CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT PROGRAMME

UNIVERSITY OF GHANA

LEGON

SOCIAL DIFFERENTIATION IN LIVELIHOOD VULNERABILITY AND ADAPTATION: A STUDY OF GROUNDNUT PRODUCTION IN THE UPPER WEST REGION

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THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON, IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF PHILOSOPHY DEGREE IN CLIMATE CHANGE AND SUSTAINANBLE DEVELOPMENT DEGREE

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DECLARATION

I, Abdul Rauf Zanya Salifu, sincerely declare that except for the references to works which have been duly cited and acknowledged, this thesis is the result of my own original research carried out under the guidance of my supervisors, Dr. Elaine Tweneboah Lawson and Dr. Charlotte Wrigley-Asante of the Institute for Environment and Sanitation Studies and the Department of Geography and Resource Development of the University of Ghana, Legon. I also certify that this thesis has not been submitted in part or whole for the award of any degree elsewhere.

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DEDICATION

I dedicate this thesis to my mum, Hajia Meiri Seidu, my late father, Mr Salifu Naba Zanya, and my elder brother Masahudu Zanya Salifu of Lands Commission, Tamale and to all my family, friends and teachers.

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ABSTRACT

Climate variability and change have become the biggest setbacks on livelihoods and wellbeing particularly in Northern Ghana where high dependence on rain-fed agriculture coexists with fragile ecosystems. These problems also interact with pre-existing social, economic, cultural and political inequalities to shape vulnerability. This study sought to investigate how social differentiation influences livelihood vulnerability and adaptation, particularly in groundnut production in the Lawra and Nandom Districts in the Upper West Region of Ghana. As the main commercial crop, farmers in the area are increasingly converting lands that were hitherto meant for food crops into groundnut cultivation due to its high economic returns and early maturity given the low rainfall and increased climate variability. The study examined the drivers of vulnerability in groundnut production and the adaptive responses adopted by farmers in that regard. It found that groundnut production was vulnerable to the impacts of climate variability and change such as droughts, dry spells, and occasional floods. Non-climatic factors such as poor markets, inaccessible roads, pests and diseases, cultural and gender barriers also affect production. The adaptation strategies adopted by farmers are a combination of autonomous and planned strategies. Some of the strategies include changing planting dates, using early maturing seeds and the use of compost. Some of the farmers also adapt by engaging in off-farm jobs such as "*pito*" brewing, fishing and Shea butter processing. This study considered three social groups based on gender, age and farm ownership as the main units of analysis. It was found that the adoptions of adaptation strategies were differentiated by social groups. The study found that interventions from NGOs and the Department of Agriculture were helping to improve agricultural livelihoods in the study areas. At the same time, several challenges were faced by these institutions in their effort to reduce vulnerability and improve the wellbeing of farmers.

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LIST OF ABBREVIATIONS

ACDEP- Association of Church-Based Development Projects

AR4- Fourth Assessment Report

AR5- Fifth Assessment Report

ATR- African Traditional Religion

BBC- British Broadcasting Corporation

CCAFS- Climate Change, Agriculture and Food Security

DoA- Department of Agriculture

ELCAP- Enhancing Livelihood through Climate Change Adaptation Project

EPA- Environmental Protection Agency

FAO- Food and Agriculture Organization

FGD- Focus Group Discussions

GHG- Greenhouse Gases

GLSS- Ghana Living Standard Survey

GNFS- Ghana National Fire Service

GSS- Ghana Statistical Service

IPCC- Intergovernmental Panel on Climate Change

KII- Key Informant Interviews

LAC- Local Adaptive Capacity

MDGs- Millennium Development Goals

MESTI- Ministry of Environment, Science, Technology and Innovation

MoFA- Ministry of Food and Agriculture

MT- Metric Tons

NANDIRDEP- Nandom Deanery Integrated Rural Development Programme

NGOs Non-Governmental Organizations

OGP- Optimum Growing Period

PHC- Population and Housing Census

PICS- Purdue Improved Cowpea Storage

PWD- People with Disabilities

RCP- Representative Concentration Pathways

RESULT- Resilient and Sustainable Livelihoods Transformation

RHM- Risk-Hazard Model

SDGs- Sustainable Development Goals

SPSS- Statistical Package for the Social Science

SSA- Sub-Saharan Africa

TAR- Third Assessment Report

UWR- Upper West Region

WEDO- Women's Environment and Development Organization

CHAPTER ONE

INTRODUCTION

1.1 Background to Study

Climate variability and change constitute part of the biggest menace facing this planet and the systems within it in the 21st Century (IPCC, 2014). Based on widespread evidence (at macro, meso and micro scales) the Intergovernmental Panel on Climate Change has described the changes witnessed in the earth's climate system as unequivocal (IPCC, 2013). This evidence include *inter alia* rise in mean temperature, changes or shifts in precipitation patterns, disruptions in ecosystems, widespread thawing of glaciers, snow and ice caps, rise in average sea level and the increased frequent and intensity of extreme weather events (World Bank, 2013; IPCC, 2013).

Although Africa's historical contribution to the build-up of Greenhouse Gases (GHG) in the earth's atmosphere is very marginal, research has revealed that Africa will be one the hardest hit by the impacts of anthropogenic climate variability and change based on the continent's vulnerability and low adaptive capacity (MESTI, 2013; Niang *et al*., 2014). Africa's high vulnerability relative to other parts of the world is highlighted by the fact that the continent is struck with extreme poverty, prevalence of diseases, conflicts, poor infrastructure, bad governance and heavy reliance on climate-sensitive livelihoods (rain-fed agriculture) and fragile ecosystems (Boko *et al.*, 2007; Niang *et al.*, 2014). The FAO (2005) estimates that about 95% of the cultivated fields in Sub-Saharan Africa are rain-fed.

Past records indicate that over the 20th century, global average surface temperature increased by 0.6 ^{o}C (IPCC, 2001). Changes in climate have occurred in the past five decades, leading to many extreme weather and climatic events such as droughts, floods, heat waves and thunderstorms

(IPCC, 2013). For West Africa, near surface temperature rose up by between 0.5^{o} C and 0.8^{o} C between 1970 and 2010, with future temperature expected to rise above global average by the end of the century (Niang *et al.*, 2014). Historical observations have shown an overall reduction in rainfall over the Sahel (which covers a large part of West Africa) over the 20th century. This was characterized by widespread occurrence of droughts across West Africa including Ghana during the 1970s and 1980s (Owusu *et al.*, 2008). Padgham *et al.* (2015) also revealed that over last five decades rainfall patterns have been erratic and variable across the semi-arid areas of West Africa (which covers Northern Ghana), with some areas getting wetter and others getting drier.

Ghana's average temperature has risen by 1^{o}C with a concomitant decrease in mean annual rainfall and increased variability in all the agro-ecological zones over the past four decades (1960-2000) (EPA, 2011). The average rate of rise in temperature has been 0.21^{o}C per decade, with more rapid increases in the Northern Savannah regions (MESTI, 2013).

Although the nature of climate variability and change is characterized by uncertainty and unpredictability, climate models suggest that projections for temperature are more robust than it is for precipitation. This is due to the complexity of the climate system (IPCC, 2013). The Fifth Assessment Report (AR5) uses four greenhouse gas (GHG) emission scenarios known as Representative Concentration Pathways (RCP) to project how future temperature changes could occur by the end of this century. Based on the RCP, temperature could rise within the ranges of 0.3^{o} C to 4.8^{o} C depending on the emission levels and mitigation efforts (IPCC, 2013). But, Future projections for precipitation still remain unclear due to inter-model variations. Different models project dryness in some areas whiles other models show wetness (World Bank, 2013).

In Ghana and other parts of Sub-Saharan Africa (SSA), rainfall projections are fraught with uncertainties. However, most projections point to overall shifts in precipitation patterns including increased variability, late onset and lengthening of dry spell periods (Padgham *et al.*, 2015). Future projections for temperature in Ghana generally show that temperatures are expected to rise by 0.6°C, 2.0°C and 3.9°C by the years 2020, 2050 and 2080 respectively (MESTI, 2013).

The impacts of climate variability and change on the livelihoods of poor societies cannot be overestimated. Under high intra- and inter-seasonal climate variability, societies dependent on rain-fed agriculture and fragile ecosystems become exposed to climatic stresses, putting their livelihoods under serious risk and jeopardy (Niang *et al.*, 2014; Nyantakyi-Frimpong and Bezner-Ker, 2015). Agricultural productivity is expected to decline as a result of climatic stressors and perturbations (rise in temperature, precipitation shifts and extreme events) and further limit the efforts put in place by these countries to combat poverty, disease, food insecurity and ensure social stability (Raleigh, 2010; Padgham *et al.*, 2015).

Further, the impacts of climate variability and change in SSA is going to be exacerbated by a suite of non-climatic threats including sociocultural practices, environmental degradation, land-use change, population growth, poverty and conflicts (World Bank, 2013; Niang *et al.*, 2014). Climate variability and change impacts have the potential to reverse Africa's progress toward achieving the Millennium Development Goals (MDGs) (IPCC, 2014) and the current Sustainable Development Goals (SGDs).

Past and current changes in Ghana's climate have adversely affected the country's predominantly agro-based economy (Owusu and Waylen, 2009; EPA, 2011) particularly in the semi-arid Northern Ghana where close to 50% of the poor are located (Pickbourn, 2011). Also, projected impacts are expected to further worsen the preexisting vulnerabilities in agricultural livelihoods especially among resource-poor communities and marginalized groups (Nyantakyi-Frimpong and Benzer-Ker, 2015).

1.2 Problem Statement

Climate variability and change are projected to exacerbate pre-existing challenges to sustainable development in the developing world particularly Sub-Saharan Africa (SSA) (IPCC, 2014). Although the problem of climate variability and change affects and will continue to affect all sectors in different geographic locations, the adverse impacts are however not expected to affect systems proportionately across the globe (MESTI, 2013). Due to differences in levels of vulnerability and coping capacity, the impacts of climate variability and change will vary considerably among regions, countries, sectors as well as social groups, with the world's poorest being the worst affected (Kasperson and Kasperson, 2001; Popke *et al.,* 2014; Nyantakyi-Frimpong and Bezner-Ker, 2015). Existing studies have shown that under climate change and other related impacts, marked dissimilarities exist among different social groups (age, gender, level of education) pertaining to how livelihood systems are severely affected (Nielsen and Reenberg, 2010a; Arora-Johnson, 2011; Coirolo and Rahman, 2014).

In SSA and Ghana in particular, food production systems and rural livelihoods are projected to be severely impacted by climate variability and change (World Bank, 2013). This is so because these areas are characterized by high degrees of exposure to droughts, dry spells, intra and inter annual variability, high temperatures (Padgham *et al.,* 2015); high levels of sensitivity due to over-reliance on climate-sensitive (over 90% rain-fed agriculture) economic and livelihood systems (MoFA, 2011), as well as limited capacity to adapt or mitigate the adverse impacts of climate variability and change (Niang *et al.,* 2014; Antwi-Agyei *et al.,* 2015a).

Akudugu *et al.* (2012) argue that in Northern Ghana, continuous decline in crop yields was as a result of unreliable and erratic rainfall patterns. They argue further that food and livelihood insecurity has become a "normal" phenomenon in Northern Ghana under climate variability and change.

Studies have revealed that the Upper West Region has been found to be one of the poorest and most vulnerable to climate variability and change (Rademacher-Schulz *et al.,* 2014; Etwire *et al.*, 2013). Just as how levels of vulnerability vary across space, individuals and households also show socially differentiated degrees of vulnerability (Adger, 2006; Coirolo and Rahman, 2014). Under climate change impacts, the social differentiation lens helps to understand how different social groups are vulnerable, and what specific risks they are vulnerable to (Padgham *et al.,* 2015).

The impacts of climate variability and change on communities, households or individuals are partly shaped by societies' values, culture, perceptions and power structures (Popke *et al.,* 2014). Thus, vulnerability is not only determined by biophysical factors (floods/droughts) but also by socio-cultural, structural and institutional factors that may include caste, gender, age, disability status, ethnicity, level of education and political affiliation among others (Heltberg *et al.,*2009). These factors determine the adaptive responses of different social groups (Heltberg *et al.,* 2009) by shaping their levels of asset base, access to services and infrastructure, level of dependence on climate sensitive livelihoods and political agency (Padgham *et al.,* 2015).

Moreover, it is argued that some adaptation programmes, projects and resources at the local scale may create new inequalities or have unintended adverse effects, and thus create new winners and losers (Adger *et al.,* 2006) particularly when the one-size-fit-all approach is applied (Heltberg *et* *al.,* 2009). Thus, failing to recognize the nuanced and socially differentiated dynamics of vulnerability may lends most adaptation interventions to further exacerbate the existing risks, marginalize the poor and vulnerable groups leading to maladaptation (Heltberg *et al.,* 2009; Popke *et al.,* 2014).

Under the present harsh and unreliable climatic conditions in Northern Ghana (Akudugu *et al.,* 2012), this study sets out to explore how social differentiation shapes livelihood vulnerability and adaptation in groundnut production in the Upper West Region. It is argued that groundnut is the most important cash crop in the region (Abu, 2013). The region produces about 37% of the total output of groundnut in Ghana (Angelucci and Bazzucchi, 2013). As a crop that supports livelihood (income and food security), climate variability and change and other socio-economic factors are expected to adversely affect this big income-generating activity, and may lead to livelihood insecurity and exacerbate poverty (Cramer and Thornton, 2012; Sarr *et al.,* 2015).

This study therefore seeks to understand how vulnerability and adaptation in groundnut production is differentiated among social groups under both climatic and non-climatic stresses.

The study seeks to answer the following research questions;

1. What factors influence vulnerability in groundnut production?
2. How do groundnut farmers cope with or adapt to the current vulnerabilities they face?
3. What are the differences in the adaptation strategies within different social groups?
4. How do current adaptation interventions influence the vulnerability or wellbeing of groundnut farmers within different social groups?

1.3 Research Objectives

The overarching objective of the study is to examine social differentiation under climate –related vulnerability and adaptation among groundnut farmers in the upper west region.

1.3.1 Specific Objectives:

1. To examine the factors responsible for vulnerability in groundnut production in the region.
2. To identify the adaptation strategies adopted by groundnut farmers in response to vulnerability.
3. To determine the differences in the adoption of adaptation strategies within different social groups.
4. To assess the implications of current adaptation strategies and interventions in groundnut production on the vulnerability and wellbeing of the different social groups.

1.4 Significance of the Study

The main aim of this study is to understand how vulnerability and adaptation varies disproportionately among different human systems, particularly in resource-poor and climate-sensitive societies. It aims to propose or recommend actions or interventions that are responsive, socially-appropriate and context-specific.

Coirolo and Rahman (2014) however maintain that there is dearth of empirical research on how climate-related impacts on livelihoods vary across or within groups of poor people, as evident in Ghana and other developing countries. As a result, climate vulnerability and related literature have come under several attacks (Adger, 2006) recent times. It is generally argued that such literature has given less importance to the extent to which different social groups experience climate-risks (Bohle *et al.*,1994 cited in Nyantakyi-Frimpong and Bezner-Ker, 2015) or how social, cultural and political elements interact to shape the vulnerability positions of the poor, marginalized and underrepresented groups (Nyantakyi-Frimpong and Bezner-Ker, 2015).

The Upper West Region of Ghana is one area where climate variability and change pose serious threats to livelihood systems amid differential capacity to cope or adapt to this menace (Ndamani and Watanabe, 2015). Albeit small, there is a growing body of research on climate change and related studies that seeks examine the differentiated impacts of climate variability and change in relation to non-climatic stressors (Nielsen and Reenberg, 2010; Coirolo and Rahman, 20014). Understanding local level experiences could provide vital information for making policies that builds resilience, adaptive capacity and promote sustainable development (Simoes *et al.*, 2010).

The study will be very significant for the following reasons. First, the study's central aim is to contribute to an on-going body of empirical works by providing in-depth knowledge that highlights the role tangible and intangible assets, entitlements, factors and processes in defining differential vulnerability to climate-related shocks and stresses as well as differential coping or adaptive capacities to changing climate.

Moreover, the study could also serve as decision-supporting guide for policy makers (governments or NGOs) to develop socially-appropriate adaptation policies and responses to reduce vulnerability and improve resilience in groundnut production.

Finally, the study will also help to identify the gaps and weaknesses of current adaptation policies and interventions to serve as an entry point for rectifying the ongoing adaptation activities in the region and beyond.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of literature relevant to the study. It encompasses the review of evolving literature on the evidence of climate change in Ghana, the concept of smallholder farmers, the perceptions of smallholder farmers of climate variability and change. It also presents climate change vulnerability and impacts in the context of social differentiation. Further, the effects of climatic and non-climatic factors on groundnut production and the adaptation to climate variability and change by groundnut farmers are presented. Also, barriers or constraints and enablers to effective adaptation to climate variability and change are discussed. This chapter concludes with a conceptual framework for the study.

2.2 Climate variability and change and its Manifestation in Ghana

Climate variability and change are expected to disproportionately affect developing countries particularly in semi-arid areas (Raleigh, 2010; Niang *et al*., 2014). Among the numerous impacts of climate variability and change include increases in temperature and shifts in the pattern of precipitation across the globe. Other impacts may also include increase in the frequency and intensity of extreme weather events and climate related disasters such floods, droughts, heat waves, thunderstorms and coastal inundation (from sea level rise) (IPCC, 2013; World Bank, 2013).

Studies have revealed that the adverse impacts of climate variability and change is expected to be more prevalent in Africa than other parts of the world because, aside the issue of climate variability and change, Africa faces other multiple stressors (conflict, diseases, poor governance and population growth) and also lacks the capacity to adapt (Etwire *et al*., 2013; Niang *et al*., 2014).

Like many other countries in Sub-Saharan Africa (SSA), Ghana has experienced changes in its climate over the past years (Owusu and Waylen, 2009; Yaro, 2010). Some studies have shown that between 1960 and 2000 Ghana witnessed a 1^{o}C rise in temperature coupled with decrease in average precipitation across the country (EPA, 2011). The EPA (2000) also stated that, over the past years rainfall has reduced by 20% and run-off by 30% due to changes in Ghana's climate. Yaro (2010) predicts that annual rainfall total could decline by 9-27% by the end of this century. EPA (2011) also indicates that over the period between 1960 and 2000, mean sea level in Ghana rose by 2.1 mm annually. Based on projections, it is assumed that a global mean sea level rise of 1m by 2100 would inundate a large part of the east coast of Ghana, leading to other hazards like coastal erosion, saltwater intrusion into surface and groundwater sources as well as exacerbating the risk of earthquakes (Yaro, 2010). Table 2.1 shows future climate projections for Ghana.

Table 2.1 Climate projections in Ghana for the years 2020, 2050 and 2080.

Climate Change Indicator	**Year**		
	2020	**2050**	**2080**
Average Temperature rise	0.6°C	2.0°C	3.9°C
Average decline in rainfall	2.8%	10.9%	18.6%
Average level Sea level rise	5.8 cm	16.5 cm	34.5 cm

Source: EPA (2011)

The semi-arid northern part of Ghana lies within the southern frontiers of the West African Sahel. This region is characterized by relatively high temperatures, erratic rainfall, severe droughts and climate variability (Ndamani and Watanabe, 2015; Nyantakyi-Frimpong and

Benzer-Ker, 2015; Padgham *et al.,* 2015). These climate related stresses have profound implication for the region's rain-fed agricultural livelihoods (crops and livestock) (Yaro, 2010; Akudugu and Alhassan, 2012). Studies have shown that Northern Ghana experienced a decrease in rainfall between 1.5% and 11.3% between 1950-1970 and 1971-199 (Lacombe *et al.,* 2012). A study by Kasei *et al.* (2010) further showed that drought frequency, intensity and extent in the Volta Basin (which drains much of Northern Ghana), has increased since the 1970s as confirmed by farmers and rural dwellers alike (Akudugu and Alhassan 2012; Padgham et al., 2015). In a study by Nyantaky-Frimpong and Bezner-Ker (2015), they noted that the annual rainfall pattern in the Upper West Region is characterized by immense temporal variability with sporadic surges, halts and "false starts". They further reveal that the "planting rains" also known as the Optimum Growing Period (OGP) have shifted over the last two decades. The study also showed that due to rising temperature in the Upper West Region (UWR), evapotranspiration has consistently been above average (142.61 mm) since the early 2000s.

2.3 Smallholder Farmers Perceptions on Climate variability and change

The main element used to define smallholder farming in Ghana and other parts of the world is the size of the farmland or plot (Abu, 2013). Smallholder farmers as defined by the Ministry of Food and Agriculture (MoFA) (2011) refer to farmers whose land size is less than two (2) hectares. Ekboir *et al.* (2002) refers to smallholder farmers in Ghana as farmers cultivating on less than five (5) hectures of Land. Others also conceptualize smallholder farming in terms factors such the level of wealth or resources, vulnerability to climatic and economic shocks and the market orientation of farmers (Chamberlain, 2007; Dixion *et al.,* 2004). Like in many parts of SSA, agriculture in Ghana is predominantly smallholder in nature, accounting for about 90% of the farming activities (MoFA, 2011). Smallholder farming in the UWR is done mainly under rain-fed conditions, on traditional or family basis, and characterized by the extensive us of rudimentary tools such as hoes, cutlasses and bullocks but with little mechanization (GSS, 2013; MoFA, 2011).

Extant research on climate variability and change in Ghana and other parts of Africa have revealed that understanding the perceptions of smallholder farmers are critical for developing effective adaptation responses (Maddison, 2007; Jarawura, 2014; Mabe *et al.*,2014; Nhemachena *et al.,* 2014). Maddison (2007) argues that adaptation to climate variability and change actually consists of a two-stage process: first, the perception that the climate has changed and second, deciding whether or not to adopt a particular response. Ndamani and Watanabe (2015) posit that smallholder farmers' willingness to embrace and use a prescribed adaptation measure is enhanced if their perceptions of climate change are considered in designing such measures. Similarly, Kuruppu and Liverman (2010) also argued that farmers' perception on climate variability and change are often expressed and interpreted through personal life stories and experiences acquired in their continuous interaction with the local environment.

Maddison (2007) conducted a macro-scale study on the perceptions of farmers on climate change across ten (10) countries in Africa including Ghana. The findings of the study indicated that in 6 out of the 10 countries, over 50% of the respondents perceived that the climate has changed (increased temperature and decreased precipitation). For Ghana in particular, the study revealed that 62% of farmers perceived an increase in temperature whiles 57% have observed a decrease precipitation (ibid). Micro-level studies within Northern Ghana have shown similar trends in the perceptions of smallholder farmers on climate variability and change (Jarawura, 2014; Rademacher-Schulz *et al.*, 2014). It has been observed that farmers have noticed changes in the rainfall pattern, characterized by reduction in the amount of rainfall, shrinking in the length of the growing season and erratic rainfall pattern. Temperature on the other hand is also perceived by most smallholder farmers' to have increased (Mabe *et al.,* 2014; Ndamani and Watanabe *et al.,* 2015). Although some perceptions are not always consistent with reality, they could be meaningful and should be considered in addressing the biophysical and socioeconomic challenges posed by climate variability and change.

A study by Ndamani and Watanabe (2015) in the UWR revealed that smallholder farmers perceived such factors as deforestation, bushfires, gods or ancestral spirits as the cause of changing climate and variability. Similarly, a study by the British Broadcasting Corporation (BBC) World Service Trust (2010) in the UWR revealed that though most local populations do not properly understand the science of climate change, they have noticed changes in the climate of their surroundings (BBC World Service Trust, 2010).

Most literature on the perceptions of farmers on climate change shows that relatively experienced farmers are more likely to perceive climate change as compared to younger ones. Therefore in most cases a farmers' years of farming experience influences his or her perception on climate variability and change (Maddison, 2007; Deressa *et al.,* 2008).

Aside the biophysical factors that shape smallholder farmers' perception of climate variability and change, a range of social, cultural and economic factors may also influence perceptions (Maddison, 2007). He asserts that smallholder farmer perception on climate variability and change may be determined by level of poverty, gender, marital status, level of education, social status and whether the farmers' livelihoods are diversified or not. Also the proximity to market centres, access to extension services and weather information could also influence farmers' perceptions (Maddison, 2007).

