family lands allocated to them. Women in this way extend the use of their portions of lands to their spouses or sometimes rent out land to settler farmers. In recent times women have tended to establish cashew plantations to ensure a near permanent use and control of their share family lands. An important finding made was the rapid growth and shift to the cultivation of cashew plantations. The gravitation towards cashew farming was found to be in response to growing effects of climate variability on seasonal crop production such as maize and the increasing popularity of cashew as an important export and cash crop with a significant financial reward.

Diversions of on-farm activities especially in Nkoranza South have resulted in the gradual change in the nature of tenures and land use practices. Besides the known tenures such as annual or seasonal rents, shared cropping and freehold use, labour-tenant arrangements of varied forms are emerging. These different forms of labour tenancies are fraught with conflicts and disagreements. The changing land tenures and land use arrangements and the contestations they give rise to, are potential areas for further study and exploration.

7.2.3 High Vulnerability to Climate Variability Impacts Arising from Low Adaptive Capacities of Households

Having established the forms of inheritance patterns and land use arrangements as well as their influence on land access, the sixth chapter interrogated how the gendered differences in adaptive options influenced the vulnerability of households to climate variability impacts. It was found that differences in access to adaptive options influenced the forms and nature of vulnerability faced by households. The types of households, socio-demographic and economic characteristics of the household head constituted important determinants of the households' likelihood of becoming

vulnerable to climate variability impacts. The multi-dimensional livelihood vulnerability index analysis showed that the incidence and intensities of vulnerabilities are very high for all households in the two districts in spite of the differences in access and use of adaptive options for male and female headed households. It was found that adaptive capacities were generally weak, contributing significantly to the generally heightened exposure and sensitivity of most households in the two districts, especially Bawku West to climate variability impacts.

7.3 Conclusions

It has been established through the study that there exists significant variability in climatic conditions especially rainfall over the past thirty years. The variability has resulted in the decrease in the quantity of monthly average and annual rainfall. Besides the reduction in the levels of precipitation, the erratic climatic patterns affect planning of planting and plant growth generally. Production outputs of important staple crops such as maize have been affected due to the increased variability during peak planting and farming periods. Floods in Bawku West have been most devastating, limiting the potential for increased yields. The outputs of maize in metric tons per hectare indicated a decrease overtime especially in the Nkoransa South municipal which is one of the important maize producing areas of Ghana. Since the year 2011 the yield of maize has dropped from an average of 2.5Mt/Ha to below 2Mt/Ha. The decreasing trend has implications for household consumption due to the effect on incomes. At the national level, important food security concerns have been mooted as maize output is reported by the Institute of Statistical Social and Economic Research (ISSER) of the University of Ghana to have fallen behind by a significant 80% in yield as at 2017.

Additionally, the lack of climate information and early warning systems at the district and community levels result in significant losses to farmers due to erratic and

unpredictable rainfall patterns. For instance, households in Bawku West will be better served with information on long dry spells and prolonged destructive rains to plan farming and planting of fields. The continued loss of income through repeat purchase of inputs such as seeds, fertilizers and payments of labour demotivates farmers from continued production.

Furthermore, women's limited access to land in Bawku West due to cultural and social prohibitions on inheritance and land access has deepened the vulnerability of entire households. This is shown in the high incidence and intensities of multi-dimensional livelihood vulnerability to climate change in both male and female-headed households.

Though the case of Nkoranza South seems better, the threat to women's security of tenure is problematic. The changes in land use practices in responses to several factors among which include the need to safeguard the use and control of land by women may threaten migrant access to land for the cultivation of food crops. Increased commitment of lands in Nkloranza South to the production of cashew has far reaching ramifications for food security and food cultures.

Finally, the high incidence of vulnerability across the two districts highlight the need to strengthen cultural, social and communal systems to improve the personal and collective conditions of households. Improved conditions will enhance other forms of adaptive capacities which are less sensitive to climate variability and therefore engender successful adaptation to climate variability and change impacts.

7.4 Recommendations

Based on the conclusions drawn recommendations are suggested for policy and development.

1. **Education and installation of early warning climate technologies and systems to facilitate agricultural production**

   Due to the growing impacts of climate variability on the productive lives of smallholder households, it has become imperative to institute community based early warning weather systems to inform the planning of farming activities. In line with providing efficient warning systems to enhance the productivity of smallholder farmers, collaborations between community leaders, local assemblies, district directorates or agriculture and the meteorological agency can facilitate a process of education and enhancement farmer knowhow for effective use of climate related information.

   The warning systems will ensure that farmers are reasonably informed to predict weather events in order to effectively maximize the changing conditions. Households in Bawku West for instance can plan and utilize the limited precipitation for their farming activities as well as avoid or minimise the destructive effects of storms and floods on farms.

2. **Development of district and community-based rain harvesting systems to harness the positive potential of rain water.**

   An important innovation which could be considered for policy action is rainwater harvesting and development of community-based canals and rain collection systems especially in Bawku West. This will forestall the destructive effects of annual rains on lives and properties. This could be integrated into the government's policy on one-village-one-dam agenda through the support of district assemblies. The canals ones developed, could be linked directly into smaller dams in communities. Since the lands of the district have low siltation capacity, hence the annual floods, the use of such systems will not only improve

infrastructural progress but enhance the work of smallholder farmers by enabling them to farm all year round through irrigation systems.

3. **Promote community level education to eschew practices which stall collective progress and development**

   An important step towards contextual adaptation is to address the inhibitions and limitations inherent in the architecture of entitlements. In addressing this, community-based education and sensitization of community and traditional leaders must be undertaken to make people appreciate the ill effects of some practices on certain marginalized groups. The ministry of chieftaincy, national commission on civic education, the national disaster management organization and the district assemblies could lead in this process. These forms of education can highlight the collective disadvantages borne out of outmoded practices and the benefits transformations can bring to all. Community based results sharing of studies such as this will raise consciousness and weaken resolve to hold on to unhelpful practices.

4. **Enhancement of all forms of education to boost adaptive capacities of smallholder households**

   As has been noted earlier, education is essential to reducing the propensity of becoming vulnerable to climate variability impacts. The need to improve the education of rural population cannot be over emphasized. Education in this sense is not limited to classroom, formal education but the utilization of all forms of education to enhance the ability of people to seek and use information to effectively adapt to climate variability impacts. This must be pursued at all levels. Periodic community durbars and festivals could be used to dramatize

educative materials to enhance capacities and promote effective adaptation to climate variability impacts.

7.5 Consideration for further research

Based on the findings of the study, two main areas are suggested for further exploration and study.

1. The need to ascertain the degree to which rainfall as a variable together with other ecological factors contribute to productivity of farmers. This is essential due to the need to know where to place the attention of policy without neglecting other important factors that may influence production and production decisions.
2. Explore the implications of the influence of land use change and practices on food crop production, migrants' access to land for cultivation and food cultures especially in the Nkoranza South municipal due to the increase in the conversion of lands for food crops to the production of cashew.

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LIST OF APPENDICES

Appendix 1 - Household Survey Questionnaire

INSTITUTE OF STATISTICS SOCIAL AND ECONOMIC RESEARCH

UNIVERSITY OF GHANA

PHD RESEARCH

This questionnaire is meant to examine the influence of socio-cultural norms on inheritance and land tenure practices on climate change adaptation for smallholder farmers. It further assesses how the ability/inability to negotiate the norms shape sensitivity and responses to climate variability impacts. The exercise is aimed at obtaining data for a PhD research at the **Institute of Statistical Social and Economic Research (ISSER), University of Ghana, Legon**. The purpose is entirely academic, thus all information gathered would be confidentially treated. You are encouraged to be candid with your responses to the questions. For each question, select an option (s) that best captures or reflects your response. Where options are not provided, you may state your response in the space. You are permitted to withdraw from this research if at any point you feel uncomfortable or desire to discontinue participation. Thank you.

Date:_____ Time: _____ Interviewer: _____

Section 1: BACKGROUND INFORMATION OF RESPONDENT:

B1. District and Community Name:……

B2. Age: ……

B3. Sex: 1. Male [ ] 2. Female [ ]

B4. Educational background:
1. No education [ ] 2. Non formal education [ ] 3. Primary school level [ ]
4. Middle school/ JHS level [ ] 5. Secondary / Tech/Voc. School level [ ]
6. Tertiary institution [ ] 7. Other (Specify).....

B5. Marital status:

1. Single [ ] 2. Married [ ] 3. Separated [ ] 4. Divorced [ ] 5. Widowed [ ]

B5a. If married, do you live with your spouse? 1. Yes [ ] 0. No [ ]

B5b. Age of spouse:…….

B5c. Occupation of spouse:…….

B6. How many people live in your household? …….

B7a. Number of children under 15years:…….

B7b. How many of your children are in school? …….

B8. Do you have support for the up keeping of your children?

1. Yes [ ] 0. No [ ]

B8a. If yes, what is the source of support?

1. Spouse [ ] 2. Family/Relative [ ] 3. Friends [ ]
4. Group/Association [ ] 5. Other (specify) ……..

B9. What is your status in this community? 1. Native/Indigene [ ] 2. Settler/Migrant [ ]

B10. How long (in years) have you been living in this community?