2.4 Climate Change Impacts, Vulnerability and Social Differentiation

2.4.1 Climate variability and change Impacts

The threats posed by climate variability and change are already a reality for societies in the developing world, especially for indigenous and resource-poor communities (Kuruppu and Liverman, 2011). Studies have shown that even though Africa has historically been a marginal contributor (GHG emissions) to anthropogenic climate change, the continent is likely to be one of the worst affected by the impacts of climate variability and change due to low adaptive capacity (Niang *et al.,* 2014; Onykene and Madukwe 2010; Simmoes *et al.,* 2010).

Based on existing body of evidence, the economy of Ghana like that of many other SSA countries depend to a large extent on climate-sensitive agriculture (MacCarthy *et al.,* 2013; Adiku, 2013; Asafu-Adjaye, 2013). Climate variability and change therefore presents a huge setback on food security and development especially in areas that are currently food insecure (particularly Northern Ghana) (Rademacher-Schulz *et al.,* 2014; Akudugu and Alhassan 2012).

Although the impacts of climate variability and change has affected and will continue to affect all sectors in SSA, agriculture is regarded as the most vulnerable (World Bank, 2013; IPCC, 2014). Assessing the adverse impacts of current climate variability and change on crop productivity is very important for the formulation of effective and sustainable policy decisions on technological developments that could offset those adverse effects (MacCarthy *et al.,* 2013). Agricultural systems in Sub-Saharan Africa would be the hardest hit by the impact of climate variability and change because the region is confronted with repeated exposure to intense droughts, floods, and variability. This situation is further amplified by the over reliance of rain-fed agriculture for basic food security, livelihood and national economic growth (Padgham 2009; Olesen *et al.*, 2013; MacCarthy *et al.*, 2013).

Agricultural output especially crop farming in the semi-arid regions of Ghana and elsewhere have seen significant declines over the past few decades (Ebi *et al.*, 2011; Adomako and Ampadu, 2015). Although climatic factors may not be the only determinant of the declines in crop yields, climate plays a very vital role in crop productivity especially in semi-arid regions (Akudugu and Alhassan, 2012; Somah, 2013). Mawunya and Adiku (2013) assert that because weather and climate variables are rarely stable in semi-arid areas, agricultural systems dependent on these unstable factors (rainfall and temperature) are to a great extent prone to frequent high fluctuations and food insecurity issues.

Crop production is inherently sensitive to variability in climate. The connection between climate and agricultural productivity is established through a biochemical process known as photosynthesis. This is a process by which green plants synthesize organic compound from carbon dioxide and water using solar energy (Mawunya and Adiku, 2013). Therefore, rainfall and temperature (Olesen *et al.*, 2013) and levels carbon dioxide are key determinants of crop productivity (Mawunya and Adiku, 2013; Somah, 2013).

Under climate variability and variability, the impacts of water availability on agriculture in semi-arid regions occur in two folds. First, it has to do with water shortages brought about by droughts, dry spells and “false starts” especially at critical stages of plant development (Padgham, 2009; Padgham *et al.*, 2015). Studies have noted that low yields and crop failure in semi-arid areas such as Northern Ghana are linked mainly to droughts, dry spells, truncated length of growing season and decrease in total rainfall (Sarr, 2012; Mawunya and Adiku, 2013).

In Ghana, Mawunya and Adiku (2013) attribute dwindling agricultural output to two major climatic factors. First, the late onset and early cessation of rains during the cropping season resulting in moisture stress at critical stages of plant growth. The second id is drought, which causes insufficient moisture when plants need water to complete their life cycles.

Second, water could also cause low crop productivity through flooding or prolonged saturation of farmlands under climate variability and change (Lyimo and Kangalawe, 2010; Mawunya and Adiku, 2013). This condition creates anaerobic (low or no oxygen) soil conditions, that is detrimental to crop growth (Mawunya and Adiku, 2013). Also, Sarr (2012) and Sarr *et al.* (2015) revealed that the semi-arid regions of West Africa experienced several severe and destructive flood events particularly in the years 2007, 2008 and 2009. Armah *et al.* (2010) also noted that the 2007 floods in Northern Ghana wreaked massive havoc on resource dependent and poor communities along the Volta Basin. In a similar work by Tshakhert *et al.* (2010), it was revealed that in 2007 the floods led to the death of about 56 people and massive destruction of farmlands, food storage systems, irrigation systems and other infrastructure. Projections by most global or downscaled (regional or local) climate model ensembles indicate that climate variability and change will result in more frequent and intense extreme events such as floods, droughts, thunderstorms and heat stress (Padgham, 2009; World Bank, 2013; IPCC, 2013).

Temperature is another key climatic variable that influences crop productivity in diverse ways. This is however dependent on crop characteristics, the timing of heat stress relative to the stage of crop development and the condition under which the crop is grown (Padgham, 2009). Crop yields are very sensitive to warming temperatures. It has been observed that when temperature exceeds a certain threshold for some crops, yields decline significantly (World Bank, 2013). For example, significant yield losses are recorded when groundnut crop is exposed to air and soil temperatures above 35˚C during the reproductive period (Prasad *et al.,* 2000). The IPCC (2007) notes that even with moderate increases in temperature (about 1-2˚C), considerable declines in yields are likely for major cereals. Warmer temperatures may also cause high evapotranspiration in crops, leading to crop water stress (Ebi et *al.,* 2011: Sarr, 2012), thus resulting in reduction in optimum yields (Olesen *et al.*, 2013; Dube, 2013). This means that agricultural output in Ghana is likely to fall given that mean temperatures are expected increases by 0.6˚C, 2.0˚C and 3.9˚C by the years 2020, 2050, 2080 respectively (EPA, 2011).

Increased temperature along with low rainfall is identified to affect water resources. It is argued that increased temperatures will interact with decreased precipitation to increased evaporative demand in biophysical systems that underpin farming in SSA. This would negatively affect the balance in plant water requirements, soil moisture and river and lake flow and discharge and thus have negative impacts on agricultural productivity (Bates *et al.*, 2008).

Aside these impacts of climate change on agricultural activities, climate variability and change may also trigger other indirect impacts to amplify the direct effects (Mertz *et al.*, 2009). Local crop disease patterns may change due to more humid climatic conditions or warmer temperatures (aflatoxins in groundnut), thereby affecting crop production (Christoplos *et al*., 2009).

According to the IPCC (2014), SSA is one of the most vulnerable to the impacts of climate variability and change. It has been argued that the SSA's nearness to the equator influence its exposure to climate risks (IPCC, 2007). Another reason is that much of SSA depends directly to a very large on climate-sensitive resources and activities (agriculture) (World Bank, 2013). Also, SSA is faced with numerous other challenges that are not directly linked to climate change and variability including high population growth, diseases, conflicts, market failures, structural inequality and bad governance (World Bank, 2013). These factors interact with climatic stresses to amplify vulnerability and limit the adaptive capacity of African countries to mitigate the impacts of climate change (Westerhoff and Smit, 2009). Therefore a focus solely on climate-risk alone does not provide a deep understanding of the host of factors that interact to configure risks and exacerbate vulnerability (Nyantakyi-Frimpong and Bezner-Ker, 2015).

2.4.2 The Concept of Vulnerability

Adger *et al.* (2004) assert that interest in the climate change discourse has shifted from an impact-led approach to a vulnerability-led approach. To them the vulnerability-led approach examines how existing spatial, socioeconomic, institutional and cultural factors influence how people respond and adapt to climate-related hazards. Understanding the vulnerability of a system (region, community, or a household) presents a means of gaining insight into how the impact of climate change will be distributed within and across systems, as well as to identify how vulnerability can be reduced (O'Brien *et al.,* 2004). Vulnerability assessment is therefore a crucial tool for examining peoples' adaptation needs and priorities to inform policies that will reduce the risks associated with climate variability and change (Fussel and Klein, 2006).

Climate change vulnerability assessments are regarded as important because, while climate impact-led assessments are meant to address the magnitude and distribution of the effects of climate variability and change, vulnerability assessments highlights who is susceptible, how and why they are susceptible (Moss *et al.,* 2001). Climate scientists and social scientists tend to refer to different things when the term vulnerability is used. Whereas the climate scientists often perceive vulnerability as the likelihood of occurrence and impact of climate-related events, the social scientists view vulnerability as a set of socioeconomic elements that shape people's ability to cope or adapt to climate-related stresses or hazards (Brooks, 2003).

Studies have shown that there are three major approaches to understanding vulnerability to climate change (Fussel and Klein, 2006). These include the risk-hazard approach, the social constructivist framework and the integrated vulnerability approach.

Under the risk-hazard model (RHM), vulnerability is conceptualized as the dose-response relationship between an external hazard to a system and its adverse consequences (Fussel and Klein, 2006). Also known as biophysical vulnerability, Brooks (2003) describes the RHM as a vulnerability assessment based on hazard and their impacts, where the role of human systems as mediation factors on hazard events are downplayed or neglected.

The social constructivist framework or model conceptualizes vulnerability as an a priori condition of a household, a community or a region that is shaped by socioeconomic, institutional and political factors (Fussel and Klein, 2006). Brooks (2003) term this framework as social vulnerability where actual vulnerability is something that exists within a system (internal or inherent structural factors) independent of external hazard. Studies have shown that the social vulnerability of a system is determined by such factors as poverty, inequality, resources access, health and other non-climatic factors that exist in a social system (Adger and Kelly, 1999).

The third and final model frames vulnerability in an integrated perspective. It is a combination of the biophysical and social vulnerability approaches to systematically determine vulnerability (Deressa *et al.*, 2009). It is argued that the definition of vulnerability by the IPCC (2001) which encapsulates exposure (external dimension), sensitivity and adaptive capacity (internal dimensions) accommodates the integrated model (Fussel, 2007). The IPCC's Third Assessment Report (TAR) frames vulnerability as "a function of the character, magnitude, and rate of climatic variation to which a system is exposed, its sensitivity, and its adaptive capacity" (IPCC, 2001, p.995). Cutter's (1996) "hazard of place" model is a prominent example of the integrated framework.

This study uses the integrated vulnerability approach because it corrects the weaknesses of the other two approaches (Deressa *et al.*, 2009). Figure 2.1 depicts the integrated model of vulnerability, showing how processes and interactions from internal and external factors combine to shape net vulnerability.

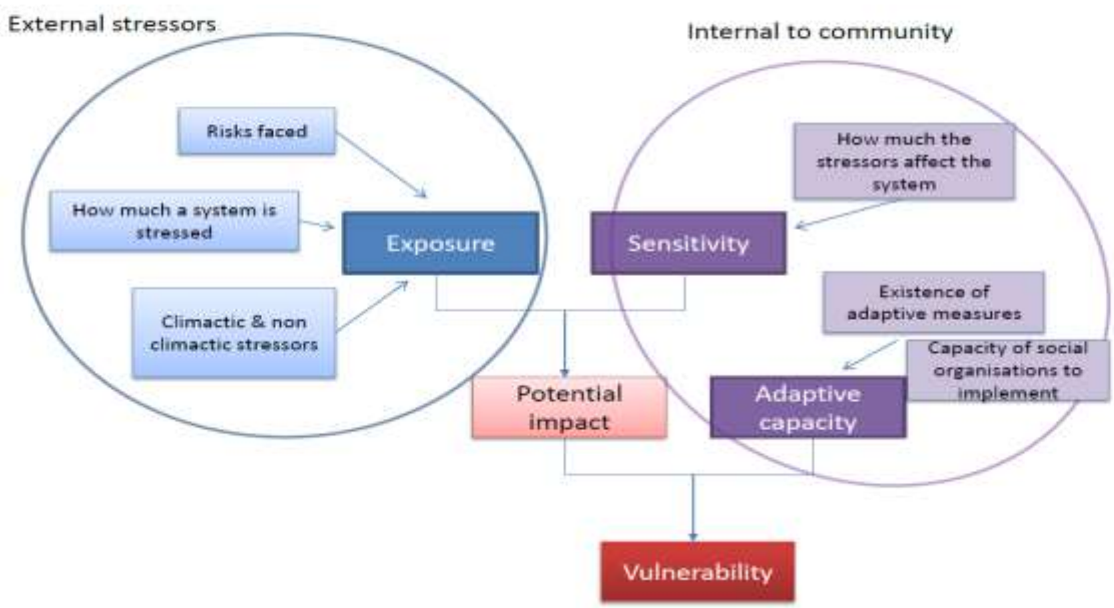

Fig 2.1 Integrated Vulnerability Framework

Source: Adapted from Allen Consulting (2005).

Smit and Wandel (2006) assert that analysis of vulnerability range in scale from an individual or household through to that of a community, to the vulnerability of the global ecosystem faced with single or multiple climate stresses. Similarly the time scale (instantaneous, months, years, decades centuries) and the phenomena of interest (biophysical, socioeconomic or both) may also vary considerably.

2.4.2.1 The Concept of Exposure

The semi-arid regions West Africa are regarded as one of the hotspots of exposure to climate risks since the 1980s. This high exposure stems from the frequent droughts and dry spells, intra-seasonal variability, higher temperatures, periodic severe flooding and harsh climatic environment (Padgham *et al.,* 2015). Future projections from models also indicate warming, drying and increased variability which will lead to increased severity and frequency of extreme events especially droughts in SSA (Boko *et al.,* 2007; Niang *et al.,* 2014). A number of authors point to the Northern Ghana as being the most vulnerable (in terms ofexposure) to droughts as the region is characterized by an increasingly erratic and unpredictable uni-modal rainfall regime and generally high temperatures (Akudugu *et al.*, 2012; Jarawura, 2014). Future climate projections for Ghana as indicated by the EPA (2011) points towards increased drought risks and a further truncation in the length of the growing season in semi-arid Ghana, with considerable implications for crop yields, food security and livelihoods (Antwi-Agyei *et al.*, 2012). In the Upper West Region, smallholder farmers are generally exposed to frequent droughts and intra- and inter seasonal variability as compared to floods, and this poses serious threats to food security and livelihoods (Nyantakyi-Frimpong and Bezner-Ker, 2015). Therefore exposure to climate-related stresses constitutes one of the biggest threats sustainable livelihoods and wellbeing in the semi-arid Ghana.

2.4.2.2 The Concept of Sensitivity

Climate sensitivity also feeds into the vulnerability situation of SSA where over 90 per cent of total crop land is rain-fed (Calzadilla *et al.,* 2009). Rrelative to other parts of the world, SSA is regarded more vulnerable due to its high dependence on natural resources and climate-sensitive economic systems and livelihoods (World Bank, 2013; Niang *et al,* 2014). Asafu-Adjaye (2013) reported that in Ghana and other African countries, rain-fed agriculture which is the main safety net employs about 70% of the population and contributes to about a quarter of the GDP. Similarly, agriculture in the Upper west region is the main source of food and household income for over 70% of the population (GSS, 2013). The work of Etwire *et al*. (2013) on Northern Ghana noted that the Upper West Region is the most sensitive to climate variability and change due its susceptibility and sensitivity to frequent droughts, dry spells and weather extremes. Antwi-Agyei *et al.* (2012) argue that across all the regions of Ghana overall crop yields are sensitive to climate perturbations, with the UWR being one of the most sensitive.

2.4.2.3 The Concept of Adaptive Capacity

Adaptive capacity is the third and final component that filters exposure and sensitivity to determine the net vulnerability of a system (IPCC, 2001). The adaptive capacity of a system (individual, household or community) represents their ability to adopt or take up adaptation strategies to moderate the adverse impacts of climate variability and change (Mabe *et al.,* 2012). The actual level of vulnerability is rarely due to only biophysical causes (exposure and sensitivity). Rather, vulnerability is a product of intersecting social, political, cultural and institutional processes that influences a systems ability to cope with biophysical or climate hazards (Smit and Wandel, 2006). It is these elements that shape and constrain the differential climate risks and adaptive capacities (IPCC, 2014). Brooks *et al.* (2005) and Niang *et al.* (2014) assert that the overall adaptive capacity in SSA is regarded as low due to economic, demographic, health, education, technology, infrastructure, governance, and natural challenges. According to Brooks (2003) adaptive capacity broadly constitutes the ability of a system to adjust, modify or alter its characteristics or processes to mitigate potential damage, take up opportunities or cope with the adverse effects of shocks or stresses. Jones *et al.* (2010) assert that adaptive capacity relates to behavioural changes as well as in technologies and resources. Bawakyillenuo *et al.* (2014) revealed that the determinants of adaptive capacity in farming systems in SSA include such factors as economic resources, infrastructure, education, knowledge and information, geographical location and access to land.

Sustainability in livelihoods can be best achieved if people are able to adapt to new circumstances (Ludi *et al.*, 2012). According to Milgroom and Giller (2013) adaptive capacity is context-specific and best understood through exhaustive and comprehensive studies of existing adaptive strategies.

Most assessments on the adaptive capacity of a system highlight such concepts as resources, livelihood assets or capital assets as factors that shape (enhance or inhibit) the capacity to adapt to climate-related shocks or stresses (Smit and Wandel, 2006; Lyimo and kangalawe, 2010; Coirolo and Rahman, 2014), with little or no room for assessment of adaptive capacity at the local or community levels where major adaptation interventions take place (Jones *et al.*, 2010).

Jones *et al.* (2010) argue that the Local Adaptive Capacity framework (LAC) which was developed under the Africa Climate Change Resilience Alliance-Project offers an effective framework for understanding and supporting adaptive capacity at the local level using a combination of intangible factors and asset-based elements. The LAC framework though similar the Sustainable Livelihood Framework, identifies five discrete yet interrelated features that shape local level adaptive capacity. These elements include: the asset base, institutions and entitlements, knowledge and information, innovation, and forward-looking decision-making as shown in Table 2.2 below.

Table 2.2 Five characteristics of the LAC framework and their features

Adaptive capacity at the local level	
Characteristic	**Features that influence a high/low adaptive capacity**
Asset base	Presence or absence of key assets that allow the system to respond to evolving or changing circumstances – natural, social.
Institutions and entitlements	Existence of an appropriate and dynamic institutional atmosphere that allows fair access and entitlements to key assets and resources.
Knowledge and information	Ability of a system to collect, analyse and disseminate information targeted at facilitating adaptive activities.
Innovation	Ability of a system to create an enabling environment that encourage and nurture innovation and experimentation in order to take advantage of new opportunities.
Flexible forward-looking decision making and governance	System's ability to accurately anticipate, incorporate and respond to changes through effective governance and planning.

Source: Jones *et al.* (2010)

The degree to which a community is capable of responding to changes in the external environment is influenced and shaped by these parameters (Ludi *et al.*, 2012). The elements in this framework may be present in different societies in varying forms (Jones *et al.*, 2010).

A study by Antwi-Agyei *et al.* (2012a) revealed that across the ten regions of Ghana, adaptive capacity is lowest in the three northern regions due to high levels of poverty. Adaptive capacity is generally determined by the capital asset base of a system as well as the presence of appropriate government and non-governmental institutions and policies that facilitate access to livelihood assets and entitlements (Antwi-Agyei *et al.*, 2012a). Therefore, in order to gain a realistic and comprehensive picture of adaptive capacity at the micro-scale, studies at household and community level is needed (Thornton *et al.*, 2010 in Milgroom and Giller, 2013).

2.4.2.4 Other Drivers of Vulnerability in Farming Livelihoods

Aside the biophysical and socioeconomic factors that shape the vulnerability of farming households or communities in the semi-arid regions, other factors and processes that are not directly linked to climate variability and change yet interact with climatic factors to shape vulnerability (Lyimo and kangalwe, 2010; Ebi *et al.,* 2011; Nhemachena *et al.,* 2014).

Atwi-Agyei e*t al.* (2012a) and Radermacher-Schulz *et al.* (2014) indicated that the inherent soil impoverishment in the savannah regions of Ghana adversely affect livelihood resilience of poor and resource-dependent communities. Quansah (2004 cited in Antwi-Agyei, 2012) revealed that most soils in these regions are characterized by stoniness, gravel and the presence of iron-pan, making soils poor in moisture retention and very low in productivity. In the savannah regions of Ghana and most semi-arid areas, continuous cropping of farmlands without the adoption of appropriate soil management techniques interact with climatic factors to influence declining soil fertility and low crop yields (Ebi *et al.,* 2011; Bawakyillenuo *et al.,* 2014; Adumaku and Ampadu, 2015). It is estimated in Ghana that, soil loss and fertility depletion has significant impacts on poverty as compared to the cases of no soil loss or depletion (Diao and Sarpong, 2007).

Further, reduction in ecosystem services in resource-dependent communities plays a key role in increasing vulnerability in semi-arid regions (Hassan and Nhemachena, 2008). In Northern Ghana, human activities and climatic factors drive ecosystem degradation (Akudugu and Alhassan, 2012) which provides services such as food, water, medicine, fuel and other socio-cultural benefits. Ecosystem services promote resilience and adaptation in resource dependent societies in semi-arid regions. Forest degradation, land degradation and desertification are contributors to the destruction of ecosystems in the semi-arid regions of Ghana (Padgham *et al.*, 2015). Therefore, vulnerability is heightened when ecosystem services are non-available to rural communities.

Pest and diseases is yet another problem that interacts with climate variability and change to shape vulnerability in agricultural livelihood systems (Akudugu and Alhassan, 2012). In a study by Etwire *et al.* (2013) on the adoption of adaptation strategies by farmers in Northern Ghana, they argue that, the pervasiveness of most adaptation strategies by farmers is as a result of increasing threats posed by crop pest and diseases among others. They further make a case that without the adoption of pest and disease management strategies, most farmers would suffer massive yield losses. Similarly Akudugu *et al.* (2012) also argued that even though timely interventions by the MoFA and some NGOs has over the years averted potential pest and disease outbreaks in Northern Ghana, some of the fringe areas still continue to battle with the incidence of pest and diseases due to their close proximity to Burkina Faso and Togo. The parasite *Striga* spp. which is prevalent in most parts of Africa including Ghana is capable of reducing crop yields by over half (Stringer *et al.*, 2007). In short, the incidence of crop pest and diseases are factors that that interacts with climatic factors (Antwi-Agyei, 2012; Laube *et al.*, 2012) to influence vulnerability, adaptation, food security and sustainable livelihoods in Northern Ghana.

Again, extant research has shown that price variability and volatility combine with climatic factors to negatively affect the wellbeing of resource-dependent rural households (Yaro, 2010; Antwi-Agyei, 2012; Wossen and Berger, 2015). The full adverse impacts of climate variability cannot be measured fully by changes in agricultural productivity alone, but rather by a comprehensive consideration of factors induced by market forces such as price changes, households' market position and their level of market integration (Hertel *et al.*, 2010). Rural farmers in the UWR as reported in a study by Rademacher-Schulz *et al.* (2014) observed that aside the decreasing household economic returns arising from declining crop yields and livestock productivity, volatility of food prices negatively affect food security and wellbeing. It is estimated for instance, that the global hikes in food prices in 2009 contributed to an additional loss of between 30,000 and 50,000 children suffering from malnutrition in Sub-Saharan Africa (Niang *et al.,* 2014). Price variability or market volatility in small scale farming in Ghana heightens vulnerability because in instances where household are unable to fetch good prices for their farm produce, it limits their ability to repay loans, cater for other household needs (health and education) and undertake effective climate change adaptation (Abu *et al.,*2013).

Last but not least, it is believed that population growth is one of the factors that may exacerbate vulnerability to climate change impacts (Simoes *et al.,* 2010; Shackleton *et al.,* 2015). Accelerated population pressure constitutes one of the non-climatic stressors that affect vulnerability to climate-related stresses in Sub-Saharan Africa (Antwi-Agyei, 2012). According to Nielsen and Reenberg (2010b) population growth influences farmers vulnerability by putting further pressure on the need to earn money to enhance food security. Again, studies have shown that population growth will put the resources on which the majority of people in Sub-Saharan Africa depend under stress (Hanjra and Qureshi, 2010; Laube *et al.,* 2012). The 2010 PHC data of Ghana estimated that the total population of the UWR increased by 21.8% over the 10-year period (2000-2010) (GSS, 2013). Should this decadal trend in population growth continue, the livelihood resources and ecosystems on which over half of the population largely depends could come under intense pressure and heighten vulnerability especially when no sustainable adaptation measures are put in place.