B11. What is your primary occupation?

1. Farmer [ ] 2. Agricultural day labour [ ] 3. Transport operator [ ] 4. Sweeper [ ] 5. Trader [ ] 5. Teacher [ ] 6. Artisan [ ] 7. Other specify: ……

B12. What is the frequency of your income flow?

1. Daily [ ] 2. Weekly [ ] 3. Monthly [ ] 4. Quarterly [ ] 5. Yearly [ ]

B13. How much do you earn?

……..

B14. Apart from your primary/current occupation, do you gain income from other sources?

1. Yes [ ] 0. No [ ]

B14a. If yes, please list the sources: [How much do you earn from these sources per day/week?]

		Earning (GHS)				
No.	**Source**	Daily	Weekly	Monthly	Quarterly	Year
1.						
2.						
3.						
4.						

B15. Please tick from the list provided the crops you farm and the number of years your have farmed them:

No	Crop	Number of Acres	Number of Years farmed (Current land)
1.	Maize		
2.	Yam		
3.	Millet		
4.	Cassava		
5.	Cocoyam		
6.	Tomato		
7.	Onion		
8.	Other specify		

B15a**. Information on farms and crops farmed:**

Please provide information on your farming activities in the table below.

No.	Farm information	Major Crop	Minor Crop
1.	Farm size (in acres)		
2.	Yield per acre		
3.	Age of farm		
4.	Average yield/acre/season		
5.	Quantity consumed consumed		
6.	Quantity sold		
7.	Income Obtained (in GHC)		

Note: For quantities consumed or sold indicate number in bags/weight or the unit and form it is sold

B15b. Do you have access to market for your produce?

1. Yes [ ] 0. No [ ]

Skip to Section 2 if your response to question B15b is "No"

B15c. If yes, who/where do you sell your produce to? [***Select as many option as apply to you]***

1. Local Markets [ ] 2. Local Aggregator [ ] 3. Other Aggregators [ ] 4. Institutional Buyers [ ]

Section 2: Household Conditions

HC1. Please select from the list provided the material used in constructing your room/building.

1. Cement block 2. Bricks 3. Clay mud 4. Wood 5. Other specify

HC2. What kind of roofing systems do you have?

1. Aluminium 2. Clay Tiles 3. Grass/Thatch 4. Other specify

HC3. What is the source of cooking fuel for the household?

1. Firewood 2. Charcoal 3. Kerosene stove 4. LPG 5. Other specify

HC4. Does your household have a toilet within you compound?
1. Yes 0. No

HC4a. If yes to question HC4, what kind of toilet do you have?
1. Pit latrine 2. KVIP 3. Water closet 4. Other specify

HC4b. If No to question HC4b, where does the household go to ease themselves?
1. Public toilet 2. Open space (bush) 3. Neighbour's house
5. Other specify

HC5. What is the main source of drinking water for you household?
1. Tap water 2. Borehole 3. Well 4. River 5. Other specify

HC6. Is your household connected to electricity?
1. Yes 0. No

HC6a. If No to question HC6, what is the source of lighting for your household at night?
1. Solar lamp 2. Lantern 3. Kerosene lamp (Bobo) 4. Other specify

HC7. Has any member of your household being sick/ill over the past 6month – 1 year?
1. Yes 0. No

HC7a. If yes to question HC7, please state the kind of sickess/ailment.

Section 3: UNDERSTANDING OF CLIMATE CHANGE: PERCEPTIONS AND VIEWS:

C1. Please for each statement provided, choose from the options (1-5) with 5 being the highest, the one that best reflect your view or response

1. Strongly disagree 2. Disagree 3. Not sure 4. Agree 5. Strongly Agree

No	Views on Climate Change	1	2	3	4	5
1	Climate change is when the rain does not come at the time expected					
2	Climate change is when the rainy period shortens					
3	Heavy rains that lead to floods is climate change					
4	Changes in the season is climate change					
5	The intensity of sun shine is a sign of climate change					

C2. What form (s) of changes in climatic conditions have you observed in your community over the past 5-10 years? [Please select as many as apply to you]

No.	Observed Changes in climatic conditions	Tick [X]
1	Unreliable and erratic rain fall pattern	
2	Shortening of the rainy period	

3	Heavy rains resulting in floods which destroys crops and properties
4	Changes in the season which affects planting and harvesting
5	Intense sun shine for long periods of the year

C3. Which of the observed changes in climatic conditions have you experienced in this community over the past 5-10 years? [***Please rank your response, with 1 being the highest***]

No.	**Statement**	**1**	**2**	**3**	**4**	**5**
1	The rain does not come at the time expected					
2	Rainy period is shortening					
3	Heavy rains leading to floods					
4	Changes in the season (planting time is changing)					
5	The sun shine has become very intense (Atmosphere is very hot)					

C4. What in your view is bringing about the observed changes in question C3? [***Please state your level of agreement***]

No.	**Statement**	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1.	Normal changes in weather conditions					
2.	Felling of trees					
3.	Bush burning/fires					
4.	Application of agro-chemicals					
5.	Punishment from the gods					

C5. How can the changes observed in question C3 be prevented? [***Please state your level of agreement***]

No.	**Statement**	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1.	Nothing can be done					
2.	Change farming practices					
3.	Stop bush burning					
4.	Reduce use of agro-chemicals					
5.	Stop the felling of trees					
6.	Make sacrifices to appease the gods					

Section 2.1. Effects/Impacts of climate variability on (Lives and work):

C6. To what extend have the changes in climatic conditions affected your livelihood?
1. Very High [ ] 2. High [ ] 3. No effect [ ] 4. Low [ ] 5. Very Low [ ]

C7. Indicate the degree to which the following specific aspects of your livelihood have been affected by the changes in climatic conditions over the past 5-10 years [***Rate your responses with 5 being the highest***]

No.	Aspect of livelihood	1	2	3	4	5
1.	Farming activity (planning and work)					
2.	Household care					
3.	Nutrition and food supply					
4.	Income					

C7a. Has the changes in climatic conditions affected your access to water?

1. Yes 0. No

C7ai. If Yes to question C7a, tick from the list provided how you were affected. [Tick as many as applies to you]

Area of effect	Tick
Water for animals	
Watering of plants	
Water for household activities	

C8. What are the nature and forms of effects of climate variability on your livelihood over the past 5-10 years? [***Rate your response from the options provided with 5 being the highest]***

No.	Nature/Form of effect	1	2	3	4	5
1.	De-roofing of building due to storm					
2.	Loss of seed due to delayed rains					
3.	Low yields					
4.	Wilting of planted crops					
5.	Pest infestation due to intense heat					
6.	Lodging of plants due to flood					
7.	Reduction in Income					
8.	Reduced ability to provide daily meals					
9.	Inability to pay school fees					
10.	Resort to borrowing to feed family					
11.	Inability to purchase inputs					

Section 2.2. Timing of effects:

C9. What period of the year (in month) do you usually experience the effects above?

No.	Nature/Form of effect	Time of Effect (in month)
1.	De-roofing of building due to storm	
2.	Loss of seed due to delayed rains	
3.	Low yields	
4.	Wilting of planted crops	
5.	Pest infestation due to intense heat	
6.	Lodging of plants due to flood	
7.	Reduction in Income	
8.	Reduced ability to provide daily meals	
9.	Inability to pay school fees	

10. Resort to borrowing to feed family
11. Inability to purchase inputs

C10. How many seasons are you able to plant annually in this community?
1. One [ ] 2. Two [ ] 3. Other specify ……
C10a. Please indicate the periods (in month) for the seasons
1. Major:
2. Minor:

C11. Which season is affected most by the factors mentioned in question C8?
1. Major [ ] 2. Minor [ ]

C12. Have the period (time in month) for planting for the season (s) remained the same?
1. Yes [ ] 0. No [ ]

C12a. If yes, indicate the changes (in month).

1. Major: ……. 2. Minor: …….....

C12b. If no, how do you plan your planting activities to prevent the effects of the variability in climatic conditions?

Section 4: SOCIO-CULTURAL PRACTICES AND GENDERED IMPLICATIONS:

SC1. What kind of inheritance system (s) do you practice in this community?
1. Matrilineal [ ] 2. Patrilineal [ ] 3. Double decent [ ]
4. Other specify: ……

SC2. Does the inheritance system practiced in this community affect your ability to access land for farming? 1. Yes [ ] 0. No [ ]

SC2a. If yes, in what way (s) does the inheritance systems affect your ability to access land for farming?

SC3. Who has the most access to the following resources in your community? [Please select either men or women for each option]

No.	Resource	Men	Women	Reason
1.	Family Land			
2.	Community Land			
3.	Extension services			
4.	Agricultural information			
5.	Farm input			

Section 4.1: Access to social/communal resources:
SC3. How did you get access to the land you are farming on?
1. Family [ ] 2. Rent [ ] 3. Chief [ ] 4. Outright purchase [ ]
5. Spouse [ ] 6. Inherited [ ] 7. Shared Cropping [ ] 8. Other specify [ ]

SC4. Are there any arrangements regarding the terms of use of the land?
1. Yes [ ] 0. No [ ]

SC4a. If yes, what are the terms/arrangements for use of the land?