2.4.3 The Concept Social Differentiation under Climate-Related Hazards

In the context of climate variability and change impacts, social differentiation is a concept that is used to determine or examine how different groups are vulnerable, and identify specific risks they are vulnerable to (Padgham *et al.,* 2015). Under climate change and other related vulnerability the concept of social differentiation is much related to adaptive capacity. Social differentiation is generally recognized in most climate change vulnerability research (Adger, 2006; Heltberg *et al.,* 2009; Antwi-Agyei *et al.,* 2015). As argued by Heltberg *et al.* (2009) in their conceptual framework, social differentiation which shapes poverty and vulnerability is a product of the adverse structural context, which stems from formal and informal policies and institutions. They further make a point that structural traps including exclusion and discrimination reinforce poverty and vulnerability. In the developing world, people are usually discriminated against or socially marginalized on grounds of caste, disability status, ethnicity, gender, education, political affiliation and other social factors (Coirolo and Rahman, 2014).

Most studies on climate change in SSA have dwelled much on exposure to climate stimuli, with relatively less attention on sensitivity and adaptive capacity (Heltberg *et al.,* 2009). This impact-driven approach has largely influenced the adaptive responses adopted in many SSA countries, leading to tangential improvements in the lives of subsistence farmers. This is because non-climatic drivers of vulnerability were glossed over (Tschaket, 2007). In most instances, adaptive responses tended to overlook the spatial and context specificity in favour of a “one-size-fits-all” approach, lending such interventions insufficient attention to the indirect risks and marginalization of poor and vulnerable groups (Heltberg *et al.,* 2009). As clearly put by Tschakert *et al.* (2013), structural inequalities profoundly influence the severity with which extreme climatic events affect vulnerable groups. Padgham *et al.* (2015) argue that socially differentiated vulnerability to climate related impacts are shaped by varying levels of asset base, access to services and infrastructure, level of dependence on climate sensitive livelihoods and poor political agency. In the semi-arid Ghana which is predominantly rural, social groups regarded as most vulnerable include low income household engaged in farming and livestock keeping and lack diversified livelihoods. These include women (especially female household heads), the elderly, migrant settlers, illiterate, the sick and the disabled (Heltberg *et al.*, 2009; Carr and Thompson, 2013; Nyantakyi-Frimpong and Bezner-Kerr, 2015).

In rural Africa, gender differentiation is one of the main challenges women face in the livelihoods. As a source of vulnerability, gender differentiation emanates from historical social and cultural inequalities and roles ascribed in social and economic activities that are reflected in unequal access to decision making and resources, limited access to information, property ownership (land) and mobility (Ribot, 2010). Gender roles limit women's ability to engage in more productive activities as compared to their men counterparts. Most women in Africa suffer from "time poverty", that is, a situation where women and girls are allocated critically and time-consuming roles, which overburden them with responsibilities in the spheres of reproduction, production, household and the community at large. Women who spend their time performing these responsibilities are considered as "not working" (Abdourahman, 2010). In his study on the gender differences in "Time Poverty" in Zimbabwe, Arora (2013) revealed that 50% of women were "time-poor" as compared to 8% of men. Under poverty of time, women are less able to undertake income-earning activities. Time poverty is one of the factors that contribute to poverty and low asset base among women in Africa (Abdourahman, 2010; Arora, 2013). In Ghana, gender inequality or differentiation is one of the main factors that defines vulnerability in terms of access to education, employment, and the performance of domestic or household responsibilities (GLSS-5, 2008).

Another most important element that defines women's relative vulnerability is land access (Naab and Koranteng, 2012; Antwi-Agyei *et al.*, 2015). Due to existing traditional laws and customs on land ownership, women in most African countries own less than 15% of the land. This situation constrains women's adaptive capacity as it limits their income, access to credit and livelihood security (WEDO, 2008). In most parts of SSA, men control the access and decision making on land, therefore access to highly productive and fertile lands for farming is major challenge faced by women and migrants (Agana, 2012). Land tenure insecurity constitutes one of the main factors that heighten the vulnerability of both women and men in most parts of Ghana (Antwi-Agyei, 2012). Deressa *et al.* (2009) maintain that female headed households more likely to be vulnerable than male-heads because women's limited access to land, information and other assets could negatively affect their adoption of soil and water conservation strategies.

The socially differentiated patterns of climate-related vulnerability may also manifest in household characteristics, with factors such as size of household and level of education of household head combining with other climatic and non-climatic factors to influence vulnerability (Apata, 2011). Deressa *et al*. (2009) assert that a relatively large household size influences adaptive capacity in two ways. First, large families may be compelled to divert part of their labour force to off-farm jobs in order to relieve the consumption pressure imposed by large families (Yirga, 2007 cited in Deressa *et al*., 2009). Second, a large household size is normally endowed with high labour capability, which would enable easy and timely accomplishment of agricultural tasks. That is, households with fewer labour shortages at peak times are more likely to adopt adaptation measures and become more resilient than ones that have more labour shortages due small family size (Croppenstedt *et al*., 2003).

In some cases however, large household or family size may heighten vulnerability (Nyantaky-Frimpong and Bezner-Ker, 2015). In their study of the UWR, they revealed that some households were facing frequent food shortages as a result of their large size. Increased population (large household size) in the UWR is mainly as a result of uncontrolled births, with men with multiple wives and many children (Naab and Koranteng, 2012). In cases where the size of the family causes vulnerability to food shortages, men and some youth could be compelled to migrate to ease food security pressure on the household (Padgham *et al.*, 2015).

Existing research on the social dimension of climate-related hazards indicate that age constitutes one of the elements of vulnerability (Westerhoff and Smit, 2009; Heltberg *et al.,* 2009; Shackleton *et al.,* 2015). The elderly regarded as particularly vulnerable to climatic and non-climatic stressors as they are less able physically and financially to respond (Westerhoff and Smit, 2009). In the work of Naab and Koranteng (2012), they made a case that the elderly were unable to migrate as an adaptive measure due to frailty of infirmity of body. In circumstances where the migration of able bodied men and women to urban centres yields very little or no remittance flow, the elderly become helplessly vulnerable to shocks (Padgham *et al.,* 2015).

2.5 Groundnuts Production in Semi-Arid Regions

Groundnut (*Arachis hypogaea* L.) is an annual legume plant that comes from the pea family. It is also known as peanut, earthnut, monkey nut and poor man's nut in different geographic locations (Thornton and Cramer, 2012; Ani *et al.,* 2013). It is a native South American crop (Thornton and Cramer, 2012), but is successfully grown several parts of the world particularly in the semi-arid regions of Africa and Asia (Craufurd *et al.,* 2003). Worldwide, groundnut is grown in over 100 countries, with a global production of 68% and 25% concentrated in Asia and Africa respectively (Ntare *et al.,* 2008). Groundnut is one of the most important and universal oilseed crops in the world. Groundnut seeds contain 50% oil, 26-28% protein, 10-20% carbohydrate and are also rich in dietary fibre, minerals and vitamins (Okello *et al.*, 2010; Ekunwe *et al.*, 2013). In Sub-Saharan Africa, the cultivation of groundnut is mainly undertaken by smallholder farmers, using traditional methods (Ekunwe *et al.,* 2013).

4.5.1 Soil Requirements

Groundnut requires well-drained sandy loam that enables penetration of the pegs after pollination and easy harvesting without pod loss. Salinity and high soil acidity (pH<5) could affect effective plant growth due magnesium or aluminium toxicity (Ntare *et al.*, 2008). The top soil must have low clay content with a loose structure to enable peg penetration easily. Where the topsoil has a high percentage of clay groundnut pegs may break during harvest. Groundnuts are suitable on deep soils (900-1200 mm) (Cilliers, n.d).

4.5.2 Climate Requirements

Craufurd *et al.* (2003) and Ntare *et al.* (2008) indicate that the optimum temperature for cultivating groundnut ranges from 25˚C to 35˚C. Groundnut growth is also sensitive to photoperiodic changes. Generally groundnut is drought tolerant. However, high output is strongly linked to sufficient soil water content at sowing time and a fairly well-distributed rainfall. Rainfall requirement for early maturing variety such as the *Shitaochi* or "*China*" variety is about 300-500 mm while the medium to late maturing variety requires 1000-1200 mm (Ntare *et al.*, 2008).

2.5.3 Importance of Groundnut to Livelihoods

Groundnut is an important universal crop across the globe ranking fourth and thirteenth among oil and food crops respectively (Monyo *et al.*, 2012; Ani *et al.*, 2013; Ekunwe *et al.*, 2013). About 90% of the global production of groundnut occurs in the tropical and semi-arid tropical Africa (Abate *et al.*, 2012). In Ghana and other tropical countries groundnut is an important crop both as food for the household and a cash crop (Abate *et al.*, 2012; Angelucci and Bazzucchi, 2013). As a major source of nutrition, it can be consumed raw, cooked, roasted, can be used to make oil (Thornton and Cramer, 2012) or used as a confectionary and livestock feed (Craufurd *et al.*, 2003). As indicated by Ani *et al.* (2013), groundnut could be used to produce over 300 commercial products.

Groundnut as a cash crop is a major source of income for smallholder farmers in Ghana and other semi-arid areas (Abate *et al.*, 2012). Masters *et al.* (2013) argue that relative to other staple crops, groundnut is a high-value and readily marketable crop in Ghana. It can produce relatively high returns for limited land area as it is well adapted to semi-arid environments (Thornton and Cramer, 2012). A recent study showed that farmers in the UWR of Ghana were increasingly cultivating groundnuts because selling this major cash crop enabled them to buy food from local markets to sustain their families. They further made a case that, farmers in the area saw earning money from selling groundnut as crucial for ensuring food security. In that, in years where groundnut yields are expected to be low, most farmers decide to migrate as an adaptive or a risk management strategy Rademacher-Schulz and Mahama (2012).

One of the important reasons why groundnut is appealing to smallholder farmers in resource-poor semi-arid areas is the relative cost effectiveness in cultivating groundnuts. Christensen *et al.* (2002) studied groundnut production in UWR and revealed that most smallholder farmers were increasing their acreage under groundnut cultivation because groundnut required no fertilizer and fewer pesticides (less financial resources) as compared to the cultivation of cereals such as maize. Declining soil fertility could also be cited as one of the reasons for the shift in cropping patterns away from cereals to groundnut (Christensen *et al.,* 2004). Similarly, Okello *et al.* (2010) and Masters *et al.* (2013) also argue that in low-output agricultural systems in Africa, cultivating groundnut is attractive to smallholder farmers because it requires few inputs and maintains soil fertility by fixing nitrogen. Groundnut is considered as a women's crop because it was originally grown by women to supplement household protein (Kenny and Finn, 2004). Also, the harvesting, processing and marketing of groundnut is mostly done by women (Masters *et al.*, 2013).

As a legume crop, groundnut increases soil fertility by enriching it with nitrogen. Studied have shown that smallholder farmers are increasingly becoming aware that legumes like groundnuts not only act as food or commercial crops but also as soil fertilizers (Ani *et al.*, 2013).

2.5.4 Groundnut Production in the Northern Ghana

Groundnut is predominantly cultivated in the drier, northern half of the country characterized by Guinea and Sudan Savannah agro-ecological zones. These areas are conducive for the cultivation groundnut because the uni-modal rainy season is followed by a dry period that facilitates post-harvest processing and marketing. In Northern Ghana, nearly all (90%) farming households cultivate groundnut and about 72% of them sell some their produce. The three Northern regions produce about 94% of the groundnut in Ghana that is, 14%, 37% and 43% from the Upper East, Upper West and Northern Regions respectively (Angelucci and Bazzucchi, 2013).

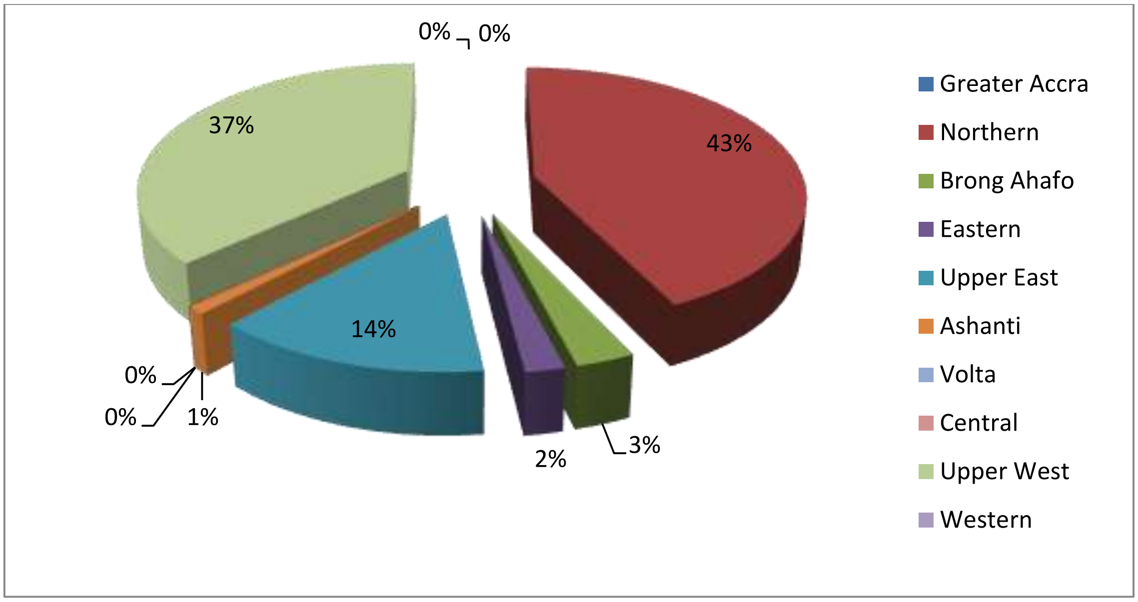

Figure 2.2 Production of groundnut per Region in Ghana (2010).
Source: MoFA, 2012

Groundnut production in the UWR is increasingly gaining grounds among smallholder farmers. Declining soil fertility and economic constraints are argued as the reasons why farmer have shifted from cereal production to groundnut (Christensen *et al.*, 2004). The average farm size for groundnut cultivation is 1.22 hectares (Abu, 2013). In the UWR, about 77% of the farmers cultivate groundnut for both consumption and commercial purposes, whereas 19% cultivated for purely commercial purposes (Abu, 2013). Although planting of crops is influenced by the onset of the rainy season, most farmers in the region sow their groundnuts between May and June (Christensen *et al.*, 2004). In the same study, the authors found that in the UWR five main variety types were cultivated. Three were indigenous varieties whereas two were improved (Chinese or *Shitaochi*, a 90-day maturing variety and *Manipinta*, a 120 day variety). About 73% of farmers grew the Chinese variety. Masters *et al*. (2013) also reveal that these two varieties remain the most widely cultivated across the country.

2.5.5 Challenges or Constraints in Groundnut Production in Northern Ghana

The main challenge affecting the higher yields and quality of groundnut in Ghana is intermittent drought due to erratic and highly variable rainfall pattern in Northern Ghana. Like other crops in semi-arid regions, groundnut is produced almost entirely without irrigation (rain-fed), thus making it more susceptible to the erratic and highly unstable single maxima rainfall pattern in Northern Ghana (Christensen *et al.,* 2004; Angelucci and Bazzucchi, 2013; Masters *et al.,* 2013; Kumar *et al.,* 2013; Rao *et al.,* 2015). Most varieties cultivated in Ghana and other semi-arid regions mature between 90 and 120 days, so when there is late onset and early cessation of rains yields loss or total crop failure is recorded. This increases the livelihood vulnerability of the poor smallholder farmer (Masters *et al.,* 2013).

Higher temperature also constitutes the main climatic variable that effects groundnut production in semi-arid regions (Craufurd *et al.,* 2003; Thornton and Cramer, 2012; Hamidou *et al.,*2013; Rao *et al.,* 2015). Significant yield losses are recorded when groundnut crop is exposed to air and soil temperatures above 35˚C during the reproductive period (Prasad *et al.,* 2000). Rao *et al.,* (2015) highlighted the detrimental effects of temperature on groundnut yield in semi-arid India by revealing that a yield decline of 21.7% and 26.5% was observed for rise in temperature by 1˚C and 2˚C respectively. Soil temperature beyond the optimum threshold causes decline in dry matter accumulation, flower production, peg and pod formation, and individual seed mass (Prasad *et al.,* 2000). Loss of seed viability may also come about as a result of storage at high temperature (Thornton and Cramer, 2012).

The high incidence of pest and diseases is another major problem facing groundnut farmers in semi-arid areas (Ekunwe *et al.,* 2013; Li *et al.,* 2013; Kumar *et al.,* 2013) both on the field and after harvest (Ntare *et al.,* 2008). The most common pests that destroy groundnut includes pod borers, millipedes, termites, the seed bug, the groundnut seed beetle and the Khapra beetle. When the environment is conducive in terms of weather (wet or dry spells) and food availability, pest population builds up, posing serious threats to farmers (Gadgil *et al.,* 2002). Aflatoxins contamination is also a big issue for resource-poor smallholder groundnut farmers in semi-arid regions who depend on for nutrition and income generation (Angelucci and Bazzucchi, 2013; Waliyar *et al.,* 2015). Aflatoxins are mycotoxins caused by the *Aspergillus flavus* and *Aspergillus parasiticus* fungi (Monyo *et al.,* 2012; Hamidou *et al.,* 2014). Aflatoxin contamination often occurs when crops are stressed by high rainfall, high temperatures, droughts and insect infestation both in the field (pre-harvest) and storage (post-harvest) (Monyo *et al.*, 2012). Studies have shown that consumption of high doses of aflatoxins is deadly (acute aflatoxicoses), while it may also cause liver cancer and liver cirrhosis when consumed in small quantities (Williams *et al.,* 2004 cited in Wilayar *et al.*, 2015). In Ghana, an estimated 5 to 15 per cent of groundnuts are discarded during sorting as a result of aflatoxins (Masters *et al,* 2013).

Groundnut production in semi-arid regions soils is faced with the problem of inherent low soil fertility and organic matter content (Christensen *et al.*, 2004; Abu, 2013; Hamidou *et al.,* 2014). Over the years, Northern Ghana has been experiencing declining soil fertility due to the mining of soil nutrients and erosion (Masters *et al.,* 2013). Similarly, Naab and Koranteng, (2012) and Wossen *et al.* (2014) also attributed declining soil fertility to environmental degradation caused by bush burning and felling of trees. In some cases decline in soil fertility and productivity in Northern Ghana is caused by continuous or over cropping on the same piece of land, with high poverty levels preventing smallholder farmers from adopting appropriate soil management strategy (fertilizer) (Antwi-Agyei, 2012). Where farmers do not own the land and risk losing it at any time, they are much reluctant to invest in any type of soil fertility improvements (Masters *et al.*, 2013).

Another constraint of farmers in Northern Ghana as highlighted in the literature is access to credit and inputs (Armah *et al.,* 2010; Wossen *et al.*, 2014). The presence of these assets is crucial in enhancing adaptation to climate variability and change (Fosu-Mensah *et al*., 2012). Antwi-Agyei (2012) found in Northern Ghana that most household lack access to credit, making it difficult for them to purchase inputs such as improved varieties. In groundnut production in particular, farmers in the UWR as shown by Christensen *et al.* (2004), ranked lack of access to credit as their third most important problem after inadequate rainfall and declining soil fertility. Angelucci and Bazzucchi (2013) argue that the relatively little or no fertilizer use in groundnut production could be due to farmers in ability to purchase or lack of knowledge on fertilizer use.

As indicated by Al-Hassan *et al.* (2006) and other studies (e.g. Antwi-Agyei, 2012; Nelsen and Reenberg, 2010b), limited access to stable markets for produce is a major problem facing smallholders in Ghana, citing high volatility as a key factor that hinders effective market participation. Unfavourable market conditions constitute one of the most pressing constraints faced in groundnut production in UWR (Abu, 2013).

2.6 Adaptation to Climate Variability and Change

Adaptation to climate variability and change has in recent times become a pressing issue particularly in the developing world (Eriksen *et al.*, 2011). Studies have shown that a certain degree of climate change is inevitable regardless of reduction in GHG emissions due to the historical emissions and the inertia of the climate system (Matthews and Caldeira, 2008).

Adaptation is therefore critically important to sustain the earth's systems and to avoid dangerous climate change (Eriksen *et al.*, 2011).

Adaptation to changing circumstances has been an innate attribute in human systems (Stringer *et al.*, 2009). Therefore adaptation in farming is not a new phenomenon in SSA (Vogel, 2005). As put by the IPCC (2007), adaptation refers to the adjustments in practices, processes and systems to mitigate or tone down the negative effects and capitalize on the opportunities associated with climate change. It includes activities that are deliberately done in response to multiple stresses and changes that affect peoples' lives (Stringer *et al.*, 2009). Adaptation in the context of agriculture is therefore a suite of pre-emptive activities undertaken to lessen the negative impacts envisaged under climate variability and change (Ndamani and Watanabe, 2015).

Due to high dependence on climate-sensitive and fragile economic systems, the adverse impacts of climate variability and change are expected to weigh heavy on resource-poor societies in SSA (Laube *et al.*, 2012). Adaptation in this context becomes highly imperative in order to sustain the predominantly agrarian livelihoods in these societies (Adger *et al.*, 2003).

In understanding adaptation to climate variability and change in the context of agriculture and rural livelihoods, adaptive capacity are important. Coping or adaptive capacity are elements of adaptation that are situated in the wider sociocultural, religious and political milieus of any society. Therefore in order for climate change adaptation to be successful, policy makers must consider these processes (Anwi-Agyei, 2012).

2.6.1 Types of Adaptation to Climate variability and change

Studies have identified various types of adaptation but the fundamental forms of adaptation to climate variability and change in agriculture are autonomous and planned adaptations (Dinar *et* *al.*, 2008). Autonomous adaptation is defined as actions that take place in reaction or response to changes occurring in climatic variables independently or without the intervention of a public institution or agency (Smit and Pilifosova, 2001). These include strategies implemented by individuals or agents on mostly temporary basis depending on the availability and accessibility of resources (adaptive capacity) to adopt strategies (Dinar *et al.*, 2008). For example changing planting times or seasonal migration adopted by rural farmers in Northern Ghana in reaction to climatic stresses (Bawakyillenuo *et al.*, 2014). Planned adaptation on the other hand, embodies a suite of deliberate and well-informed policy choices or response strategies, often multi-sectorial in nature, targeted at improving the adaptive capacity of farming a farming system or to facilitate a specific adaptation (FAO, 2007). Planned adaptation may either be anticipatory (seeking to tackle future climate stresses) or reactive (tackling adverse climate effects based on past experience) (Smit and Pilifosova, 2001). For instance, putting up irrigation infrastructure constitutes a planned adaptation strategy (Antwi-Agyei, 2012).

2.6.2 Adaptation Strategies to Climate change and Related Stresses

Responses to stresses posed by climate change and other related problems have become very important in rural farming systems in SSA as documented by several authors (Nyantakyi-Frimpong and Bezner-Ker, 2015; Bawakyillenuo *et al.*, 2014; Mertz *et al.*, 2009). The adaptation strategies or responses by farmers are not only limited to tackling climate variability and change, but also in response to evolving socioeconomic and political challenges that interact to shape the vulnerability of livelihood systems in rural and resource-poor societies in SSA (Mertz *et al.*, 2010; Nielsen and Reenberg, 2010b).

Adaptation strategies are grouped into on-farm and off-farm strategies. On-farm adaptation strategies include agronomic practices that aim at taking advantage of the harsh climatic conditions to improve crop growth and yield. Whiles off-farm strategies consist of activities undertaken outside the farm in order to lessen livelihood vulnerability to climatic and other related challenges stresses (Antwi-Agyei, 2012). Table 2.4 shows the adaptation strategies used by smallholder famers in Ghana and many African countries.

These adaptation strategies constitute the general responses adopted to manage livelihood risks and vulnerability in Ghana and other African countries. The adoption of adaptation practices as argued by many authors are shaped by the relative adaptive capacities of individual farmers or households (Bawakyillenuo *et al.,* 2014). Socioeconomic factors such as age, gender, level of education, wealth, cultural norms and practices, household size, geographical location and land tenure (Coirolo and Rahman, 2014). The presence/absence of Political and institutional interventions also play a key role in shaping adaptive capacity (Yaro *et al.,* 2014). As argued by Agrawal *et al.* (2009) local institutions play a central in shaping climate change adaptation by; linking individuals or households to local resources and collective action; serving as nexus between remote populations and national interventions; and determining the flow of external support to different social groups. Table 2.3 shows common adaptation strategies adopted by smallholder farmers in Ghana as indicated in literature.

Table 2.4 Common adaptation strategies adopted by smallholders

On-farm adaptation strategies	Source in literature	Off-farm adaptation strategies	Source in literature
Changing planting dates	Ndamani and Watanabe (2015)	Livelihood diversification	Bawakyillenuo *et al.*, (2014)
Planting early maturing varieties	Antwi-Agyei (2012)	Selling of livestock	Antwi-Agyei (2012)
Planting drought-tolerant crops	Etwire *et al.* (2013)	Changing dietary habits	Rademacher-Schulz *et al.* (2012)
Crop diversification	Ndamani and Watanabe (2015)	Temporary migration	Rademacher-Schulz *et al.* (2012)
Crop rotation	Naab and Koranteng (2012)	Reforestation	Mertz *et al.* (2009)
Agro-forestry	Antwi-Agyei (2012)	Avoid (by punishment) and extinguish bush fires	Mertz *et al.* (2009)
Use of irrigation	Etwire *et al.*, (2013)	Relying on family and friends	Antwi-Agyei (2012)
Change in tillage practices	Bawakyillenuo *et al.*, (2014)	Support from government and NGOs	Yaro *et al.*, (2014)
Application of fertilizer and other inputs	Etwire *et al.*, (2013)	Reliance on indigenous knowledge and external climate information	Naab and Koranteng (2012)
Composting and manure	Nyantakyi-Frimpong and Bezner-Ker (2015)		
Index-based weather risk insurance	Bawakyillenuo *et al.*, (2014)		

2.6.3 Barrier to Climate Change Adaptation among Smallholder Farmers

The implementation of climate change adaptation strategies in Ghana and other SSA countries may be impeded by several barriers (Ndamani and Watanabe, 2015; Antwi-Agyei *et al.,* 2015b; Nielsen and Reenberg, 2010a). As defined by the IPCC in AR4, barriers or limits to adaptation are those conditions or obstacles that make effective and sustainable response to climate variability and change unachievable (Adger *et al.,* 2007). A lot of studies have failed to highlight how behavioural, socioeconomic and institutional factors may shape adaptive strategies. This has led most adaptation interventions to adopt a one-size-fits-all, thus lending such interventions to maladaptation. Therefore understanding the barriers to adaptation could help improve current and future responses in order to reduce vulnerability and enhance resilience (Antwi-Agyei, 2012). Barriers to adaptation are not only limited to climatic factors but also non-climatic factors as well (Mertz *et al.,* 2010). In most adaptation literature the common barriers identified are discussed below.

2.6.3.1 Financial Barriers

In Ghana and many SSA countries financial constraints constitute one of the biggest impediment to effective adaptation to climate change and related stresses (Antwi-Agyei *et al.,* 2015b, Ndamani and Watanabe, 2015). It is argued that the use of any form adaptation including the use of improved groundnut seeds entails financial costs. But most farmers in Northern Ghana often report lack of finance to purchase these inputs (Peterson, 2013). This situation often leads to farmers seeking to use their stored seeds. Financial difficulty may also reflect smallholder farmers' inability to access credit facilities thus limiting their ability to improve production (Bryan *et al.,* 2009 cited in Antwi-Agyei *et al.,* 2015b).

2.6.3.2 Socio-Cultural Barriers

In Northern Ghana and many African countries belief and cultural systems influence the effective implementation of adaptation responses by individuals and households (Antwi-Agyei *et al.,* 2015b; Nielsen and Reenberg, 2010a). In Northern Ghana, cultural norms governing the land tenure systems prevent women from owning land (Bugri, 2008). Also social and cultural norms limit female migration in the UWR (Rademacher-Schulz and Mahama, 2012). These cultural arrangements constrain women's adaptive capacity.

2.6.3.3 Climate Information Deficits

Effective adaptation to climate variability and change can be spurred by access to accurate climate data. This is however a problem in Ghana particularly in the UWR (Ndamani and Watanabe, 2015). Naab and Koranteng (2014) assert that accurate and reliable climate information enables smallholder farmer to manage risks and enable adaptation because it offers farmers the opportunity plan for droughts or floods. Antwi-Agyei *et al.* (2015b) argues that lack of state-of-the-art equipment at meteorological station across West Africa and within countries could be responsible for the lack of climate information. This is further heightened by inability to access information due to high illiteracy rates (Naab and Koranteng, 2014) and lack of access to electronic gadgets (radio sets, mobile phones or television sets (Ndamani and Watanabe, 2015). As a result, most rural farmers in Ghana tend to depend on the less robust and reliable indigenous knowledge for forecast (Antwi-Agyei *et al.,* 2015b).

2.6.3.4 Lack of Infrastructure including Markets

The adaptive of capacity of rural population in the context of climate variability and change is enhanced by the presence of infrastructure such as storage facilities, good roads, irrigation facilities and ready market where farmers can buy improved varieties and agro-chemicals to boost their capacity to adapt (Antwi-Agyei *et al.* 2015b). In Northern Ghana as argued by (Rademacher-Schulz and Mahama, 2012) poor infrastructure is one of the drivers of vulnerability in livelihood systems. Poor infrastructure has led to limited markets access in many farming villages across Ghana (Antwi-Agyei *et al.* 2015b).

2.6.3.5 Institutional Constraints

Institutions (formal and informal) play a central role in shaping climate change adaptation (Yaro *et al* 2014). Institutions are a set of rules, norms and strategies that determine individual or organizational behaviour (Koelble, 1995 cited in Yaro *et al.,* 2014). Local institutions as argued by Agrawal *et al.* (2009) shape climate adaptation in three ways; first by connecting households to local resources; by creating a nexus between local population and national interventions; and finally dictating the flow of external support to different social groups. The roles played by Government and NGOs in enabling adaptation in rural and resource-poor societies in SSA cannot be downplayed. However, the top-down approach adopted by central governments often constrains the adaptive capacities of local actors. Most government institutions overseeing climate change adaptation are also constrained by understaffing, thus making it difficult to reach the overwhelming numbers of local populations. Lack of funds and logistics also sets constrains on the capacity of institutions (government and NGOs) to promote effective adaptation (Antwi-Agyei *et al.,* 2015b).

2.7 Conceptual Framework of the Study

The thrust of this study is to understand the different factors that shape vulnerability withi different social groups particularly groundnut farmers in the UWR of Ghana. A vulnerability study provides a starting point for tracing the social causality vis-à-vis biophysical processes and their inter-linkages (Hesselberg and Yaro, 2006). The conceptual framework used for this study as shown in Figure 2.3 was adapted from Gbetinuou *et al.* (2010). The original framework was used to analyse the vulnerability of South African agriculture to climate variability and change by comparing vulnerability indicators (Gbetinuou *et al.,* 2010).

Under this study however, the vulnerability of groundnut farmers with socially differentiated characteristics is shaped by a combination of biophysical and socioeconomic factors that interact at varying degrees. Net vulnerability is determined by potential impacts from biophysical elements (exposure and sensitivity) and adaptive capacity from socioeconomic elements.

Potential impacts emanate from the exposure to climate variability and change and the sensitivity of ecosystems and livelihood systems. Manifestations of climate variability and change include events such as droughts, dry spells and floods. Sensitivity is reflected in the over reliance on rain-fed agriculture, impoverished soils and fragile ecosystems as evident in the UWR (Padgham *et al.*, 2015). The combination of these elements (exposure and sensitivity) constitutes the potential impact that can determine the vulnerability of groundnut farmers in the UWR.

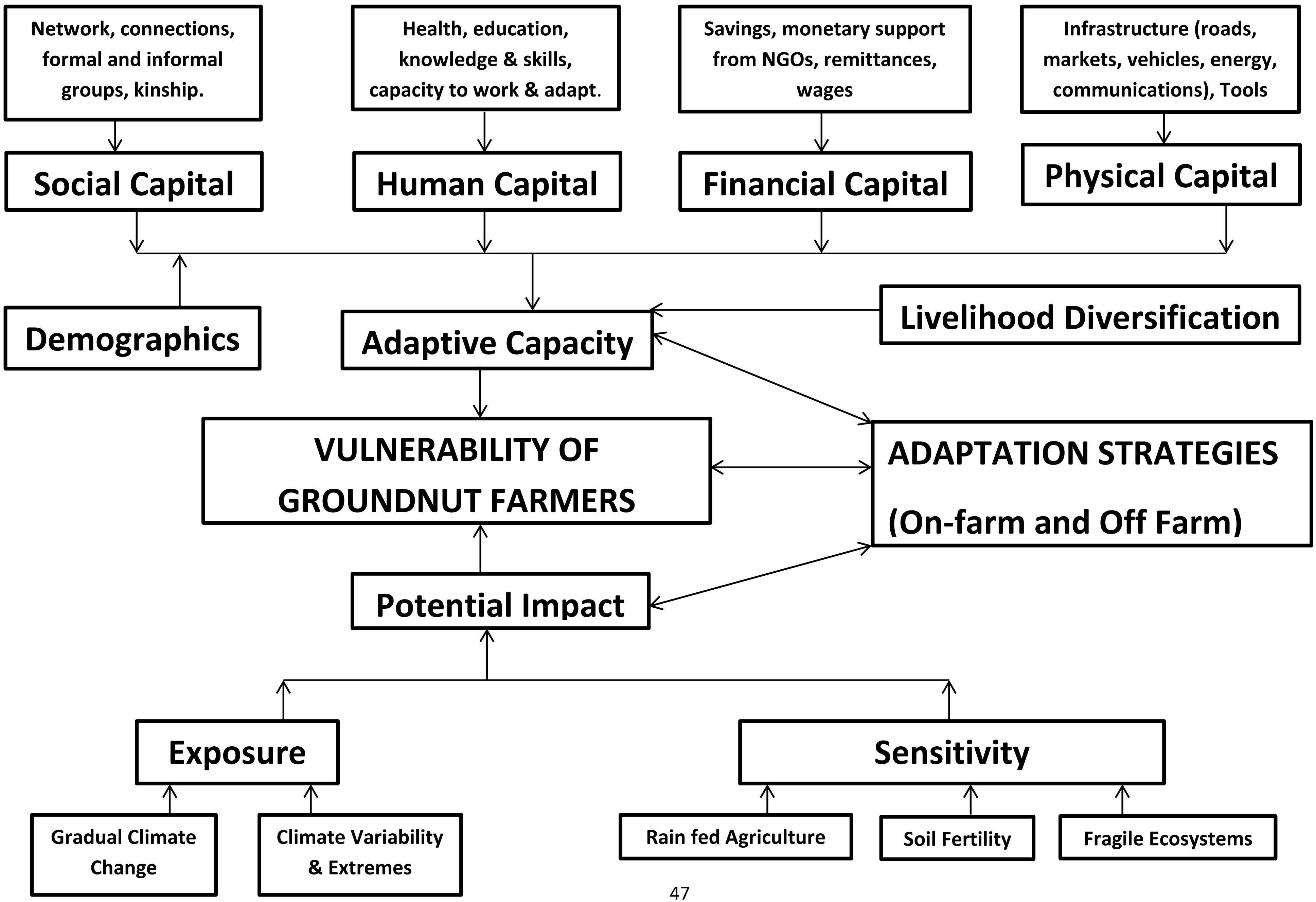

Figure 2.3 A Conceptual Framework for the Study Adapted from: Gbetibuou et al., (2010)

The adaptive capacity refers to a range of factors that presents groundnut farmers the opportunity to lessen or minimize the potential impacts emanating from exposure and sensitivity. The adaptive capacity of groundnut farmers depends on their asset base (human, social, physical and financial), demographics (gender stereotypes), adaptation strategies and other livelihood portfolios (Hesselberg and Yaro, 2006).

A good capital asset base may present groundnut farmers the opportunity adapt in order to lessen the potential impacts from the stresses to reduce vulnerability, while lack of capital assets could also combine with potential impacts to heighten vulnerability in their livelihoods. Human capital entails networks, formal and informal group membership and kinship ties that influence adaptive capacity. Human capital consists of such factors as health, education, knowledge and skills that may enable farmers to adapt to lessen potential impacts. Financial capital entails savings, wages, remittances and monetary support from government agencies and NGOs could enhance the coping capacity of farmers. While physical capital is made up of infrastructure (roads, markets, machinery) that could facilitate adaptation to climate change and other related challenges. In SSA where pre-existing cultural and structural conditions exist demography and social differentiation shape entitlements and access to capital assets (Hesselberg and Yaro, 2006).

Adaptive capacity, which is influenced by the asset or capital base of the farmer, which in turn determines the type of adaptation responses and livelihood diversified to be adopted to lessen vulnerability. That is, adaptive capacity shapes the adaptation responses and the livelihood portfolios of farmers across different social groups in the UWR.

Therefore, the actual vulnerability of groundnut farmers within different social groups is an interaction between potential impacts from biophysical factors and adaptive capacity of farmers.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter presents the research methodology that guides the entire research process. It encapsulates background information on the study areas and the procedures for the selection of the study areas, methods, sampling, research instruments, data collection and data analyses.

3.2 Description of Study Area

3.2.1 Location of Study Area

This study was conducted in the Upper West Region ($1^o25''$ and $2^o45''$ W; $9^o30''$ and 11^o N) located in North-West of Ghana. The region shares borders with Burkina Faso to the north, to the south with the Northern Region, to the east with the Upper East Region and to west with La Cote D'voire. The region covers a land size of 18,476 square kilometres, which is about 12.7% of the total land of Ghana and a population of 702,110 (GSS, 2013).

3.2.2 Vegetation and Climate

The Upper West Region falls within the Guinea savannah belt in the southern fringe of the West African Sahel (Nyantakyi-Frimpong and Bezner-Ker 2015). It has a unimodal rainy season, starting from April to September, with an annual average of about 115cm. This is followed by a seven-month dry season characterized by a cold and hazy weather known as harmattan. The monthly mean temperature ranges between 21^oC and 32^oC even though temperatures could go as high as 40^oC in March. The common trees within this region are baobab, *dawadawa,* acacia, Shea and neem.

3.2.3 Relief, Soils and Drainage

The region is generally flat in topography with an average height of between 275m and 300m above sea level, except eastwards of Wa where the land rises over 300m above sea level. Soil types in the region include the Savannah ochrosols, tropical brown yeast, terrace soils found along the banks of rivers and streams, and groundwater laterites (GSS, 2013).

3.2.4 Economic Activities

The majority of the people in the region are peasant farmers, mostly done on family basis. Farming is both done on subsistent and commercial basis (GSS, 2013). Crops cultivated in the region include maize, millet, sorghum, groundnuts, rice, yam, soya beans and cowpea. Livestock (pigs, cattle, goats, sheep and poultry) rearing is also common in the region (GSS, 2013). It is widely believed throughout the region, by administrators as much as farmers, that the overall quantity of rain falling is declining and that the distribution is more unfavourable than before (Blench, 2006).

Figure 3.1 shows the map of the study areas and the specific study communities in the Upper West Region of Ghana.

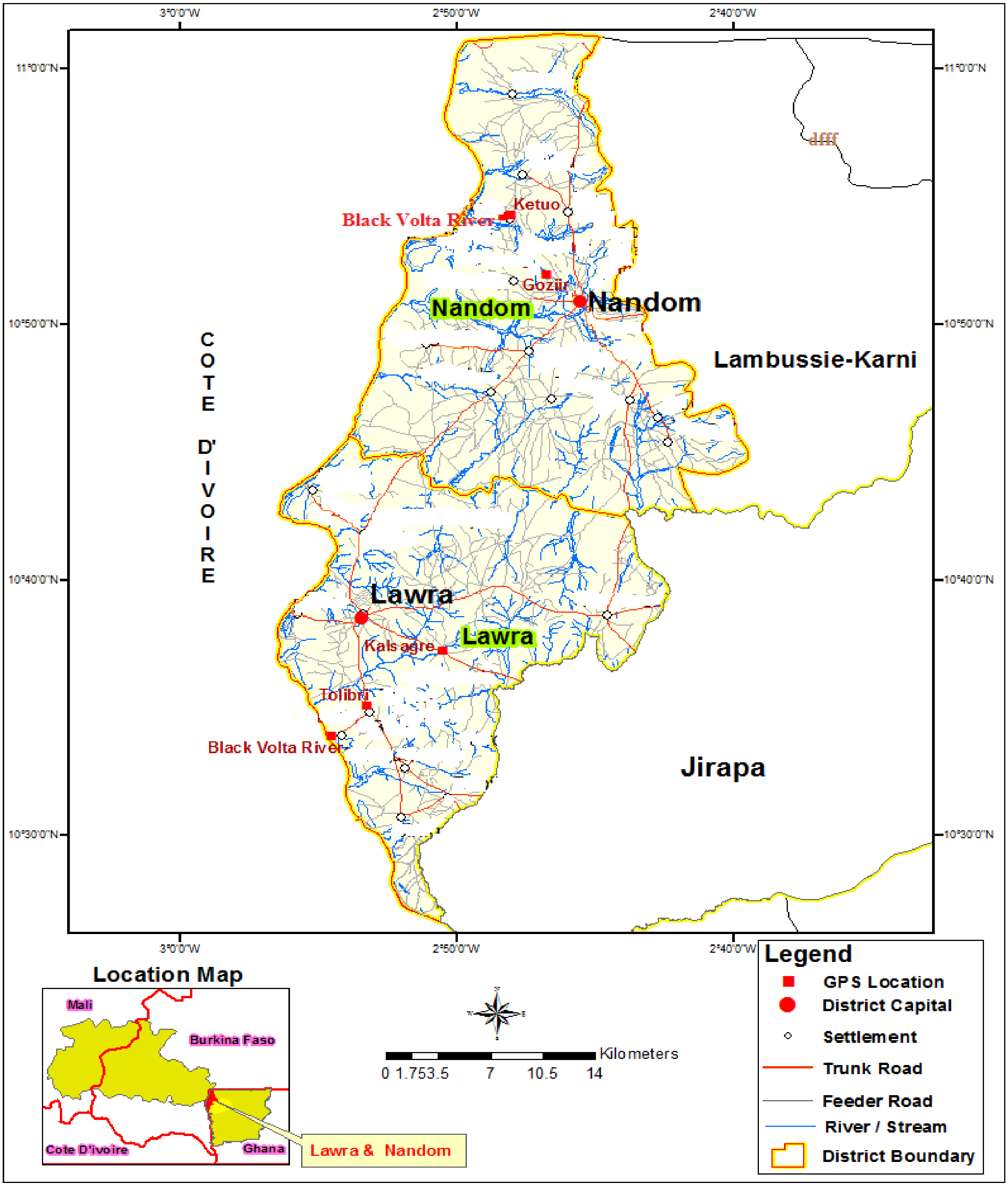

Figure 3.1 Map of study area

Source: Ghana Water Research Institute (2015).

3.3 Research Design

The study was conducted using the mixed method approach, that is, a combination of both quantitative and qualitative research designs (Creswell, 2009). Antwi-Agyei *et al.* (2012) argue that because climate variability and change are complex societal problems that interact with different processes, a mixed method approach is suitable for a holistic understanding of the various dimensions of the problem. The qualitative aspect of the research helps to explain and explore the experiences, attitudes and life circumstances of the people in the context of the phenomena under study (Bryman, 2001). The quantitative part uses statistical techniques to analyse quantifiable aspect of the research problem and make prediction and generalization (Teye, 2012). Mixed methods are based on the idea that no single approach ever really solves, delineates, or validates a particular problem (Creswell and Plano Clark, 2011). Thus, it involves the adoption of both approaches in tandem in order to strengthen the study over either qualitative or quantitative approach (Creswell, 2009). It is regarded as an effective means of comprehensively cross-validating data from multi-methods. Thus in some instances, researchers use quantitative evidence to validate qualitative claims and the vice versa (Sharan, 2002 as cited in Teye, 2012).

The mixed method approach is however criticized as having the tendency to expand the scope of a study beyond the initially planned (Teye, 2012). That is, in trying to get the appropriate research questions right under this approach, it could lead to *"broadening the scope of the study beyond the optimal"* (Teye, 2012).). Moreover, this approach is not appropriate under time and resource constraints. This is because mixed method is regarded as expensive and time-consuming as compared to either qualitative or quantitative approaches (Creswell *et al.*, 2003; Teye, 2012). Studies on climate change that have adopted the mixed method include Lyimo and

Kangalawe, (2010), Nielsen and Reenberg (2010), Antwi-Agyei *et al.,* (2015), and Nyantakyi-Frimpong and Bezner-Ker (2015).

3.4 Source and Nature of Data

Both primary and secondary data were collected from the study area

3.4.1 Primary Data

It is argued by Robson (2002) that primary data is very vital in research because it enhances the researcher's ability to tackle the most important concerns in the research context. The primary data was obtained using individual questionnaires, focus group discussions (FGDs) and key informant interviews (KII). The questionnaire and FGD data collection were carried out with the help of two (2) field research assistants. This was due to the fact that the researchers was not familiar with the study communities and the common language (Dagaare) spoken in the study area. Therefore in situations where the use of the English language was not possible (such as in most FGDs and some questionnaire administration), the research assistants acted as translators to facilitate communication.

3.4.1.1 Focus Group Discussions

Qualitative data was obtained from focus group discussions (FGDs) with smallholder groundnut farmers in the study sites. The use of participatory methods of data collection are regarded as a very effective in eliciting farmers' understanding about climate change and the utilization of uncertain climate information (Roncoli e*t al.,* 2009). FGDs were conducted to obtain detailed information from farmers using semi-structured interview guides. FGD make way for group interaction that may be absent in one-on-one interview (Darlingtion and Scott, 2003) and allow the exploration of varied meanings rural smallholder farmers have about climate change variability (Bryman and Bell, 2007). The main objective of the FGDs is to gain a deeper understanding on the perception climate change and variability, the importance of groundnut production in their livelihoods, the factors that drive vulnerability in groundnut production systems and the coping or adaptation strategies under a socially differentiated lens. The Dagaare language was used to conduct FGDs since most people in the communities could not speak the English language. The data from the FGDs were collected via tape recording with each session lasting between 90 and 120 minutes.

3.4.1.2 Key Informant Interviews

Qualitative data was also obtained through key informant interviews (KIIs) with stakeholders such as local leaders, representatives from local level government institutions and non-governmental organization that provide support and interventions on livelihoods particularly groundnut farming in the districts of study. KIIs also sought to gain in-depth information on the roles played these local institutions, their perceptions on livelihood vulnerability and how their interventions have influenced vulnerability or wellbeing of different social groups. The key local stakeholders interviewed during the study included officials from the District Department of agriculture (DoA) under MoFA, and NGOs such as ACDEP and NANDRIDEP and some community leaders. KII were conducted in English language as all respondents in this group could speak English. This data was collected via tape recording and taking notes. Generally, each interview took between 60 and 90 minutes.

3.4.1.3 Questionnaire Survey

Semi-structured individual questionnaire were used to gather quantitative data to complement the data obtained from the FGDs and the KIIs. The survey questionnaire was prepared after a review of relevant literature and pre-tested for content, context and clarity. The sort of information gathered from the questionnaire included demographic and socioeconomic data, perceptions on vulnerability in groundnut production and coping or adaptation strategies used by farmers. The survey was conducted using a combination of both English and Dagaare languages depending on the respondent's ability to speak English or not.

3.4.2 Secondary Data

Secondary data was collected from the department of agriculture under the MoFA in the Districts and a review of available and relevant literature and information on the topic area including reports and working documents prepared by government agencies and NGOs. The review of literature for secondary sources of data also included archival research from books, journal articles, magazines, articles, published and unpublished theses, videos, related websites, and other related information.

3.5 Sampling Method and Sample Size

A multi-stage sampling procedure was adopted considering the nature of the study. First, the Upper West Region was selected purposefully because studies have shown evidence of climate change and variability in the region (Rademacher-Schulz *et al.,* 2014; Ndamani and Watanabe, 2015; Nyantakyi-Frimpong and Bezner-Ker, 2015). Also, evidence shows that the Upper West Region is relatively the most vulnerable regions to the impacts of climate change and variability in Ghana (MESTI, 2013; Etwire *et al.*, 2013).

Secondly, simple random sampling was used to select two (2) out of eleven (11) the districts in the region. The two (2) districts are the Lawra and Nandom Districts. This study did not set out to do a comparative study on the two districts. The two (2) districts are used because they were once under a single district (Lawra District) until June 2012. In June 2012, the Nandom District was carved out of the Lawra District (GSS, 2013). However, although Lawra and Nandom now have their own districts, some government institutions and agencies such as the DoA under MoFA still has one office located in Lawra, overseeing agricultural activities in both districts.