SC5. Are you able to get land for farming in this community when needed?
1. Yes [ ] 0. No [ ]

SC6. Are there any social/cultural hindrances to your access to land?
1. Yes [ ] 0. No [ ]
SC6a. If yes, why are you hindered? …….

SC7. Are there differences in access to land for men and women? 1. Yes [ ] 0. No [ ]

SC7a. If yes (if there are differences), what is the nature of difference?

SC7b. If no (if there are no differences), what account for the equal access to land by men and women?

SC8. Apart from land, are you able to access other resources in the community unhindered?
1. Yes [ ] 0. No [ ]

SC8a. If yes, what resources are available to you? [***Please select as many as are applicable***]
1. Fuel wood [ ] 2. Fruits [ ] 3. Water [ ] 4. Economic plants in the wild [ ] 5. Other specify: ……

SC8b. If no, why don't you have access to community resources?

Section 4.2: Control and management of land farmlands:
SC9. Are you able to take decision on the management of the land you are using for farming?
1. Yes [ ] 0. No [ ]

SC9a If yes, what kind (s) of management decisions are you able to take regarding your farmland?

SC9b. If no, why are you unable to take decision on the management of the land?

SC10. Can you decide to use your farmland for any other purpose apart from farming?
1. Yes [ ] 0. No [ ]

SC10a. If yes, what are the other things you can do with your farmland apart from farming?

SC10b. If no, why are you unable to use the land for other purposes?

SC11. Can you rent/give your farmland to anyone you wish?

1. Yes [ ] 0. No [ ]

Section 5: ADAPTIVE STRATEGIES:

Section 5.1: General Livelihood Adaptive strategies:

AS1. Which of the following measures do you resort to address the climate change impacts on your livelihood? ***[Please tick as many as are applicable to you*]**

No.	Adaptive Strategy	Tick [X]
1.	Borrow from friends and relatives	
2.	Work as farm labour for others	
3.	Engage in non-farm activities (Trading, food vending, processing etc)	
4.	Reduce number of meal per day	
5.	Sell assets	
6.	Reliance on family for up keep	
7.	Seek help from associations / groups	
8.	Use savings	
9.	Take a Loans	
10.	Engagement of children in economic activity	
11.	Other specify :……..	

Section 5.2: On Farm Adaptive Strategies:

AS2. When you are affected by climate change impacts on your farm, which of the following measures do you resort to? [***Please tick as many as are applicable to you*]**

No.	Adaptive strategy	Tick [X]
1.	Change timing of planting	
2.	Use drought resistant seed variety	
3.	Use of organic fertilizer	
4.	Use of chemical fertilizer	
5.	Use of pesticide	
6.	Seek advice from Agricultural Extension Officers	
7.	Relocate farm	
8.	Other specify……	

Section 5.3: Level of effectiveness of adaptive strategy on farm:

AS3. Which of the actions taken to address the effects of climate change is effective on your farm? [***Please rank the level of effectiveness with 5 being the highest***]

No.	Coping Strategy	1	2	3	4	5
1.	Change timing of planting					
2.	Use drought resistant seed variety					
3.	Use of organic fertilizer					
4.	Use of chemical fertilizer					

5. Use of pesticide
6. Seek advice from Agricultural Extension Officers
7. Relocate farm
8. Other specify

Section 5.4: Level of effectiveness of adaptive strategy on livelihood:

AS4. Which of the actions taken to address the effects of climate is most effective to secure your livelihood? [***Please rank the level of effectiveness with 5 being the highest***]

No.	Coping Strategy	1	2	3	4	5
1.	Borrow from friends and relatives					
2.	Work as farm labour for others					
3.	Engage in non-farm activities (Trading, food vending, processing etc)					
4.	Reduce number of meal per day					
5.	Sell assets					
6.	Reliance on family for up keep					
7.	Seek help from associations / groups					
8.	Use savings					
9.	Take a Loans					
10.	Engagement of children in economic activity					

AS5. Have you participated in any training/workshop to enhance your ability to manage the impact of the changing climatic conditions?

1. Yes [ ] 0. No [ ]

Skip to Section 6 if your response to question AS5 is "No"

AS6. If yes, which institution organized the workshop?