Abu (2013) found that the annual groundnut outputs from the two districts were relatively low as compared to others in the region. Also, data from the DoA (2016) under MoFA shows that in 2014, the estimated area under groundnut cultivation for both Lawra and Nandom was 18,272 hectares, with an estimated average yield of about 12,795 metric tons compared to a regional average of about 14,751 metric tons.

Out of 54 and 62 communities in the Lawra and Nandom Districts respectively (DoA-Lawra, 2016), two (2) communities were randomly selected from each district for the study. The communities selected were part of several communities visited during a reconnaissance survey in September 2015, during which time community members indicated the sort of stresses they faced in their main livelihood activity (farming) and the evidence that they were experiencing the impacts of climate change and variability.

Table 3.1 showing study Districts and Communities used for the study

Name of District	**Community One**	**Community Two**
Lawra	Kalsagre	Tolibri
Nandom	Goziri	Ketuo

Source: Computed from Fieldwork (2016)

The Slovin's formula (1960) for sample determination was used to calculate the sample for the study. It is denoted by the equation:

$$n = \frac{N}{1 + Ne^2}$$

Where ***n*** is the sample of the population

N is the size of the population

And, e^2 is the margin of error which is always constant (0.05).

According to the DoA in Lawra (2016), the total number of smallholder crop (groundnuts) farmers in both districts is about 69,000. So using the Slovin's formula to calculate the sample for the study, it is shown as follows.

$$n = \frac{N}{1 + Ne^2}$$

$n = ?$

$N = 69{,}000$

$e^2 = 0.05$

$$n = \frac{69{,}000}{1 + 69{,}000\,(0.05)^2} = 400.$$

Therefore *n* (sample size) is equal to 400.

However due to financial and time constraints, the original sample size of 400 was reduced to 180. It was also assumed that the focus group discussions and key informant interviews data would help offset the number reduced since the study used a mixed method approach. So the questionnaire survey was conducted with a sample size of 180 respondents.

For the focus group discussions, a total of eight (8) FGDs were conducted during the study. Two (2) FGDs were held in each community (one with males and the other with females). The reason for the gender disaggregation is that in societies where cultural and structural barriers or inequalities exist as in Northern Ghana, women are generally reluctant to participate when an elderly male or male member of the household is present (Kuruppu and Liverman, 2011). Each

FGD consisted of individuals between 10 and 15 selected irrespective of any social, religious or economic considerations.

Purposive sampling was used to select the interviewees of the key informant interviews. Marshal (1996) argues that this sampling strategy is used by researchers who actively want to select the most productive and credible respondents to answer a particular research question. To him this is a more intellectual strategy though age, gender, or social class might be important variables. The key informants were drawn from local level institutions that were directly or indirectly engaged in activities related to agriculture and adaptation to climate change impacts through policies, programs or interventions in the study areas. A total of five (5) key informant interviews were conducted during the study consisting of personnel from the DoA under MoFA.

Table 3.2 Key Informants interview in the study

Key Informant Interviewed	**Number Interviewed**	**Name of Organization/Institution**
District Crops Officer (for both districts)	1	DoA under MoFA
Agricultural Extension Officer	1	DoA under MoFA
Project Manager/Chairman of CCAFS	1	NANDRIDEP/CCAFS Platform
Project Desk Officer	1	ACDEP/RESULT Project
Opinion Leader	1	Community Leader

Source: Computed from Fieldwork (2016)

Convenience sampling technique was used to obtain the respondents of the questionnaire survey as used by Lawson *et al.* (2016). That is, a sample is obtained based on the availability, accessibility and readiness of target respondents to participate in the survey (Marshal, 1996; Frey *et al.*, 2000 as cited in Latham, 2007). This technique was used because the researcher could not obtain a sample frame for the target respondents in the study areas. Out of the 180 target respondents, 45 smallholder groundnut farmers were selected from each community. The survey questionnaires were administered to groundnut farmers within the selected communities irrespective of gender, age, level of education, marital status, socioeconomic status and physical/disability status. This was to avoid a preconceived notion that some social groups are vulnerable as compared to others.

3.6 Data Analysis

The study systematically harmonized both the qualitative and quantitative data in such a way that they could meaningfully tackle the research objectives and questions of the study.

The qualitative data from FGDs were translated into English by linguistic experts. Both the FGDs and KII were transcribed manually, categorized into themes and interpreted in line with research objectives. The quantitative data on the other hand were edited, cleaned and entered into SPSS software. The SPSS software was then used to analyse data by running descriptive statistics; mainly frequencies, means and crosstabs. The analyses from the SPSS Version 21 software were then imported into Microsoft Excel version 2010 to generate statistical computations such as frequency tables and charts. Inferential statistics in the form of chi-square test and binary logistic regression were also used to analyse the relationship between some adaptation strategies and social groups and incomes of farmers respectively.

Crosstabs, frequency tables and chart were generated to present demographic and socioeconomic characteristics of groundnut farmers in the study areas.

The factors influencing vulnerability in groundnut production were presented mainly from the issues that came up from the FGDs. Responses from the questionnaire presented in the form of charts, percentages and frequency tables and crosstabs were used to support the data obtained from the FGDs.

Frequency tables were generated to show farmers' adaptation strategies based on the survey data as well as reasons for their inability to adopt some strategies. A table was also generated based on the FGDs to show the adaptation measures adopted but were not captured in the questionnaire.

A binary logistic regression was run to predict how the adoption of some adaptation strategies influences farmers' incomes from groundnut sales. Also a Chi-square test was run to examine if there was relationship between the adoptions of some adaptation strategies were socially differentiated (gender, age and landownership).

The implication of adaptation interventions on the wellbeing or vulnerability of different social groups was analysed thematically from the qualitative data from the KII.

3.7 Ethical Considerations

Ethical clearance to undertake study was sought from the University of Ghana Department of Geography and Resource Development under the Climate Change and Sustainable Development Programme. In the study area, the permission of gatekeepers (chiefs, individuals from relevant agencies or organizations, assembly men and others in authority) was sought before commencing this study.

Also, all respondents were informed of the nature of the study to get their consent before proceeding with the interview. Research participants were not exposed any risk of physical and psychological threat. Participation in the research was voluntary and respondents had the right to partake or not. They could even quit in the middle of participation without providing a justification for their actions. In this study however, none of the respondents declined from participation. Participants in the study were assured that the data would be used for academic research purposes only and would be handled properly to guarantee their safety and confidentiality.

CHAPTER FOUR

RESULTS AND FINDINGS

4.1 Introduction

This chapter presents the results and findings of the study. The description of demographic and socioeconomic characteristics of groundnut farmers in the Nandom and Lawra Districts are presented. Further, it shows factors that influence vulnerability in groundnut production. It also presents the adaptation measures adopted by groundnut farmers and how these adaptation strategies vary across different social groups. Finally, it highlights the implications of current adaptation interventions on vulnerability and wellbeing of groundnut farmers within social groups.

4.2 Demographic Characteristics of Surveyed Groundnut Farmers

This section discusses demographic characteristics of surveyed farmers. The characteristics discussed are gender, age, marital status, household size, and religion among others.

4.2.1 Gender of Surveyed Farmers

Table 4.1 shows that majority of the respondents, corresponding to about 57% were female whiles the remaining 43% were male.

4.2.2 Age of Respondents

The age distribution of the surveyed farmers shows that their ages range from 21 to 80 years. The mean age was 47.5 years. Majority of the farmers (35.6%) were within the ages of 46-55 years while 7.8% of the respondents were 66 years and older.

Table 4.1 Demographic Characteristics of Surveyed Groundnut Farmers

Characteristic/Grouping	Mean	Min.	Max.	Frequency	Percentage (%)
Gender					
Male				77	42.8
Female				103	57.2
Age	47.52	24	80		
Under 25				1	0.6
26-35				29	16.1
36-45				50	27.8
46-55				64	35.6
56-65				22	12.2
66 and Older				14	7.8
Marital Status					
Unmarried				3	1.7
Married				144	80.0
Widow(er)				33	18.3
Religious Affiliation					
Christian				145	80.6
Traditional				35	19.4
Islam				0	0
Size of Household	7.26	2	21		
Under 4				18	10.0
5-8				115	63.9
9-12				41	22.8
13 and Above				6	3.3
Ethnicity					
Dagaaba				176	97.8
Waala				4	2.2
Disability Status					
None				163	90.6
Sight (Blind)				8	4.4
Hearing				3	1.7
Movement				6	3.3

Source: Computed from Survey Data (2016).

4.2.3 Marital Status of Respondents

Out of 180 respondents as shown in Table 4.1, majority (80%) of groundnut farmers were married while 18.3% and 1.7% were widowed and unmarried respectively.

4.2.4 Size of Household

Mean household size of the respondents in the study area was 7 (7.26) and ranged from a minimum 2 to a maximum of 21. Based on the 2010 Population and Housing Census (PHC) the average household size is about 6 for both Districts whiles the region's average household size is 6.4 (GSS, 2013). Majority (63.9%) of the households have between 5 to 8 people whiles 22.8% of the households have between 9 and 12 people. Only 3.3% of the households have people more than 13.

4.2.5 Religious Affiliation of Respondents

The majority (80.6%) of farmers surveyed profess the Christian faith while 19.4% profess African Traditional Religion (ATR). None of respondents belonged to the Islamic religion.

4.2.6 Ethnic Distribution

The ethnic distribution of the surveyed farmers in the area shows a fairly homogeneous pattern, where 97.8% of the respondents are Dagaabas and the remaining 2.2% belonging to the Waala ethnic group.

4.2.7 Disability Status of Respondents

The results of the study also revealed that about 91% of the respondents were without any form of disability. While the remaining 9% included respondents with various forms of disability such as sight, hearing and movement. PWD are defined as person who are unable to or restricted in the performance of specific tasks as a result of loss of function of some parts of the body due to impairment (GSS, 2013).

4.3 Socioeconomic Characteristics of Surveyed Farmers

4.3.1 Educational Level of Surveyed farmers

The results of the study shows that majority (68.3%) of the farmers have no formal education, with more female (47.2%) illiteracy than male (21.1). About 15% of respondents (8.9% males and 6.1% females) have primary school education. It further shows that 14.5% of the respondents have secondary education, with more males (10.6%) than females (3.9%) in this category. Only 2.2% of the respondents in the survey had tertiary level education and no women were found in that category.

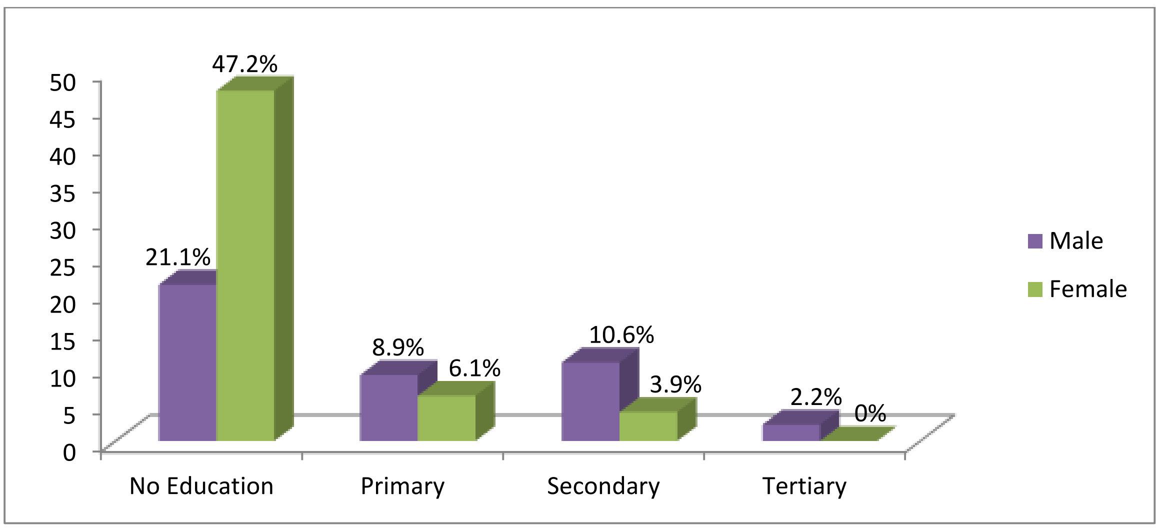

Figure 4.1 Level of education of respondents

Source: *Computed from Survey Data, 2016*

4.3.2 Land Access/Ownership

The findings of the study reveal that majority (62.2%) of the respondent do not own land, with only 37.8% of them being landowners. Because majority of the respondents were females, 42.2% of them indicated they borrowed the land from their husbands, while 16.1% and 3.3% of the respondents (both males and females) stated that they borrowed their lands from relatives and friends respectively as shown in Figure 4.2.

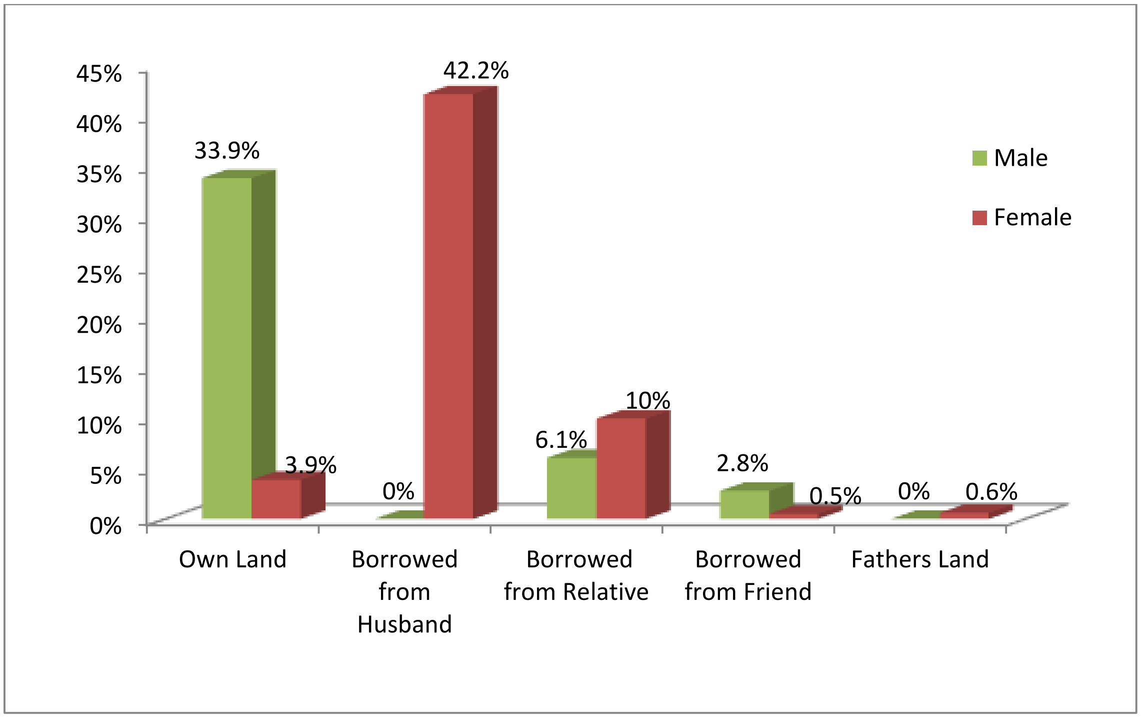

Figure 4.2 Land access distributions by gender
Source: *Computed from Survey Data, 2016*

4.3.3 Farm Size of Respondents

The mean farm size from the survey was about 2.29 acres, with a minimum size of 0.5 acre and a maximum of 6 acres. The findings also show that majority of the females had relatively smaller fields as compared to their male counterparts. The analysis show that farm sizes ranging between 0.5 and 1 acre was cultivated by females only, with a distribution of 6.1% and 29.4% respectively. Also, 29.4% of the respondents farm on 2 acres land size (that is, 17.2% females and 12.2% males). 13.3% of the farmers had lands that were 3 acres in size and while those with 4 acres and over constitute about 22%. The majority of the farmers, who cultivate on lands that are 3 acres and above, were males as shown in Figure 4.3.

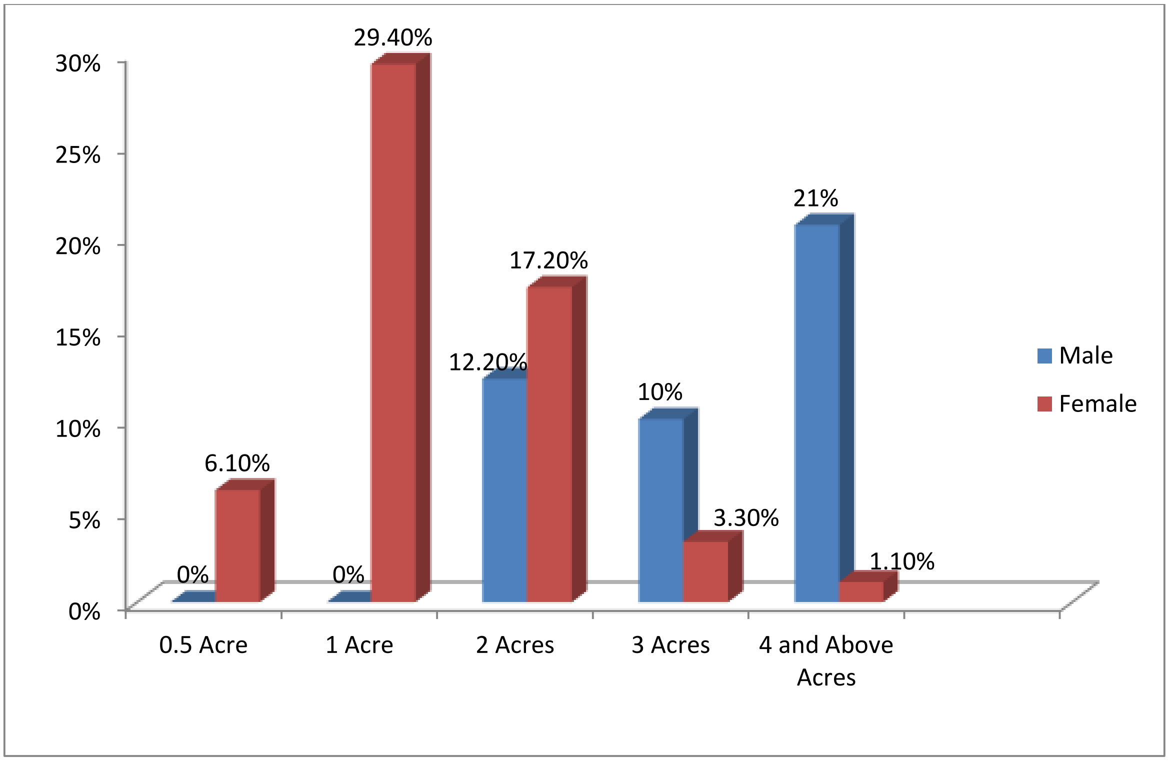

Figure 4.3 distribution of farm size based on gender
Source: *Computed from Survey Data, 2016*

4.3.4 Farming Experience of Surveyed Farmers

The survey revealed that farmers have on the average 20 years of farming experience. The minimum and maximum farming experience were 4 and 50 years respectively. Majority (about 40%) of the farmers had experience ranging between 11 and 20 years. This is followed by 30% of respondents with years of farming, between 21and 30 years. Farmers with experience under 10 years were about 17%.

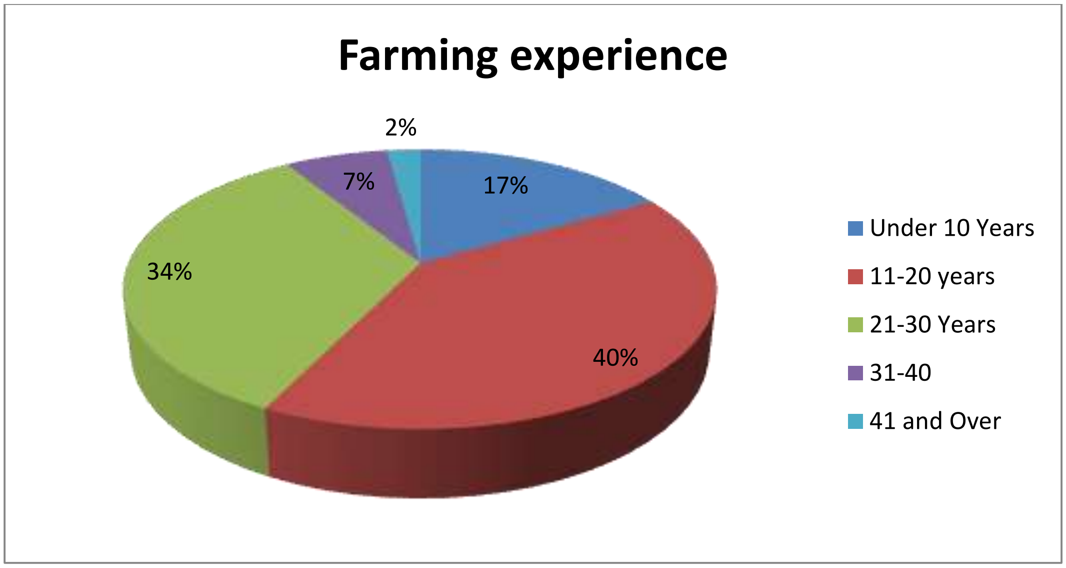

Figure 4.4 Farming experiences of respondents

Source: *Computed from Survey Data, 2016*

4.3.5 Reasons for Farming Groundnuts

About 92% of the famers' surveyed indicated their cultivation of groundnut is for both household consumption and commercial purposes, while only about 8% indicated that it was solely for household consumption.

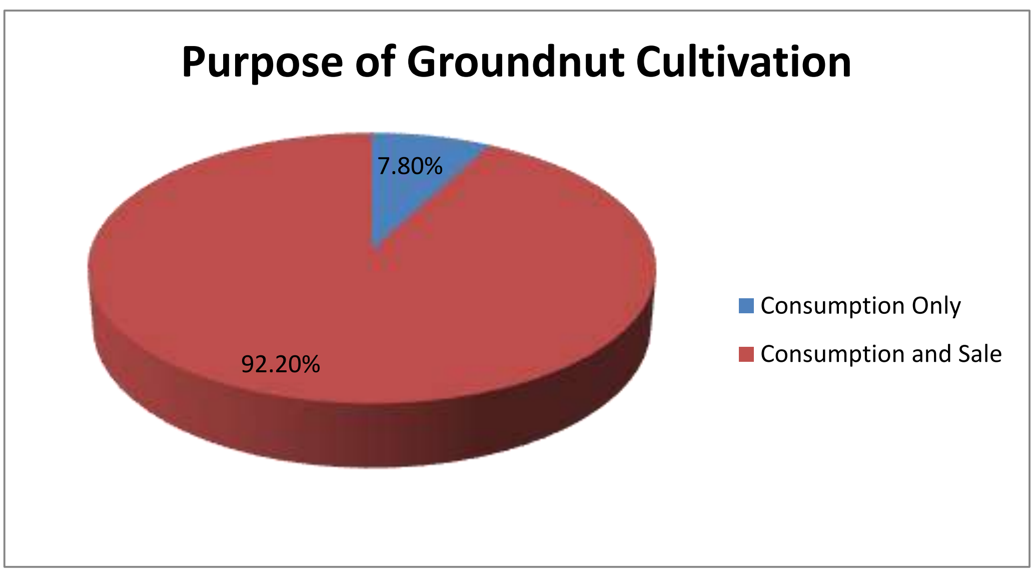

Figure 4.5 Purpose for cultivating groundnut
Source: *Computed from Survey Data, 2016*

4.3.6 Income Estimates per Season

The study shows that the mean annual (seasonal) income from the sale of groundnut was about GH¢200. About 55% of the respondents earned between GH¢100 and GH¢300 per season while 22.3% earn between GH¢400 and GH¢600. 18.3% of the famers earn below GH¢100 while only 2.4% of them earn GH¢700.