1. MoFA [ ] 2. District/Municipal Assembly [ ] 3. NGO [ ] 4. Other specify [ ]

AS7. What is the main reason for participating in the training? [***Select as many as applies to you***]

1. To learn how to manage resources sustainably [ ]
2. To learn more about alternative livelihoods [ ]
3. To obtain financial assistance [ ]
4. To learn how to better plan farming activities [ ]
5. Other specify: …….

Section 6: NETWORKS AND SUPPORT SYSTEMS:

Section 6.1: Family and Relatives:

FR 1. Do you receive any kind of support from your extended family and relatives in times of need?

1. Yes [ ] 0. No [ ]

FR1a. What kind of support do you receive from your family? [***Please tick as many as applicable***]

1. Money [ ] 2. Labour on farm [ ] 3. Help with care of children [ ] 4. Food [ ]
5. Other specify: …….

FR1b. If no, who offers you support in times of need?

FR3. Does your extended family support you in times of need arising from impacts of climate variability/change?

1. Yes [ ] 0. No [ ]

Skip to section 6.2 if response to question FR3 is "No"

FR4. What kind of support do you receive from your extended family/relatives? [***Please select as many as applies***]

1. Monitory support [ ] 2. Supply food to household [ ] 3. School fees of children [ ] 4. Work on farm[ ] 5. Land for farming [ ] 6. Renovation of house [ ]

Section 6.2: Membership of Groups and Association:

GA1. Do you belong to any form of groups/associations?

1. Yes [ ] 0.No [ ]

Skip to section 6.3 if response to question GA1 is "No"

GA1a. If yes to question GA1, what kind of group/association do you belong to? [***Please select as many as applicable***]

1. Farmer based organization (FBO) [ ]
2. Community [ ]
3. Ethnic [ ]
4. Church [ ]
5. Other (specify): ……

GA2. Thinking about the members of the group (s) are most of the same?

1. Yes [ ] 0. No [ ]

GA2a. Please tick from the options as many as are applicable

1. Neighbourhood/Village [ ]
2. Family/Kin group [ ]
3. Religion [ ]
4. Gender [ ]
5. Age [ ]
6. Ethnic/Linguistic [ ]

GA3. Do the members have the same occupation? 1. Yes [ ] 0. No [ ]

GA3. Do the members have the same educational background or level?

1. Yes [ ] 0. No [ ]

GA4. What is the main benefit from joining the group? [***Select as many as apply to you***]

No.	**Type of support**	Tick
1.	Financial Assistance	
2.	Improves my household's current livelihood or access to services	
3.	Assistance in times of emergency/in future	

4. Help on farm
5. Enjoyment/Recreation
6. Spiritual, social status, self-esteem
7. NGO support
8. Other (specify)

GA5. Does the group help you get access to services?
1. Yes [ ] 0. No [ ]

Skip to section 6.3 if response to question GA5 is "No"

GA5a. If yes, Please select from the list the services applicable to you
1. Education/Training [ ]
2. Health services [ ]
3. Credit/savings [ ]
4. Agricultural inputs or technology [ ]
5. Irrigation [ ]
6. Other (specify): ……

Section 6.3: Economic/Financial:
EC1. Are you able to save part of your income/earnings? 1. Yes [ ] 0. No [ ]

EC1a. Where do you save?
1. Home [ ] 2. Susu (group) [ ] 3. Susu (Micro-finance Inst.) [ ]
4. Family/Friends [ ] 5. Bank [ ] 6. Mobile money wallet [ ]
7. Other specify …….

EC1b. For each saving point, indicate how much you have currently saved?

No.	Saving Point	Amount saved (GHS)
1.	Home	
2.	Susu (group)	
3.	Susu (Micro-finance Inst.)	
4.	Family/Friends	
5.	Bank	
6.	Mobile money wallet	

EC2. Are you registered and contributing to any insurance package? 1. Yes [ ] 0. No [ ]

EC2a. If yes, what kind of insurance?
1. Farm/Drought insurance [ ] 2. Fire insurance [ ] 3. Life insurance [ ] 4. Health Insurance [ ]

EC2b. If no, why are you not registered to any insurance package or scheme?

EC3. Do you have any property in this community or elsewhere? 1. Yes [ ] 0. No [ ]

Skip to section 6.3.1 if response to question EC3 is "No".

EC3a. If yes, specify the property type and location?

No.	Property type	Location
1.		
2.		
3.		

EC4. Have you ever had to sell any of your properties due to difficulties arising from climate variability impacts? 1. Yes [ ] 0. No [ ]

EC4a. If yes, what kind of property did you sell?
1. Clothes [ ] 2. Bicycle [ ] 3. House [ ] 4. Land [ ] 5. Household Food Stock [ ] 6. Other specify: ……

EC4b. How much money did you raise? GHC
……

EC4c. What did you do with the money?
1. Acquired new land [ ] 2. Bought new seed [ ] 3. Roofed my building [ ]
4. Paid for farm labour [ ] 5. Hired a tractor [ ] 6. Provide household needs [ ]
6. Other specify: ……..