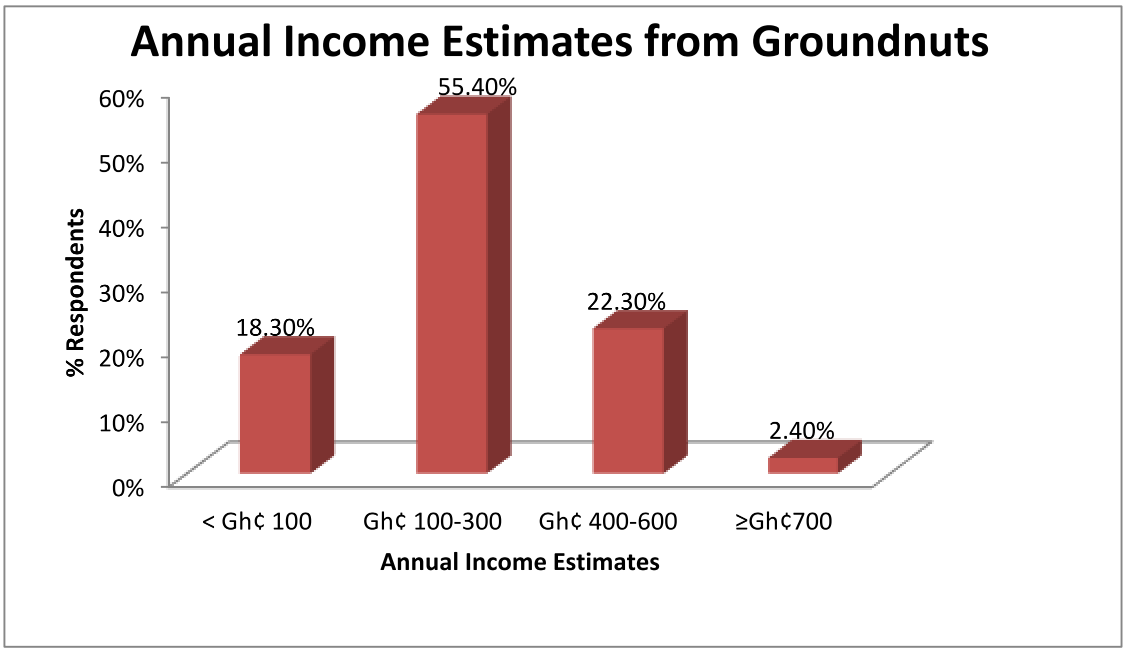

Figure 4.6 Annual income estimates of groundnut farmers

Source: *Computed from Survey Data, 2016*

4.3.7 Reasons for Selling Groundnuts

Groundnut is regarded by farmers as their main cash crop as it has over 90% market participation. Majority (46.6%) of the famers stated that groundnut was sold to cater for the school and health needs of their households while 34.8% of them indicated that they sold groundnut to buy other food stuff to sustain their households. Another 12.4% and 6.2% stated they sold to buy farm inputs and pay for labour respectively. This is displayed in Figure 4.7.

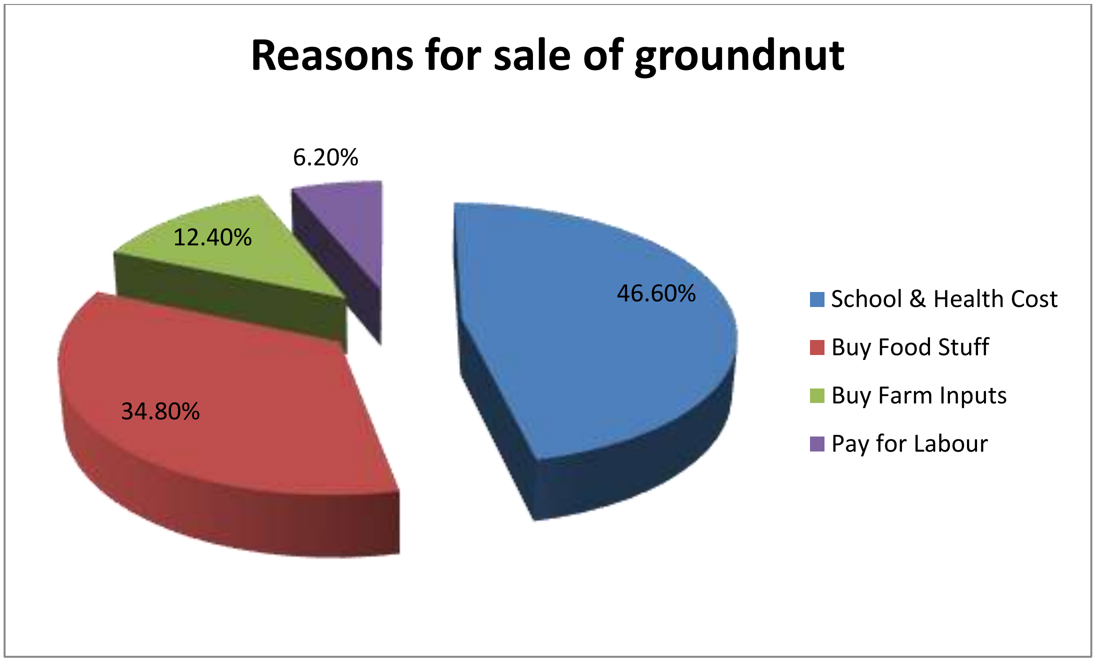

Figure 4.7 Reasons for selling groundnut
Source: *Computed from Survey Data, 2016*

4.4 Factors that Influence Vulnerability in Groundnut production

This section presents the findings on objective one (1) of the study. Here the factors identified by groundnut farmers as drivers of vulnerability in groundnut production are examined. These include a combination of climatic and non-climatic elements that operate in varying degrees to affect groundnut production, the main cash crop in the study areas. The problems named in this section were examined in both the survey and FGDs.

4.4.1 Erratic and Variable Rainfall Patterns

Findings from the study show that groundnut farmers regard the current rainfall pattern as the main threat to groundnut production. Respondents' perception on rainfall shows that about 61% noted a decreasing trend while about 32% noted a variable/unpredictable pattern. Only about 7% noted an increase in rainfall. Drought was identified as one of the main threats to groundnut production; where about 69% of the respondents stated that drought occurrence has become intermittent in the study areas. About 26% indicated they experience drought frequently.

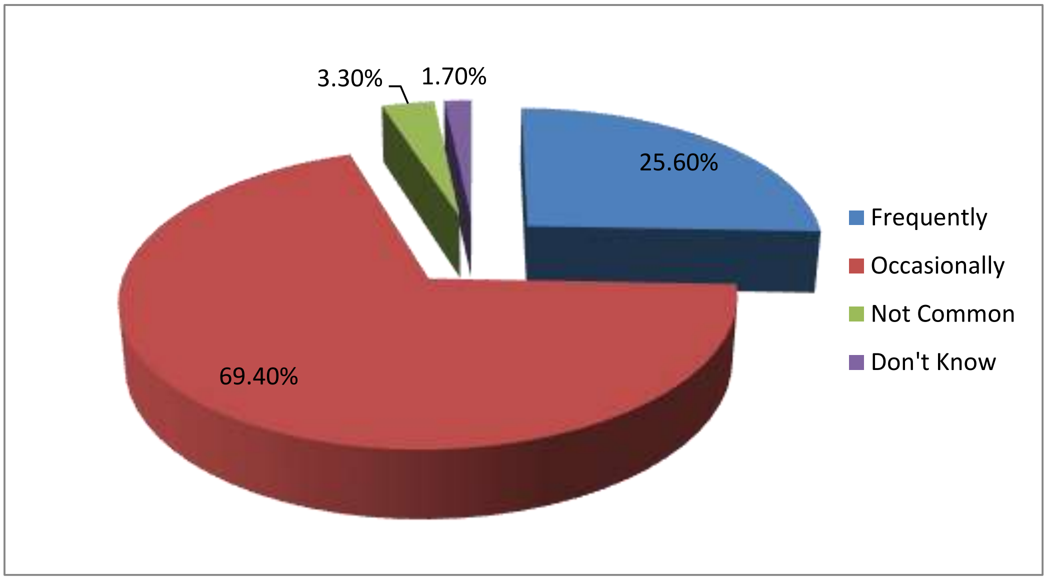

Figure 4.8 Farmers experience of drought occurrence
Source: *Computed from Survey Data, 2016*

About 89% of the farmers identified the effects of rainfall on groundnut production as shown in the Table 4.2.

Table 4.2 Perceptions of the effects of rainfall pattern on groundnut production

Effects	Percentage of Respondents
Yield loss due to no rain (land dryness) at harvest	31.7%
Poor seed formation due to low rainfall during pegging	30%
Seed loss due to rain failure after planting	11.7%
Crop failure due to late onset and early cessation of rain	13.9%
Promotes pest and disease infestation (Aflatoxins)	1.7%
Total	**89%**

Source: Computed from Survey Data, 2016

From the survey, 31.7% of the respondents noted yield loss at harvest due to land dryness at the time of harvest as the main effect of lack of rainfall, while 30% stated that crops suffer poor seed formation due to drought during pegging of groundnut crop. About 14% argued that crop failure occurred due to late onset and early cessation of rainfall. Only 1.7% mentioned pest and disease infestation.

With respect to floods however, most of the respondents (78.9%) did not see the occurrence floods as a source of vulnerability in crop production. Only 6.7% of them, particularly in Ketuo stated they frequently experience flooding of their farms which are near the Black Volta.

> "*... Some years ago we used to start planting our crop between April/May and the rains end in October/November but these days the rains usually start in June and end by October. We sometimes lose our groundnut seeds after planting when there is drought or long dry spells after early rains. So if you are not able to buy new seeds you cannot farm that season.* "*The rainfall pattern has changed and it is a big problem here. In seasons when there is enough rainfall, we get good yields and high income from groundnuts, but in some years crops may fail due to low rainfall. So when there are low yields or crops fail due to drought or rain failure, it becomes difficult for me because I have 14 people in my household and I have to provide food, health, clothing and education. So it is always difficult for me to cater for these needs. For instance, last three seasons I could not my son's school fees for UDS* (University for Development Studies)*". (59 year-old man from Goziiri-Nandom).*

4.4.2 Temperature Changes

Majority (69.4%) of the respondents observed an increasing temperature trend, while 11.1% and 11.7% observed a decreasing and a fluctuating trend respectively. Rising temperatures were seen as a source of stress on groundnut production as respondent linked several problems such as crop failure, poor germination, and pest and disease infestation. Table 4.3 shows respondents' perception of the impact of high temperatures on groundnut production. Over 80% of the respondents identified changing temperatures as having negative effects on groundnut production.

Table 4.3 Perception of the effects of temperature on groundnut production

Effects	**Percentage of Respondents**
Crop failure due to withering/drying of crops	34.4%
Poor germination and seed loss after planting	18.9%
Stunted growth leading to low yields	14.4%
Pest and disease infestation (Aflatoxins)	11.1%
Inability to work on farm	2.2%

Source: Computed from Survey Data (2016).

Most (34.4%) of the farmers noted crop failure (from withering) as a major stress from rising temperatures while 18.9% attribute poor germination and seed loss to rising temperature. 2.2% stated that rising temperature made them unable to work on their farms. A 65 year old woman (Kalsagre-Lawra) noted in the FGD:

> *"The temperatures are very high nowadays as compared to first* (2 to 3 decades ago)*, so when I go my farm on a hot day I cannot work because I will fall sick…"*

4.4.3 Poor and Infertile Soils

Soil infertility was also highlighted by respondents as a main obstacle to crop farming including groundnuts. About 89% of the respondents complained about soil infertility as a problem for groundnut production while 11% did not see it as problem for them. Farmers noted during the FGDs that poor soil fertility was causing low yields in groundnut. During the survey farmers stated the following as the cause of soil impoverishment. Among those who observed declining soil fertility, 48.3% linked soil infertility to bush burning and tree felling, 31.7% noted over-cropping excessive cultivation on the same land as the cause of infertility, while 9% noted excessive use of agro-chemicals as the cause of soil impoverishment. A 46 year old woman (Ketuo-Nandom) noted in the FGD that:

> *"…our soils are not good that is why we don't get good yields. Farming 1 acre before is not the same as 1 acre now because now the yields are low due to low soil fertility. The same farm is cultivated continuously so the nutrients get depleted and if you can't afford fertilizer- you can't get more yields.*

4.4.4 Crop Pests and Diseases

Farmers also indicated crop pests and diseases as another main threat to their livelihood (groundnut farming). Most of the survey farmers have observed an increase in the incidence of pest and diseases their communities over the past years and they see that as a threat to groundnut production. Aflatoxin contamination is the main disease affecting groundnuts both on the field and after harvest mainly due to high rainfall variability and high temperatures. As indicated by the Agricultural Extension Officer and the Head of NANDIRDEP, the main weakness of the widely used groundnut variety (commonly called '*China'* variety) is its high susceptibility to pest and disease infestation. Other common pests and diseases identified by respondents include pod borers, grasshoppers, beetles, leafspot disease and groundnut rust.

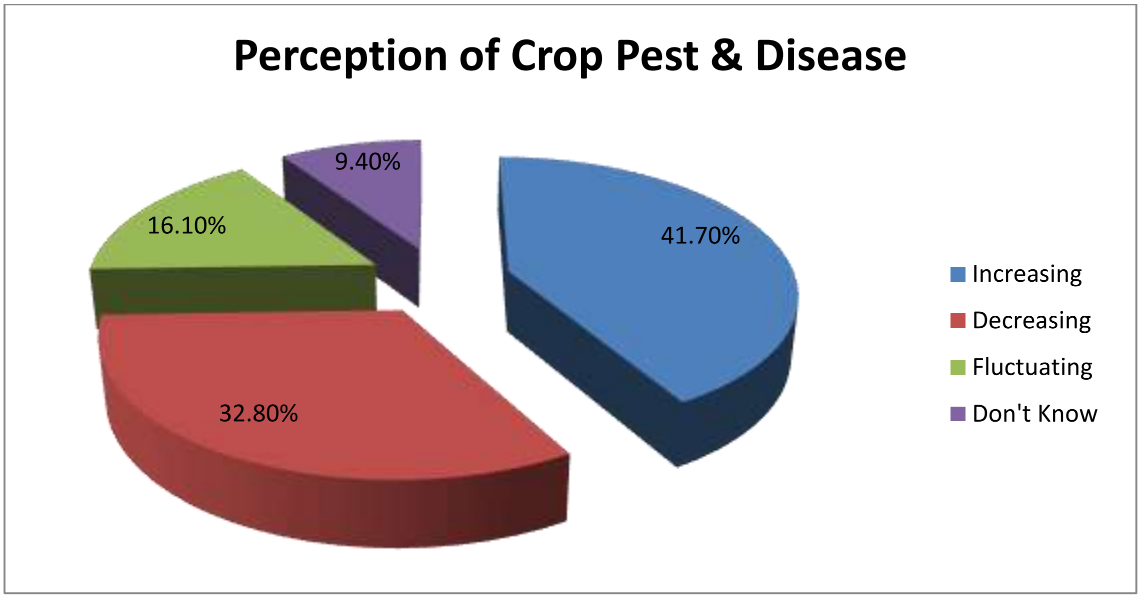

Figure 4.9 Perception of pest and diseases in groundnut production
Source: Computed from Survey Data (2016).

Figure 4.9 above shows that majority (41.7%) of the farmers have observed an increasing trend in the occurrence of pest and diseases in groundnut production, while 32.8% noted a declining trend. Another 16.1% observed a fluctuating trend and 9.4% indicated lack of knowledge. Respondents identified the following as the effects of pest and diseases on groundnut. Majority (25.6%) of the farmers argued that the incidence of pest and diseases makes them unable to store groundnut for longer periods, while19.4% of them stated that pest and diseases does not encourage increased cultivation. Another 13.3% noted that pest and diseases causes low yields. Another 40 year old man (Tolibri-Lawra) said:

> *"...pest and diseases are affecting our yields and incomes. Insects spoil our crops on the farms and groundnut seeds when we store it. Sometime when you even get good harvest*

you are afraid of losing it because when you store it for some time it gets spoilt. So you don't have any option than to sell it after harvest".

4.4.5 Restricted Land Access

Finding from the survey reveal that only 37.8% of the respondents own land, the remaining 62.2% farm on insecure lands. A Chi-square test was run to determine the whether there was a significant difference between land ownership and gender. The results show that there is significant (X=98.321, p=0.000) difference between gender and land ownership (see Table 4.4). The cross tabulation shows that only 6.8% of the females own land as compared 79.2% of the males.

Table 4.4 Crosstabs on gender and land ownership

	Own Land	**Borrowed Land**
Gender		
Male	79.2%	20.8%
Female	6.8%	93.2%

X=98.321, p=0.00*

*sig p<0.05
Source: Computed from Survey Data (2016).

Farmers who had problem with land tenure insecurity constituted 69.5% of the respondents. They identified the following as the impacts on groundnut production (Table 4.5).

Table 4.5 Effect of land tenure/access insecurity on groundnut production

Effects	**Percentage of Respondents**
Limited capacity to increase production	22.8%
Cannot invest on land to improve soil fertility	26.7%
Low crop yield due to poor soil nutrients	20%
Total	**69.5%**

Source: Computed from Survey Data (2016).

Farmers identified the impacts of land tenure insecurity on crop production as limited capacity to expand production (22.8%), inability to invest on land to improve soil fertility (26.7%) and low crop yield due to poor soil fertility (20%).

> *"…some husbands or landowners will take back their land when they realize you have improved the land fertility. So the lands on which we farm are not secure. It can be taken away from you at any time by the owners. Some women may also lose the lands they cultivate on after the demise of their husbands*" - *(A 36 year old woman from Tolibri-Lawra).*

4.4.6 Reduced Intervention and Lack of Input/Machinery

Most of the respondents indicated a limited or lack of support from government and NGOs as obstacles to crop production in the areas. 51.1% of the surveyed respondents noted that decreased local support (from the District Assembly, Department of Agriculture-Ministry of Food and Agriculture and NGOs) has negatively affected production. While 13.9% noted that local support from such agencies were inconsistent. Most of the discussants in the FGDs mentioned lack of subsidies on inputs, lack of access to inputs and machinery (such as tractors) as the problems that limit their ability to cultivate groundnut on a larger scale. Some of the discussant argued that some years ago they enjoyed subsidies on farm inputs. Also they had access to cheaper tractor services which made farming activities more profitable than at present.

> "*Sometimes you will have the money to hire the tractor but it is difficult to get it in time because many farmers are competing for one tractor. The government and NGOs are not helping us to solve this problem, so we end up farming on relatively smaller land". A 56 year old male farmer from Goziiri-Nandom.*

4.4.7 Problems with Transportation

Access to means of mobility was also identified as one of the stumbling blocks to livelihood activities in the study areas. 52.8% of the surveyed respondents noted they had poor access to transportation. During the FGDs it was noted that getting access to markets to buy inputs and also to sell produce was constrained by limited access to transportation. Most of the FGD participants stated that they lacked private means of transport such as donkey-carts, bicycles or motorbikes. Hence they relied on commercial tricycle ("*motor-king"*), which was rarely available. This was because most people complained about high hiring costs. Respondents mentioned that there was lack of good roads in all but one of the communities (Kalsagre). This was also observed by the researcher's field observation. This made transportation in the study areas a big problem.

> *"…we don't have lorries* (buses or taxies) *here. So I sometimes walk from here (Ketuo) to Nandom* (about 7 kilometres) *town to sell and buy my items. Occasionally on market days there is a motor-king that transports people to Nandom Market but not all people can afford because it is costly (Gh¢ 3.00 per head). (A 48 year old widow, Ketuo-Nandom).*

4.4.8 Poor Markets

Findings from the FGDs reveal that most of the farmers were facing unfavourable market conditions. As indicated in the survey, about 92% of the respondents sell part of their cultivated groundnuts for income. Farmers however complained that poor market pricing of groundnut is negatively affecting their incomes and wellbeing. They mentioned in the FGDs that the prices of groundnut were usually determined by buyers, who always want to buy at relatively low prices. They also mentioned lack of unity among groundnut producers as the main reason for this problem.

"…We are not able to bargain for better prices at the markets because groundnut farmers are not united. That's why the buyers always cheat us. Sometimes when you send your produce to the market if the prices is bad we don't sell. But at times we have no option than to sell it at the low price just to get something home". (A 52 year old man in Tolibri-Lawra).

4.5 Adaptation to Vulnerability in Groundnut Production

This section presents the adaptation strategies adopted by farmers to reduce the risks, stresses and vulnerabilities facing groundnut cultivation in the study communities as stated in objective two of this study. These adaptation measures are a combination of autonomous (indigenous) and planned interventions (introduced by NGOs and the DoA under MoFA). The adaptation also consists of both on-farm and off-farm practices. It also presents a binary logistic regression on how the adoption of certain adaptation measures influence farmers' annual income from groundnut production.

4.5.1 Adaptation Strategies Adopted by Groundnut Farmers

Both the quantitative and qualitative data obtained from the study highlight the array of adaptation responses adopted by groundnut farmers in the study areas. Table 4.6 shows the adaptation practices that were assessed in the survey questionnaire during the study. To achieve this, descriptive statistics was mainly used to present results. From the survey, as shown in Table 4.7, majority of the respondents (85%) used early maturing varieties, about 73% used compost manure, about 96% rear livestock while all the farmers indicated thy change planting dates due to rainfall pattern. Off-farm jobs as an adaptation strategy were adopted by 37.1% of the respondents. Adaptation practices that were not widely adopted by farmers includes; the use of agro-chemicals (fertilizers/pesticides) (2.8%), use of drought tolerant varieties (5.6%) and seasonal migration (7%) to other areas to work. None of the respondents practiced irrigation farming, rain water harvesting and drought insurance.

Aside the adaptation practices that were investigated in the questionnaire survey, several adaptation practices used by groundnut farmers also emerged during the FGDs. As shown in Table 4.7, these practices are a combination of planned and autonomous (indigenous) adaptation measures which groundnut farmers use to reduce vulnerability.

Table 4.6 adaptation practices of groundnut farmers in survey

Practices	Adopted (%)	Not Adopted (%)
Use of irrigation	0%	100
Use of drought tolerant groundnut varieties	5.6	94.4
Use of early maturing varieties (China variety)	85	15
Rearing of livestock	96.1	3.9
Engage in rain water harvesting	0%	100
Mixed cropping	96.7	3.3
Change planting dates	100	0%
Use of compost (organic manure)	72.8	27.2
Use of agro-chemicals (fertilizers/pesticides)	2.8	97.2
Change in tillage practices	30.6	69.4
Buy drought insurance	0%	100
Seasonal migration to work in other areas	6.7	93.3
Engage in handicraft work	15	85
Engage in off-farm jobs	37.1	62.9

Source: computation from field work (2016)

Table 4.7 Adaptation practices identified during FGDs

Adaptation strategies by Groundnut Farmers
Non-burning of crop residue to maintain soil fertility on farms
Land rotation
Crop rotation
The use of Purdue Improved Cowpea Storage (PICS) sacks as storage
The use of powdered neem seeds and *"Lodal"* plant to store groundnut
Digging ground to harvest groundnut due to dryness of land (droughts)
Zero bush burning and no tree felling

Source: computation from field work (2016)

4.5.2 Reasons for Non-adoption of some Adaptation Measures by Groundnut Farmers

Groundnut farmers indicated the following reasons for their inability to adopt some of the adaptation practices in the questionnaire. The most cited reason for non-adoption by respondents was lack of knowledge about the strategy (33.5%) as displayed in table 4.8.

21.9% of the respondents also indicated lack of infrastructure and facilities as the reasons for non-adoption while 19.3% mentioned to lack of finance. The least cited reason for non-adoption was difficult to get tractor service (0.9%).

Table 4.8 Reasons for not adopting adaptation measures among groundnut farmers

Reason	Responses	Percentages (%)
Lack of knowledge on strategy	513	33.5
No infrastructure and facilities	335	21.9
Lack of Finance	265	19.3
Don't believe in strategy	114	7.5
Due to household responsibilities	74	4.8
Difficult to get such inputs	60	3.9
Lack of jobs in the community	58	3.8
Lack of permanent land	25	1.6
Due to old age	23	1.5
Due to disability	20	1.3
Difficult to get tractor service	13	0.9
Total	1530	100

*multiple responses

Source: computation from field work (2016)

4.5.3 Influence of Adaptation Practices on Income from Groundnut Production

Groundnut is the main commercial crop in the study areas as indicated by research participants during the FGDs and the KII. The study showed that groundnut had over 90% market participation and also fetched the highest price in the market as compared to crops such as maize, millet, cowpea and sorghum among others. To determine how some adaptation practices influenced the incomes of farmers, a binary logistic regression was run. This statistical tool was used because the income data was collected on a categorical scale involving four (4) ranges. However, based on the findings of this study, two (2) ranges were barely acknowledged hence they were collapsed to form part of the highly indicated ones. Based on this, it was appropriate for the binary logistic regression to be used. Sweet (1999) and Hosmer, Lemeshow, and Sturdivant (2013) postulate that logistic regression is the most appropriate tool for a dichotomous dependable variable and measurements of varying levels.