Section 6.3.1: Assets owned (Movable):
EC6. This section assesses the kinds of movable assets you own and how long you have had them. You may select as many as apply to you.

No.	Asset/Item Name	Quantity	Length of ownership (Months and year)	Cost (GHC)*
1.	Bicycle			
2.	Motor bike			
3.	Cooking pots			
4.	Radio			
5.	Cutlass			
6.	Wellington Boots			
7.	Knapsack sprayer			
8.	Hoes			
9.	Television			
10.	Mobile Phone			

*Use average cost where you have more than one of an asset/item

Thank you for your participation

Appendix 2 - Focus group discussion Guide

FOCUS GROUP DISCUSSION (FGD) GUIDE:

The guide will help to direct the conversations with participants. Issues raised will be based on specific themes regarding context specific socio-cultural norms on inheritance and land tenure arrangements. The themes will assist to tease out key ideas to engender relevant responses from participants. The following are the themes for the focus group discussions and the specific questions.

View and perceptions of climate variability/change and changes observed.

How do you understand climate change?

[Explore specific indicators such as weather changes, land cover etc.]

What are the things to looks out for to ascertain a change or variations?

What in your opinion contribute to these changes?

[Causes or sources of change]

Have you observed any changes?

What kinds of changes have been observed?

[Timing and period (Year/Month/Season]

Are they having any kinds of effect?

[Personally, household, work etc.]

What are the specific kinds of effects?

[Flooding, drought, pest on farm, wind storms etc]

In what ways are these effects seen on faming activities?

[Timing of planting, Change in season, Low yields, etc]

Forms of inheritance systems and modes of application

What kind (s) of inheritance system is practiced in this community?

[Explore the different types/forms: Matrilineal/Patrilineal/Double decent]

How does it work/applied?

[Explore its intricacies of execution: considerations and exemptions]

In the application of the inheritance systems are there differences based on:

Gendered variations (inhibitions/taboos/privileges)

Land use arrangements and influence of inheritance norms

How does a person acquire a land for farming in this community?

[Explore varied land tenure arrangements: Shared cropping (forms), renting, freehold, outright purchase]

Are there some arrangements in this regard?

[Explore payments, rents and royalties]

Are there challenges with the different land use and tenure arrangements?

[Explore conflicts arising from the nature of implementation]

How does the mode of application of norms on inheritance influence people's ability to access, use and control land they acquire or given to them?

[Explore differences between: Family and community lands, male and female, native and settlers]

How are adaptive options constrained or enhanced by the influence the norms have of access, use and control of resources?

[Explore gendered differences and changes in livelihood patterns as coping mechanism]

Appendix 3 - Key Informant Interview Guide

KEY INFORMANT INTERVIEW GUIDE:
The interview guide will be used for interviewing Key Informants. These will include, community leaders/authorities, leaders of farmer-based organizations, other collective self-help organizations identified and directorate of MoFA in the district. The guide will be adapted for the specific key informant being interviewed.

The guide will be used following main themes. The themes are as follows:

Community Leaders and Family Heads:

How does the inheritance systems work?
[Intricacies in allodia rules]

Are there others forms of considerations in the way the inheritance norm is applied?
[Gender – male and female; Resident status – native and settler]

Do the modes of inheritance affect or influence land use arrangements?

In what way do the land use arrangement influence access, use and control?
[Type of crop that can be planted, third party transfers etc.]

Are there cultural or social prohibitions on what kinds of resources can used?
[Barriers, Opportunities]

Farmer Based Organization Leaders:
Are your members affected by the impact of climate variability?

What are some of the effects?
[Explore: life and work]

How have the effects been addressed?
[Adaptive options and strategies]

Does the organization assist its members to deal with the effects or impacts of climate variability?
[Kinds of assistance and outcomes: Hand out, collective self help, alternate livelihood training]

What has been the outcome of support and assistance?

Institutions (Ministry of Food and Agriculture (MoFA) and District Assemblies
Has the impact of climate variability been observed in the lives and work of smallholder farmers in the district?
[Explore forms of impacts on lives and work]

What are the specific effects on farming activities?
[Rainfall, Pest, Yield etc.]

What kinds of warning systems are available to help farmers and people generally plan to minimize the impacts or effect?

When people are affected are there any support systems available to alleviate support and cushion them?