Table 4.9 Adaptation practices against the annual income from groundnut

Strategies	**B**	**Odds**	**Sig.**	**S.E**	**Wald**
Early maturing Varieties	19.90	1.96	0.01*	0.73	6.54
Livestock Keeping	19.20	1.72	0.00*	0.15	4.22
Composting	1.82	1.63	0.01*	0.67	7.34
Seasonal migration	-1.16	0.31	0.12	0.76	2.40
Off-farm job	1.28	3.61	0.00*	0.45	8.25
Constant	40.43	3.61	0.01	0.16	10.42

Nagelkerke R^2= 0.30; Hosmer and Lemeshow Test: χ^2= 8.429, df = 4, P = 0.07; Omnibus Tests of Model Coefficients: χ^2=36.60, df=5 P=0.00
Significant at *p<0.05..

The characteristics of the model (Table 4.9) include the Exp. (B) which denotes the odds of the outcome event, the Wald and the significance (P), which shows the power that each independent variable has on the entire model, and the B represents the unstandardized beta. To be considered significant in the logit model, a predictor variable should have odds of more than 1 and a P<0.05 (Sweet, 1999; Varin *et al.*, 2011). Odds ratio less than 1 means the increasing value of the variable is parallel to decreasing odds of the event's occurrence and the reverse is true. With an

Omnibus tests model coefficient of (χ^2=36.60, P<0.00) and Hosmer and Lemeshow test of χ^2=8.429, P>0.07), a statistically significant relationship was observed between the adoption of adaptation strategies and famers' annual income from groundnut. The model was fitted at a Hosmer and Lemeshow P value greater than 0.05 (Hosmer *et al*., 2013; Pallant, 2005). The Nagelkerke R^2 or the Pseudo R-Square for the model is about 0.30. This implies that the set of adaptation practices on the whole predicted about 30% of the variation in income of groundnut farmers.

However, not all influenced farmers' income in the same way. For instance off-farm jobs had the major influence on the income of farmers (Odds=3.61, P= 0.00). This means that farmers who engaged in off-farm jobs were 3.6 times more likely to experience increase in income from groundnuts as compared to farmers without off-farm jobs. Also, the use of early maturing varieties (Odds=1.96, P=0.01) had a significant influence on the income of groundnut farmers. Also, respondents who used early maturing varieties were about 2 times likely to increase their income. Similarly, those who practiced composting (Odds=1.63, P=0.01) and livestock rearing (Odds=1.72, P=0.00) were twice more likely to earn higher incomes than those who did not practice. However, seasonal migration (Odds=0.31, P=0.12) did not show any significant association as those who migrated seasonally to work in other areas were about 3 times less likely to increase their income.

4.6 Differences of Adaptation Strategies across Different Social Groups

Although the local population in the study were socially differentiated in several dimensions, three (3) main social groups were identified from the field data, based particularly on the FGDs. These social groups are bases on gender, age group and land ownership type as displayed in Table 4.10 below.

Table 4.10 main Social groups identified during field research

Social Groups		
Gender	**Age**	**Land Ownership**
Male Farmers (42.8%)	Young Farmers (44.4%)	Own Land (37.8%)
Female Farmers (57.2%)	Old Farmers (55.6%)	Borrow Land (62.2%)

Source: Computation from field work (2016).

Based on this categorization of social groups from the study, the survey found that 42.8% of the respondents were males and 57.2% females. In terms of age grouping, 44.4% were young farmers while 55.6% were old farmers. While respondents who were landowners constitute 37.8% and those who do not own land (farming on borrowed lands) were 62.2%.

Chi-square test analysis was used to examine how the adoption of certain adaptation strategies varied of differed among the social groups identified during the study. The findings from the Chi-square analysis at 1% significant level are displayed in Table 4.11.

The study sought to examine the differences in adaptation strategies across the different social groups. From Table 4.11 the chi square for goodness of fit was used to present results. As shown on the table, the adoption of strategies such as using early maturing varieties (X=16.235, P=0.00), mixed cropping (X=4.640, p=0.03) and composting (X=16.389, P=0.00) of farmlands significantly varied across gender. More (51%) females for instance adopted early maturing varieties than males. Similarly, more (55.7) females indicated to have used mixed cropping as an adaptation strategy importantly younger farmers (56.3%) acknowledged to be more engaged in off-farm economic activities. whereas composting was common with males (51.9%). However, livestock keeping (X=0.60, P=0.44) and off –farm jobs (X=3.02, p=0.08) was found to be insignificant across the gender of farmers.

Concerning adaptation strategies and age category of farmers, only off-farm jobs (X=5.293, P=0.02) were found to significantly differ across age groups. More young farmers (56.3%) indicated they engaged in off-farm jobs such as *pito* brewing, shea butter processing, petty trading, handcraft work, sale of livestock and artisanal fishing. However, the adoption of early maturing varieties (X=2.824, p=0.09), livestock keeping (X=2.683, p=0.10), mixed cropping (X=1.940, p=0.16) and composting (X=1.179, p=0.28) were found not to vary or differ significantly with age.

On land ownership and adaptation strategies, the use of early maturing varieties (X=12.464, p=0.00), mixed cropping (X=3.768, p=0.05), composting (X=8.642, p=0.03) and off-farm jobs were found to vary significantly across land ownership type. Specifically, more of those who borrowed land that is 56.9%, 60.1%, 55.2% and 81% were found to be engaged in the use of early maturing varieties of groundnut, mixed cropping, composting and off-farm jobs respectively. Livestock keeping (X=0.263, p=0.61) was not found to vary across land ownership types.

Table 4.11 Differences in the adoption of adaptation strategies among different social groups based on Chi-Square test analysis

	Adaptation strategies (%)									
Social-Groups	Early maturing varieties		Livestock keeping		Mixed cropping		Composting		Off-farm job	
Gender	Yes	No	Yes	No	yes	no	Yes	No	Yes	No
Male	75 (49)	2 (7.4)	75 (43.4)	2 (28.6)	77 (44.3)	0 (0.0)	68 (51.9)	9 (18.4)	23 (34.8)	54 (48.2)
Female	78 (51)	25 (92.6)	98 (56.6)	5 (71.4)	97 (55.7)	6 (100)	63 (48.1)	40 (81.6)	43 (65.2)	58 (51.8)
	X=16.235, P=0.00*		X=0.60, p=0.44		X=4.640, p=0.03*		X=16.389, p=0.00*		X=3.02, p=0.08	
Age group										
Young farmer	64 (41.8)	16 (59.3)	79 (45.7)	1 (14.3)	79 (45.4)	1 (16.7)	55 (42)	25 (51)	37 (56.3)	43 (38.4)
Older farmer	89 (58.2)	11 (40.7)	94 (54.3)	6 (85.7)	95 (54.6)	5 (83.3)	76 (58)	24 (49)	29 (43.9)	69 (61.6)
	X=2.824, p=0.09		X=2.683, p=0.10		X=1.940, p=0.16		X=1.179, p=0.28		X=5.293, P=0.02*	
Land ownership type										
Own land	66 (43.1)	2 (7.4)	66 (38.2)	2 (28.6)	68 (39.1)	0 (0)	58 (44.3)	10 (20.4)	12 (18.2)	56 (50)
Borrowed land	87 (56.9)	25 (92.6)	107 (61.8)	5 (71.4)	106 (60.1)	6 (100)	73 (55.2)	39 (79.6)	54 (81.8)	56 (50)
	X=12.464, p=0.00*		X=0.263, p=0.61		X=3.768, p=0.05*		X=8.642, p=0.03*		X=17.809, p=0.00*	

Source: Computation from field work (2016).

4.7 Implications of Current Adaptation Strategies and Interventions on Vulnerability

This section presents the findings on the implications of current adaptation strategies and interventions on the vulnerability and wellbeing of groundnut farmers within different social groups. This research objective was achieved from responses obtained mainly from key informant/expert interviews. Table 4.12 below shows the list of the key informants interviewed and names of their organizations or agencies. Lawra and Nandom were considered as one district before June 2012, so even after it was split into two districts they still share some offices and personnel of some government agencies such as the DoA-MoFA among others.

Table 4.12 key informants/experts interviewed in the study.

	Key Informant Interviewed	Name of Institution/Agency
1	District Crops Officer (for both districts)	DoA-MoFA-Lawra
2	Agricultural Extension Officer (for both districts)	DoA-MoFA-Lawra
3	Project Manager/Chairman of NANDIRDEP	NANDIRDEP-Nandom
4	Project Desk Officer	ACDEP/RESULT Project-Nandom
5	Opinion Leader (Retired Agriculturalist)	Community Leader-Nandom

Source: computation from field work (2016).

Findings were analysed qualitatively and categorized into themes as presented below.

4.7.1 Interventions and Adaptation Strategies Implemented

The key informants interviewed during the study highlighted similar challenges or drivers of vulnerability in groundnut production as indicated by research participant in the FGDs and questionnaire survey in objective one (1). These experts also noted climatic stresses (dry spells, droughts and rainfall variability), land tenure insecurity, lack of access to farm inputs and machinery, , pest and diseases, lack of storage facilities and low market prices of produce as the challenges that drive vulnerability in groundnut production in the study areas.

The Project Manager for NANDIRDEP noted that:

> *"… The early maturing variety [Shitaochi or China] matures within 90 days. It is however very susceptible pest and disease infestation as compared to the indigenous varieties like the 'Dagara-Simie'* [native Dagaaba groundnut] (KII, Nandom).

As one of the main commercial crops in the area, government agencies and NGOs have been involved in a number of adaptation interventions to enable farmers cope with the factors that drive vulnerability in their main source of income. From the KIIs, it was observed that the adaptation interventions implemented by the institutions and agencies were not limited to farm-related farm activities. Rather they also included the implementation of off-farm adaptation measures that could help improve resilience and reduce vulnerability among smallholder farmers. Some of the on-farm intervention strategies directly targeted boosting groundnut production in the area while others tackled challenges in farming activities in general.

The farm-related interventions given to groundnut famers according to the agencies include teaching or training farmers on sustainable farming practices as well as providing other physical assets to farmers to manage risks, as shown in Table 4.13.

Table 4.13 displaying the farm-related interventions provided by local institutions/agencies

	Farm-related adaptation/intervention services given to farmers	Agency/Organization
1	Support farmers with early maturing (*Shitaochi* or '*China'* variety) seeds to capitalize on inadequate and variable rainfall.	RESULT-ACDEP Project, NANDIRDEP-CCAFS Platform
2	Train farmers on compost making, row planting, optimum planting distance, dry season gardening and crop rotation to help improve soil fertility and reduce land wastage.	MoFA, NANDIRDEP-CCAFS Platform
3	Introduction and teaching of appropriate use of Triple Super Phosphate fertilizer to improve yields and maintain soil fertility.	MoFA (DoA)
4	Provision of information on market prices and frequent weather to farmers to enable them plan their farming activities.	ACDEP-ESOKO, NANDIRDEP-ESOKO
5	Distribution of storage sacks (PICS-Sacks) to farmers to help reduce post-harvest loses due to pest and diseases.	NANDIRDEP-Care-Oxfam, ACDEP-RESULT
6	Train and advice farmers on the use of indigenous storage techniques to prevent pest and disease attack of stored groundnut seeds. E.g. powdered neem seeds and "*Lodal*" plant.	MoFA, ACDEP-RESULT Project, NANDIRDEP.
7	Educate male farmers or household heads to release lands to women to farm.	ACDEP-RESULT Project, NANDIRDEP (CRAFS, ELCAP, Oxfam, Care)

Source: Computed from Fieldwork (2016).

Aside the farm-based interventions or adaptation strategies some of the organizations also render non-farm-based services to help increase resilience and reduce vulnerability to climate and non-climate stresses affecting livelihoods. Mostly these non-farm-based services are provided by NGOs within the districts. From the expert or key informant interviews it was noted that an array of non-farm related interventions, displayed in Table 4.14 were provided in the study areas.

Table 4.14 Non-farm based adaptation/intervention services given to groundnut farmers

	Non-Farm-related adaptation/interventions to farmers	Agency/Organization
1	Education on environmental protection against bushfires and felling of trees to mitigate environmental degradation.	MoFA, CCAFS, ACDEP, AGRA, Traditional rulers.
2	Support farmers with small ruminants (goats and sheep) under the "pass on the gift scheme" to support livelihoods in order to reduce vulnerability.	NANDIRDEP (CRAFS, ELCAP, Oxfam, Care), ACDEP-RESULT Project
3	Education on best practices in livestock keeping such as good housing techniques, disease control and feeding skills.	ACDEP-RESULT Project, NANDIRDEP (CRAFS).
4	Training on alternative livelihood knowledge and skills such as making of soap, energy-saving stoves, beekeeping, aquaculture and fish farming and small businesses to promote livelihood diversification.	ACDEP-RESULT Project, NANDIRDEP (ELCAP, CRAFS)
5	Financial support and formation of Community and Village Saving ("Susu") groups to promote savings and give loans to people in need.	ACDEP-RESULT Project, NANDIRDEP (CRAFS, ELCAP, Oxfam, Care)

Source: Computed from Fieldwork (2016).

4.7.2 Differentiated Dimensions of Interventions /Adaptation Measures

Although the intervention services provided by these agencies are open to all people in their area of operation, the differential levels of vulnerability and adaptation needs of the different social groups were considered as a basis for helping farmers as indicated by the key informants. The key informants indicated that due to different degrees of vulnerability and needs across gender and age, most NGOs have quotas (percentage) that specifically target certain social groups particularly women, in an arrangement described by Yaro *et al.* (2014) as positive discrimination.

> *"Our intervention projects target mostly people who are resource*-poor or marginalized. *Sometimes depending on the issue at hand we may look out for women groups, widows or*

> *older people. But most of the time our projects target more women than men, in a 70% to 30% ratio... Women here are generally poor and marginalized as compared to men so we are trying to bridge that gap to reduce vulnerability".* (Project Manager, NANDIRDEP – Nandom, 2016).

The Desk Officer of ACDEP-RESULT project also indicated that the intervention target about 60% to 65% women because the level of poverty and livelihood insecurity they face. Though some men also benefit from the projects, women benefit more than the men. He stated that:

> *"Widows were supported with small ruminants and trained on soap making, soya bean recipe and small financial support to start petty trading. The older people are also supported with small ruminants".* (Desk Officer of ACDEP-RESULT project, Lawra).

However, in other intervention programs by DoA-MoFA , it was mentioned by that in nearly all the adaptation strategies they implement, differential needs and vulnerabilities of social groups are not considered.

The key informants from the NGOs maintained that relevant consultations were usually done with chiefs, church leaders, assembly men and important stakeholders to select the individual beneficiaries.

4.7.3 Implications of Interventions/Adaptation strategies on Wellbeing and Vulnerability

The interventions from government agencies and non-governmental organizations in the study areas have helped shape the wellbeing or vulnerability of some of the local population as indicated by some participants in the FGDs. During the study, key informants were asked about the impacts of the interventions on the livelihoods of the local population particularly groundnut farmers.

The key informants mentioned that although interventions do not cover all the people in the communities, a considerable size of the local people have benefited from the services of their projects. As indicated by some key informants and confirmed by the discussants in the FGDs, the adoption and uptake of farming techniques by local population is as positive. They argued that most farmers tend to adopt the practices taught except in instances where adoption may require financial commitment or intense labour particularly for women and older farmers.

> *"…some poor farmers may not be able to buy fertilizer, PICS sacks and other inputs. Just like others are unable to practice compost making or row planting such women and older famers"*. (A 40 year old farmer from Goziiri-Nandom District, 2016).

It has been shown that the adoption of these agronomic and other practices have increased groundnut yields and land size under cultivation in the districts over the years as shown by the Crops Officer for both districts. (The data provided in Table 4.15 below is for the Lawra and Nandom Districts combine as they are still not completely separated in terms of certain administrative functions).

Table 4.15 Cropped area and yields in groundnut production for three farming seasons

Cropped Area (ha)	Production (MT)	Year
8,038	11,775	2012
8,249	12,010	2013
8,272	14,751	2014

Source: District MoFA Office, Lawra (2016).

Also, results from the survey and the KII have shown that more landless people (women) were increasingly gaining access to lands for cultivation through NGO advocacy and campaign. About

42% of the surveyed respondents stated that land access has improved over the years as compared to 32.2% and 22.8% who claim no changes and restricted access respectively. Similarly, about 33% of farmers have also indicated a general fall in the incidence of pest and diseases in the groundnut production value chain due to awareness in management practices.

According to the Project Manager of NANDIRDEP and the Desk Officer of ACDEP-RESULT project, the non-farm related interventions have led to capacity development among the local population, as some less privileged people especially women, widows and the youth are now equipped with alternative livelihood options (see Table 4.15) and this has improved their wellbeing. Some participants during the FGDs indicated they have benefited from the intervention provided by the NGOs. A woman in FGDs in Tolibri (Lawra) mentioned that:

> *"…the RESULT people (project) supported me with the 'China' groundnut seeds to farm. With that, even when the rain is small I still get something for consumption and also sell. They also gave me two sheep two years ago. The animals have reproduced and are now four in number. So whenever I am having a problem with paying my children's fees I can sell some to pay".*

Another woman in Goziiri (Nandom) noted that she was planning to migrate down south to brew "*Pito*", but when she came under the intervention of NANDIRDEP, she was supported with improved seeds (including groundnuts), new farming techniques and was trained how to make energy-saving stoves for a living. As result, she has decided not migrate because of her improved livelihood and wellbeing.

In the study districts, the effective collaboration among institutions such NGOs, DoA-MoFA, GNFS, Traditional Rulers and opinion leaders have raised environmental awareness against bush burning, cutting of tree and environmental degradation. In fact punitive measures have been put in place in most of the communities to deter people from engaging in such acts. An opinion leader (who is also a retired agricultural extension officer in Goziiri-Nandom) explained during an interview that:

> *"In this community (Goziiri) we don't accept bush burning and felling of tress. The chief has imposed a fine of Gh₵100 on anyone who burns the bush or cuts down tress. However, those (culprits) who are not able to afford that amount is made to gather stones that can fill a tipper truck… that is even more expensive than the Gh₵100 fine. So people are very careful with that. Personnel from Fire Service have also trained some youth of this community how to fight bush fire to protect the environment.*

Another adaptive intervention that was regarded as very important to local farmers in the study areas is access to climate information. Through collaboration with Esoko, some NGOs in the area provide frequent weather information to farmers as indicated by the Programs Manager of NANDIRDEP (2016). Participants mentioned in the FGDs that they had confidence in the frequent weather updates via voice messages and radio as it helped them to manage risks and cope with climate variability. A 41 year old woman (Ketuo-Nandom) stated in the FGD that:

> *"We get to know when the rainy season will start and also when it will rain or not from Esoko people. It is helping us a lot. We are able to plan our domestic chores and our farm activities against drought and floods".*

Farmers tend to hold this climate information as reliable and very important in reducing vulnerability to climate risks.

CHAPTER FIVE

DISCUSSION OF RESULTS AND FINDINGS

5.1 Introduction

This chapter presents discussions on the key findings of the study. The aim of this study was to assess the livelihood vulnerability and adaptation in groundnut production by considering certain elements of social differentiation. For instance age, gender and land ownership. This chapter begins by discussing the findings from the demographic and socio-economic attributes of the research participants. Further the chapter discusses the drivers of vulnerability in groundnut production. This is followed by a discussion of the adaptation responses adopted by farmers to manage vulnerability and how the adoption of certain adaptation practices varies across different social groups. It finally discusses the implication of institutional (Government and NGOs) interventions on the vulnerability of livelihoods in the study areas.

5.2 Demographic and Socioeconomic Characteristics

Results from the survey indicate that there were more female respondents (57.2%) than male in the study communities. Though this may be consistent with the 2010 PHC data (GSS, 2013), it could also perhaps be attributed to the seasonal migratory pattern, where as an adaptive strategy people from the area (mostly males) migrate temporarily to Southern Ghana to work after the rainy season up north (Rademacher-Schulz and Mahama, 2012). This may lead to depletion of local labour force and low economic returns particularly in instances where migrants stay longer, as argued by Ellis (1999).

Also, the age distribution of respondents implies that the farmer population of the area lies within the economically active population and this has positive implication for agricultural development

(Abu., 2013). Majority (35.6%) of farmers fall between the ages of 46 and 55 years followed by 27.8% falling between the ages of 36 and 46 years.

The average household size (7.26) from the study was relatively closer to the regions' average of 6.2 (GSS, 2013). Martey *et al.* (2012) posit that relatively larger households have adequate supply of labour for production. On the contrary, Makhura *et al.* (2001) argue that large households may limit the market participation of farming households as consumption is likely to dominate the sale of farm produce.

The majority of farmers (68.3%) in the study have no formal education and this corroborates the findings of Abu. (2013), who argue that this could be an obstacle to adaptation in agriculture in terms of barriers to technology adoption, information access and understanding market related issues. The lack of education as argued by Minot *et al.* (2006) limits the ability of people to gain extra employment opportunities particularly in the non-farm sector.

The mode of ownership of land in the study communities means that most farmers had insecure land access/entitlements. More than half of respondents (mainly females) did not own the land on which they cultivate. Studies have shown that this situation could stifle long term investment on lands and crop production as farmers fear losing their land under the unstable and insecure land tenure arrangements (Bugri, 2008).

The majority of farmers in the study cultivate on farm sizes between 0.5 and 3 acres. This distribution validates the constraints faced by smallholders (small land sizes). Cultivating on bigger lands spurs the production of surplus for the market (Martey *et al.*, 2012). Thus the relatively small land sizes in the study areas could limit the ability to alleviate poverty.

The survey findings also confirm the assertion that groundnut is a cash crop in the region (Angelucci and Bazzucchi, 2013; Masters *et al.*, 2013). It was found in the survey that 92% of farmers indicated they sold groundnuts rather than use it for direct consumption.

Incomes estimates from sale of groundnut as indicated by majority (55.4%) of the farmers is generally low, between GH¢100 and GH¢300 annually. This distribution could be a reflection of the small land sizes, land tenure insecurity and the market challenges in the region (Nyantakyi-Frimpong and Bezner-Ker, 2015).

The findings of this study show that over 80% of the farm income is spent on socioeconomic household needs (education, health and food) rather than farming activities. This is consistent with the findings of Abu (2013), who indicated that a relatively small proportion of income from groundnut is reinvested in farming due to high expenditure on other household needs such as education, health and food.

5.3 Drivers of vulnerability in Groundnut Production

Results from the study reveal that groundnut production is vulnerable to both climatic and non-climatic drivers, and that these two set of factors intersect to determine the actual vulnerability of livelihoods. This is similar to the findings in the works of Nyantakyi-Frimpong and Bezner-Ker (2015) and Padgham *et al.* (2015).

5.3.1 Climatic Drivers of Vulnerability in Groundnut Production

Farmers are generally aware of climate variability and change. Climate variability and change were argued by respondents to be some of the main factors that influence vulnerability in groundnut production. As argued by participants in the FGDs and survey this has manifested in the truncation of the growing season, frequent drought and dry spells, rising temperature and increased variability. This finding is in line with the study by Sarr *et al.* (2015). Majority of the farmers have partly linked the manifestations of climate variability and change to poor yields, crop failure and poor soil fertility among others. This corroborates the findings of and Thornton and Cramer (2012) and Sarr *et al.* (2015). Excessive rains leading to flooding was generally not regarded as problem for most people except communities in close proximity to the Black Volta River. Increasing temperature was also identified by most farmers as a problem. This confirms the findings of Nyantakyi-Frimpong and Bezner-Ker, (2015) and Sarr *et al.* (2015). Some farmers linked temperature increase to the rise in pests and diseases of groundnut, low yields and a reduction in farmers working time on their fields. Existing studied on groundnut production by Prasad *et al.* (2000), Wilayar *et al.* (2015) and Sarr *et al.* (2015) have confirmed these findings.

5.3.2 Non-Climatic Factors that Shape Vulnerability in Groundnut Production

Most farmers also linked low groundnut yields to poor soil fertility as also found in the works of Masters *et al.* (2013) and Ebi *et al.* (2011). The results of the survey and FGDs reveal that farmers mentioned bush burning and tree cutting, over-cropping on the same land and the excessive use of chemical fertilizers as the causes of soil infertility.

Other non-climatic stresses identified by farmers as troubling groundnut production are pest and disease occurrence. Although there were mixed reactions on the incidence of pests and diseases, majority (41.7%) of farmers indicated they have increasingly become threats to their livelihoods. These particularly include rosette virus and aflatoxins infections during production and post-harvest handling (Guchi, 2015). This was not surprising because the widely used groundnut variety – the *China/Shitaochi Variety* - has been noted to be very susceptible to pests and diseases infestation (Dapaah *et al.*, 2014). Rosette disease can cause massive yield loss in Africa as it is one of the most destructive viral diseases of groundnut (Alhassan, 2013). Masters *et al.*

(2013) also noted that about 5% to 15% of groundnuts in Ghana are discarded due to aflatoxin contamination, thus leading to low returns from sale. Studies have established connections between aflatoxins consumption and liver cancer in human (Guchi, 2015)

Findings from the study showed that about 62% of the respondents were not land owners. And this resulted in complaints by research participants (mostly women) of land tenure insecurity as an obstacle to their farm livelihoods. A chi-square test on gender and land ownership showed a significant difference between gender and land ownership. Only 6.8% of females owned land as compared to 79.2% males. This outcome reflects the socio-cultural and gendered nature of the land tenure system in Northern Ghana, where land access and ownership is male-centered or patriarchal (Bugri, 2008; Yaro 2010). This could have negative implications for agricultural development and poverty alleviation since most women who form a sizable part of the population lack land tenure security.

The study participants (52.8%) also identified lack good roads and access to transportation as other drivers of vulnerability in groundnut production. Only Kalsagre in Lawra District had a good road linking it to urban centres. Moreover, less than 10% of farmers have their personal means of transport. This could mean an increase in the overall transaction costs and therefore may limit market access and participation within urban centres where produce are sold and farm inputs are obtained (Gbetibuou *et al.,* 2010). Adger *et al.* (2004) posit that good roads determine the ability of farmers to access markets in order buy and sell the items they need. Good roads could also ease the mobility and aid distribution during disasters and also help people who may want to migrate as an adaptive strategy.

Finally, poor and unfavourable prices may interact with the poor transportation systems in the study areas to adversely affect the market participation and returns in groundnuts production. During FGDs participants argued that buyers dictating prices, market uncertainties, long distances to markets and lack of reliable means of transportation negatively affects their incomes. Abu (2013) found that most farmers in the Upper West Region prefer to sell their groundnuts at the farm-gates to avoid paying for high cost of transportation although the market centres relatively offer higher prices. He noted that the average price of groundnut was GH₵71.40 per 50gk bag at the farm-gate compared to GH₵115.40 per 50kg bag at the market centres. This finding confirms the findings of Martey *et al.* (2012), on how distance to markets and access to transportation influences market participation and income. This may limit farmers' ability to cater for certain household needs such as payment of school fees, health and buy food stuff.

5.4 Adaptation Strategies Adopted by Groundnut Farmers

Farmers in the study area have adopted several adaptation measures to tackle the challenges posed by both climatic and non-climatic drivers on farming activities including groundnut production as argued by Mertz *et al.* (2010). These adaptation measures are combination of autonomous and planned strategies implemented on-farm and off-farm to reduce livelihood vulnerability and improve wellbeing of rural population. Wossen *et al.* (2014) maintain that off-farm adaptation measures provide complimentary trading option to on-farm activities as a way out to lessen the vulnerability to the adverse impacts of climate variability and change. Tables 5.1 and 5.2 show the measures adopted by farmer in response to the various drivers of vulnerability in groundnut production and farming in general.

Table 5.1 Adaptation strategies adopted by farmers

On-Farm strategies widely adopted	On-farm strategies with low adoption
Mixed cropping	Use of drought tolerant varieties
Use of early maturing China varieties	Application of agro-chemicals
Changing of planting dates	Land rotation
Use of compost (organic manure)	
Crop rotation	**On-farm strategies with no adoption**
Digging ground to harvest groundnut due to drought	Use of irrigation
Change in tillage practices	Engage in rain water harvesting
Non-burning of farm residue to maintain fertility	Buy drought insurance
Use of weather information to plan farm work	

Source: Computation from field work (2016)

Table 5.2 Off-farm adaptation strategies adopted by farmers

Off-farm Strategies widely adopted	Off-farm strategies with low adoption
The use of powdered neem seeds and "*Lodal*" plant to store groundnut	Seasonal migration to work in other areas
The use of PICS sacks as storage	
Rearing of livestock	
Engage in off-farm jobs	
Zero bush burning and no tree felling	

Source: computation from field work (2016)

Some groundnut farmers who could not adopt both the on-farm and off-farm strategies mentioned various reasons for their inability to adopt. Most farmers indicated lack of knowledge on strategies, lack of infrastructure and facilities, financial constraints and lack of belief is strategies as the main reason for low or non-adoption. These challenges generally depict the problems facing smallholder farmers in Northern Ghana (Padgham *et al.*, 2015).

5.5 The Influence of Some Adaptation Practices on Income from Groundnut Production

A binary logistic regression was run to assess how the adoption of some adaptation practices influenced the annual income from groundnut. These adaptation measures are the use of early maturing groundnut, livestock keeping, composting, off-farm jobs and seasonal migration. The results show that these set of adaptation practices on the whole predicted about 30% of the variation in income of groundnut farmers. Within the specific adaptation measures however, only seasonal migration did not have any significant influence on farmers' income. Dimmie (2016) also found that seasonal migration of farmers from the Sisala East District of the Upper West Region were over two times less likely to increase crop output and income. He argued that farmers who migrate seasonally may be less serious with their farm work compared to those who stay at home. Off-farm jobs predicted an increase in farmers' annual income from groundnut by 3.6 times compared to those without off-farm jobs. This could be explained by the possibility of farmers investing off-farm income into increasing groundnut production. Paavola (2008) notes that livelihood diversification (Off-farm job) presents an important adaptation strategy that may reduce production risks such as low income returns that are connected to climate variability and change. The use of early maturing variety predicts an increase in income by about 2 times and this may be due to the high yielding and oil-rich content of the newly introduced "*Chinese"* variety which widely used (85%) in the study areas. Composting also had significant influence on incomes as it increases soil fertility and crop yields. This was expected because composting is one of the best ways of enriching soil nutrients for high crop yields. Finally, livestock keeping was twice more likely to increase in farmers' income from groundnut. This was also expected because it may give farmers materials for compost-making (droppings) and farm labour (bullocks) to enhance production. Studies have shown that livestock keeping may help farming households in several ways. For instance, animals may be sold to invest in crop production to increase income (Antwi-Agyei, 2012).

5.6 Differences in Adoption of Adaptation Strategies with Different Social Groups

The study also sought to understand whether the adoption of adaptation strategies varied within different social groups. As a result three (3) main social groupings were selected from the field research and were based on gender, age and land ownership. Each of the social groups considered had two (2) sub-categories. For example gender (male/female), age (young farmer/old farmer) and land ownership (own land /borrow land). The use of only three social groups for this study is not meant to suggest that no other social groupings or differentiation exist in the study areas. For example, other social groupings

Five main adaptation measures were tested using chi-square to determine whether there were significant differences in their adoption within the identified social groups. The adaptation measures include the adoption early maturing varieties, livestock keeping, mixed cropping, the use of compost and engagement in off-farm jobs.

Based on gender as a social group, it showed that the use of compost, early maturing varieties and mixed cropping varied significantly between males and females, with more female farmers adopting these practices than male farmers. This could be because more women relative to men cultivated on impoverished soils (Padgham *et al.*, 2015) and also because they lack of finance to buy fertilizer. The use of early maturing by more women may reflect the seriousness they attach to groundnut production as it is regarded as “women’s crop” by Masters *et al.*, (2013).

By age group (young and old farmer), the engagement in off-farm jobs varied significantly, with more young farmers doing off-farm jobs than old farmers. This could imply that due to old age and lack of strength, old farmers are less into off-farm work.

Based on land ownership, only livestock keeping did not differ significantly across those who own land and those did not own land. This could be because keeping livestock has no direct connection with land ownership. That is, whether a farmer owns land or not they can rear animals. It was however shown that the adoption of off-farm jobs significantly differ across land ownership type. Thus more people without land engaged in off-farm jobs than those who own land. This may be explained by the fact that land tenure insecurity faced by people who do not own land (mostly women) in Northern Ghana as indicated in Bugri (2008) and Agana (2012) is necessitating the need to engage in off-farm jobs to increase resilience and supplement livelihoods.

5.7 Implications of Current Adaptation Strategies and Interventions on Livelihood

Interventions in the form of planned adaptation are carried out by both local government agencies and NGOs to help reduce livelihood vulnerability in the study areas. As underscored by Agrawal *et al.* (2009), local institutions are very central to adapting to climatic and other related vulnerabilities. They posit that these institutions perform three key roles functions. First, they serve as links between household and local resources; second, they connect local communities to national interventions; and finally they determine the allocations of aid to differential vulnerable groups (Agrawal *et al.,* 2009). In the study areas there were several government and NGOs in operation but due to resource and time constraints not all of them were involved in the study. Only a few including DoA-MoFA, NANDIRDEP, ACDEP and Traditional Authorities were involved in the study. These organizations are presently implementing both on farm and off-farm adaptation interventions in the areas. On-farm strategies include training on sustainable land and water management, the use of PICS sacks, composting, use of early maturing groundnut variety among others. These institutions also liaise with traditional leaders to enforce no-burning and no tree-cutting policies. As climate change and variability continuously interact with socioeconomic, cultural and institutional factors to make farm livelihoods unstable, a focus on on-farm adaptations alone could exacerbate vulnerability in agriculture-dependent households. Thus off-farm jobs (livelihood diversification) have become important means of increasing livelihood resilience and wellbeing of the local population (Antwi-Agyei *et al.,* 2012). These include training on making of soap and energy-saving stoves and support with small ruminants.

The activities of these institutions have made positive impacts on the lives of the rural population as revealed by some community members and confirmed by key informants. The adopters or beneficiaries of the various adaptation measures have underscored several improvements in the farming activities and livelihood activities in general.

This is however not to suggest that the adoption of adaptation strategies are 100% successful. Several barriers to successful adaptation were highlighted by research participants during the study.

First, some farmers and key informants admitted that the implementation and adoption of adaptation measures are constrained by financial inadequacy on the side of both the organizations and the individual farmers. Lack of resources limit the coverage of organizational interventions while at the level of the farmers, they are unable to purchase inputs (PICS-sacks) that can improve their groundnut production.

In most of the FGDs gender and age were mentioned to be barriers to adaptation among groundnut farmers. That is, most women and the older farmers in general stated that they are unable to adopt practices such as stone ridging and row planting due the labour intensity.

Culturally, both the organizations and some farmers (women) face obstacles. For example, some NGOs were prevented from supporting poor farmers with two (2) small ruminants in some communities because it was a taboo to give a gift starting with two. Rather the traditional leaders said beneficiaries can take only one animal. In another community in Nandom, women were prevented from learning how to make energy-saving cooking stove for a living because men thought women would turn against them when they become financially resourced.

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENTATIONS

6.1 Introduction

This chapter presents the summary, conclusions and recommendations of the study.

6.2 Summary and Conclusion

This study was done basically to examine livelihood vulnerability and adaptation in groundnut production within socially differentiated groups. Groundnut production is very important to livelihoods in the UWR as it provides several benefits to farmers. Aside the nutritional benefits household derive from it consumption, groundnut fetches the highest market price it has the highest market participation. Due this relative advantage, income from groundnut production are used to buy household food stuff, pay fess of wards, health bills and buy other farm inputs.

Despite this livelihood potential, groundnut production is faced with a combination of climatic an, which may adversely affect the livelihoods of rural populations in the region, particularly resource-poor and marginalized social groups. This source of vulnerability is reinforced by certain socio-cultural and structural barriers on certain social groups within those societies. The study revealed that the way people are affected by these elements of vulnerability is mainly shaped by gender, land ownership and age of farmer.

It emerged that a combination of autonomous and planned adaptation strategies are being adopted, both on-farm and off-farm by groundnut farmers to manage these risks in order to sustain livelihoods. The uptake or adoption of certain strategies differed within the social groups that were identified in the study. Thus gender (male/female), landownership (own land/borrowed land) and age (young/old farmer) either enhanced or constrained famer ability to adopt certain adaptation practices within groundnut production. Study also found that the annual income of farmers from groundnut production is predicted by their adoption of certain adaptation practices particularly the use of early maturing varieties, composting, livestock keeping, off-farm jobs and seasonal migration.

The study also underscored the central role played by GOs and NGOs in the adoption and dissemination of adaptation intervention in the area to improve wellbeing and livelihood resilience. The NGOs in particular have contributed to improvement s in local livelihoods through a combination of on-farm and off-farm adaptation interventions in the face of climate variability and change as well as other drivers of vulnerability.

The main barriers to adaptation as highlighted by research participants in the KIIs and FGDs include socio-cultural practices, gender-related barriers, market failures, transportation, financial and logistical constraints.

A case can be made from this study that the groundnut crop has the highest level of market participation in the region and is regarded by farmers as their main cash crop. Also, the use of the early maturing "*Chinese*" variety is helping farmers to make good use of the low and variable rainfall pattern to maintain their livelihoods.

6.3 Recommendations

Based on the above summary and conclusions of the study, the following recommendations are proposed;

- It has been shown that the use of the early maturing variety is widely adopted by farmers in the region. Therefore, to increase production, efforts should be put in place by Government and NGOs to subsidize the seeds to enable poor farmers to get access. In the same vein, farmers should be helped storage materials and facilities such the PICS sacks to help control and manage pest and diseases that cuts deep into incomes.

- ❖ Although achievements have been made in the efforts to allow more women to farm, land access and tenure insecurity are still a main problem for women and non-natives within the study areas. To improve this situation, more campaigns and advocacy to lessen the restrictions and land tenure insecurity against women should be pursued by Government, NGOs, religious leader and chiefs to remove these cultural barriers.
- ❖ Based on the market challenges found in the study, the government should invest in the development of modern market centres at vantage communities. Moreover, the feeder roads department and the Ghana Highway Authority under the Ministry of Road and Highway should target improving rural roads to facilitate easy mobility and also reduce the cost of transportation that reduces farmers' profits.
- ❖ Also, NGOs that engage in group formation among farmers should take up the initiative of forming groups of farmers that will unite as a marketing front for groundnut farmers. This will reduce the practice of buyers dictating the prices at the local markets.
- ❖ The problem of limited access to extension services to farmers should be looked into and improved by government. That is, more extension agents should be made available to promote effective and proactive extension services.
- ❖ Finally, more interventions from Government and NGOs should be directed towards training and teaching local population off-farm or alternative livelihoods as overdependence on rain-fed agriculture may increase their livelihood vulnerability.

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APPENDICES

Appendix A: Farmers' Questionnaire

Introduction

Hello, I am Abdul Rauf Zanya Salifu, a student from the University of Ghana. As part of my studies, I am interviewing groundnut farmers in this community to learn more about the challenges they face and how they deal with those challenges. This information will be used to help build better and resilient policies and programs that will help farmers solve the problems and challenge they face. We would be grateful if you could spend a little of your time answering the questions below.

Important Note

This questionnaire is completed anonymously.

1. Participation is voluntary.

2. If there is any question which the respondent feels strongly about not to answer, then he/she is not compelled to do so.

3. Information gathered is for research purposes only.

To Be Completed By Interviewer

District: ……………………….……….......... Enumeration Community: ………………

Respondent Code: …………………………....

Language Used: ……………………………......

Section A: Background Information

1. Gender: a. Male [ ] b. Female [ ] **(PLEASE TICK)**
2. Age: ………………………..
3. Marital Status: a. Married [ ] b. Single [ ] c. Divorced [ ] d. Widowed [ ]
4. Level of Education: a. Primary [ ] b. Secondary [ ] c. Tertiary [ ] d. No Formal Education [ ] e. Other (Please Specify) ………………………

5. Ethnicity: a. Dagaaba [ ] b. Sisala [ ] c. Waala [ ] d. Lobi [ ] e. Other (Please Specify) ………………..
6. Religion
   a. Christianity [ ]
   b. Traditional Religion [ ]
   c. Islam [ ]
   d. Other (Please Specify) …………………………..
7. Residence Status: a. Indigene [ ] b. Migrant [ ]
8. Disability Status
   a. None [ ] b. Sight [ ]
   b. Hearing [ ] d. Speech [ ]
   e. Movement [ ] f. Other (Please Specify) ……………….
9. Relation of Respondent to Household Head: a. Household head [ ] b. Wife of Household Head [ ] c. Son/ Daughter of Household h Head [ ] d. Other (Please Specify) [ ]
10. Size of Household: ……………………………………

Section B: Farming Characteristics

1. How many years have you been farming groundnuts? ……………………………………
2. How do you get access to the land you cultivate on……………………………….........
3. What is the size of your farm (in acres)? ……………………………………………….
4. Do you cultivate only groundnut on your land? a. Yes [ ] b. No [ ]
5. If no, what other crops do you cultivate? ……………………………………………….
6. Purpose of cultivating groundnuts: a. Household Use [ ] b. Commercial [ ] c. Both [ ]
7. Reason …………………………………………………………………………...............
8. Estimate your annual income from groundnut production? a. <GhC100 [ ] b. 100-300 [ ] c. 400-600 [ ] d. 700-900 [ ] e. >1000 [ ]
9. Is farming your only form of livelihood? a. Yes [ ] b. No [ ]
10. If no, what other forms of livelihood do you engage? …………………………………..

……………………………………………………………………………………………

11. Which form of livelihood activity is most important for your wellbeing? ………………

Section C: Perceptions and Understanding of Vulnerability on Livelihood Activities.

1. Have you witnessed any changes in your livelihood over the past 2-3 decades?
   a. Yes [ ] b. No [ ]
2. Which aspect or sector has the changes occurred? a. Crop pest and diseases [ ] b. Land tenure system [ ] c. Local governance and interventions [ ] d. Rainfall [ ] e. Temperature [ ] f. Financial [ ] g. Other (specify) ……………….. **(you can tick more than one)**
3. The incidence of crop pest and diseases in this area over the past 2-3 decades. a. Increased [ ] b. Decreased [ ] c. Fluctuations [ ] d. Same [ ]
4. How did this influence you groundnut production? ………………………………… ……………………………………………………………………………………………… ……………………………………………………………………………………………..
5. Have you noticed changes in the land tenure system of this area over that same period? a. Improved access [ ] b. Restricted access [ ] c. No change [ ]
6. How has the land tenure situation affected your groundnut production? ……………………………………………………………………………………………. ……………………………………………………………………………………………… ……………………………………………………………………………………………..
7. Have you noticed changes in the governance system over the same period? a. Increased support [ ] b. Reduced Support [ ] c. Inconsistent [ ] d. No changes [ ]
8. How has changes in the local governance system affected your cultivation of groundnut? ……………………………………………………………………………………………… ……………………………………………………………………………………………… ………………………………………………………………………………………………
9. The observed temperature of this area over the past 20 -30 years? a. Increased [ ] b. Decreased [ ] c. Extreme fluctuations [ ] d. Don't know [ ] e. No changes [ ]

10. The rainfall pattern in this area over the past 20-30 years? a. Increased [ ]
    b. Decreased [ ] c. Unpredictable/Erratic [ ] d. Don't know [ ]
    e. No changes [ ]
11. What is responsible for these changes you have observed?
    ……………………………………………………………………………………………
    ……………………………………………………………………………………………
    …………………………………………………………………………………………..
12. How frequent do you experience flooding in this community?
    a. Every year [ ] b. Every other year [ ] c. Once in 5 years [ ]
    d. Not common [ ] e. Don't know [ ]
13. How often do you experience droughts and dry spells during the farming season?
    a. Frequently [ ] b. Occasionally [ ] c. Not common [ ] d. Don't know [ ]
14. How do changes in temperature affect groundnut production?
    ……………………………………………………………………………………………
    ……………………………………………………………………………………………
15. How do changes in rainfall affect your groundnut production?
    …………………………………………………………………………………………..
    ………………………………………………………………………………………….
16. How does flooding affect your groundnut production?
    ……………………………………………………………………………………………
    ……………………………………………………………………………………………
    ……………………………………………………………………………………………

Section D: Coping or Adaptation Strategies

1. **Which of the following strategies did you adopt to deal with challenges relating to your livelihood? For each strategy adopted, state whether it was able to helped or not. If a strategy was not adopted, can you explain why?**

Coping /Adaptation Strategy	Strategy adopted?		Did strategy helped to reduce the hazards	Give reasons why strategy was not adopted (Use codes 1. lack of finance; 2. lack of Knowledge 3. Did not believe in strategy 4. Did not have a permanent land. 5. (Other) (*Indicate if reason is more than one*)
	Yes	No		
Use of irrigation				
Use of drought tolerant varieties				
The use of early maturing crops				
Integration of crops and livestock				
Use Water-harvesting techniques				
Plant different crops				
Change planting date				
Adapt fertilizer/pesticide application				
Change in tillage practices				
Use of compost (organic manure)				
Buy insurance				
Seasonal migration to urban areas				
Handicrafts				
Find off-farm job``				
Other				

Appendix B: Interview Guide for Focus Group Discussion with_Groundnut Farmer in the Lawra and Nandom Districts

To identify how groundnut farmers within different social groups cope or adapt to vulnerability and risks associated with their livelihoods.

Community: ……………………..

Number of People: ……………..

Gender: ………………………….

Section A: Perceptions and Impacts of Climate Change

1. What challenges/problems do you face in your farm activities especially with groundnut production?
2. Describe how these challenges have changed in the past 2-3 decades.
3. Explain how these challenges affect your crop production.
4. Which social groups are more or less impacted by these challenges and hazards?

Section B: Groundnuts Production

5. Is groundnut a common crop for certain social groups or it is a general crop?
6. Explain why you cultivate groundnuts.
7. Do you cultivate only groundnut or in combination with other crops? Why?
8. What is the importance of the groundnut crop to your livelihood?

Section C: Coping or Adaptation Strategies

9. Explain how you respond to these Challenges (e.g. access to land, agric. inputs, government interventions, lack of information, crop pest and diseases, access to markets, dry spells, drought, floods and soil degradation).
10. Are these responses carried out autonomously (self-initiative) or they are from gov't or NGOs (planned)?
11. Where did you learn of the responses or strategies or did you develop it on your own? (Sources of practices – extension officers, NGOs, experiences from returned migrants, continual experimentation through indigenous knowledge).
12. Which practices do you regard as the most important in your efforts to respond to these challenges and hazards?

13. Explain how your responses or coping strategies vary among or within different types of groundnut farmers.
14. What other non-farm adaptive strategies (migration, petty trading and handicraft) do you adopt in response to risks and stresses?
15. What barriers do you face in your attempt to cope or adapt to these challenges? (Leadership, gender, lack of social & financial capital, disability etc.).
16. What factors serve to help (Group membership, NGO interventions, support from gov't agencies, social safety nets) your ability to cope with stresses?
17. How do you to give feed back to the planning or policymakers on the policies and interventions?

Appendix C: Interview Guide for Experts/Key Informants

This interview guide was used to interview key informants or experts on the implication of adaptation strategies or intervention on the vulnerability or wellbeing of groundnut farmers in the Upper West Region of Ghana. The respondents of these interviews include key individuals from local/ district level government agencies, NGOs and community opinion leaders.

Key Informant: ……………………………….. District: ……………………………………

Institution: ……………………………………..

Questions

1. Indicate the kinds of challenges groundnut farmers experience in this area.
2. Explain how different these challenges vary across different social groups.
3. What interventions or services do you give to groundnut farmers in the face of these challenges and hazards? (Mention and explain)
4. What specific/special interventions or services do you give to different social groups? (Groups vary in their needs, priorities and resources available).
5. Describe the criteria (age, gender, disability, marital status, education, wealth) you use to identify the different social groups?
6. Explain how the interventions/adaptation strategies are adopted by different social groups.
7. Explain how these interventions or adaptive strategies have influenced the vulnerability or wellbeing of different social groups.
8. Explain how local participation (within different social groups) is included in the formulation of your interventions and adaptation programs.
9. Explain the channels of communication used to reach groundnut farmers on these interventions?
10. What factors (cultural, socioeconomic or political) act as enablers or barriers to the adaptive strategies you provide to groundnut farmers?
11. What gaps are there in current adaptive strategies or interventions you provide for groundnut farmers?