[Form of support and structures]

Are there farmer and community education programmes to build resilience and safeguard livelihoods?

[Explore further into the types and forms]

What are the outcomes?

Appendix 4 - Ethical Clearance Letter

UNIVERSITY OF GHANA
ETHICS COMMITTEE FOR THE HUMANITIES (ECH)
P. O. Box LG 571, Legon, Accra, Ghana

My Ref. No.....

2nd October, 2018

Mr. Alexander Nii Adjei Sowah
Institute of Statistical, Social and Economic Research
University of Ghana
Legon

Dear Mr. Sowah,

ECH 170/17-18: SOCIO-CULTURAL FACTORS AND THE GENDERED ADAPTATION TO CLIMATE VARIABILITY IMPACTS ON AGRICULTURAL HOUSEHOLDS IN TWO ECOLOGICAL ZONES

This is to advise you that the above reference study has been presented to the Ethics Committee for the Humanities for a full board review and the following actions taken subject to the conditions and explanation provided below:

Expiry Date:	17/06/19
On Agenda for:	Initial Submission
Date of Submission:	16/05/18
ECH Action:	Approved
Reporting:	Annually

Please accept my congratulations.

Yours Sincerely,

Prof. C. Charles Mate-Kole
ECH Vice Chair

CC: Dr. Simon Bawakyillenuo, Senior Research Fellow, ISSER

Prof. Felix Asante, Director, ISSER

Tel: + 233-303933866 Email: ech@ug.edu.gh

Appendix 5 – Protocol Consent Form

UNIVERSITY OF GHANA

Official Use only
Protocol number

Ethics Committee for Humanities (ECH)

PROTOCOL CONSENT FORM

Section A- BACKGROUND INFORMATION

Title of Study: Socio-cultural factors and the gendered adaptation to climate variability impacts on agricultural households in two ecological zones

Principal Investigator: Alexander Nii Adjei Sowah

Certified Protocol Number

Section B– CONSENT TO PARTICIPATE IN RESEARCH

General Information about Research

This study is aimed at understanding the influence of socio-cultural factors such as inheritance rights and land tenure arrangement on the ability of smallholder farmer to adapt to the impact of the rapid changes in weather and climatic conditions. Also, it seeks to examine how adaptive options and practices are different between men and women within the rural context. The questionnaire administration is estimated to last for 20 minutes.

Benefits/Risks of the study

Participation in the study will help produce knowledge on adaption to the rapidly changing climatic conditions. The study will clearly show the difference in adaptive options and capacities between men and women. In so doing, socio-cultural practices which affect access and control of resources can be changed or refined to help people better adapt in order to safeguard their livelihoods.

Confidentiality

- Information will be anonymously collected from participants. This will help to protect the identity of participants form anyone who may handle the data at any point. Additionally, research assistance that may be hired to transcribe audio

recordings will be required to sign a non-disclosure and confidentiality agreement. To ensure that the data is secured, transcriptions and analysis will be carried out on computers provided for by the investigator.

- Records and data collected from participants will be accessible to the 1. The student researcher 2. All three supervisors 3. Research Assistants who will take part in the data collections, analyses and transcription of audios from focus group discussions and key informant interviews. Therefore, by signing or thumb printing a written consent form, the participant or their representative is authorizing such access.

Compensation

No form of compensation will be given for participation in this study. Participation is entirely voluntary.

Withdrawal from Study

Participation in this study is voluntary. You are therefore free to withdraw or discontinue your participation in the study if at any point you feel uncomfortable. The researcher will not hold any grudge against you for or any harm come to you for choosing to withdraw from this study. The interview may also be rescheduled if you like to meet at a different date to continue.

Contact for Additional Information

If you wish to raise any concerns relating to this study or any harm or injury brought to you due to this study, you may please contact:

Dr. Simon Bawakyillenuo, Institute of Statistical Social and Economic Research (ISSER), University of Ghana, Legon, Tel: +233548731902, Email: bawasius@hotmail.com or bawasius@isser.edu.gu

If you have any questions about your rights as a research participant in this study you may contact the Administrator of the Ethics Committee for Humanities, ISSER, University of Ghana at ech@isser.edu.gh / ech@ug.edu.gh or 00233- 303-933-866.

Section C- PARTICIPANT AGREEMENT

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

_____

Name of Participant

_____ _____

Signature or mark of Participant Date

If participants cannot read and or understand the form themselves, a witness must sign here:

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

_____

Name of witness

_____

_____

Signature of witness / Mark Date

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

_____

Name of Person who Obtained Consent

_____

_____

Signature of Person Who Obtained Consent Date