UNIVERSITY OF GHANA

IMPACT OF CLIMATE CHANGE ADAPTATION MEASURES ON SMALLHOLDER FARMERS' CROP PRODUCTIVITY: INSIGHT FROM KASSENA NANKANA WEST DISTRICT OF THE UPPER EAST REGION OF GHANA

BY

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THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF SCIENCE DEGREE IN CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT

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DECLARATION

I, Ibrahim Alidu, the author of this thesis, titled **"IMPACT OF CLIMATE CHANGE ADAPTATION MEASURES ON SMALLHOLDER FARMERS CROP PRODUCTIVITY: INSIGHT FROM KASSENA NANKANA WEST DISTRICT OF THE UPPER EAST REGION OF GHANA"** hereby declare that, this work was entirely done by me at the Business School, University of Ghana, Legon, from August 2017 to July 2018.

This has never been presented either in whole or in part for any other degree at this University or elsewhere, except for the past and present literature, which have been duly cited.

……. Date…….

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This has been presented for examination with the approval of my supervisor

…….. Date…….

DR. (MRS.) IRENE S. EGYIR

(SUPERVISOR)

DEDICATION

I dedicate this work to the Almighty Allah, my parents, siblings, and loved ones for their immense contribution to the realization of this thesis. May Allah grant us fortitude and bless us abundantly.

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ABSTRACT

It is imperative to assess impact of climate change adaptation measures on smallholder farmers' crop productivity for increased household food security and income. The title of the study is "Impact of Climate Change Adaptation Measures on Smallholder Farmers' Crop Productivity: Insight from the Kassena Nankana West District". The major objective of the study was to assess the impact of climate change adaptation measures on crop productivity of smallholder farmers in the district. The study employed mixed methods of quantitative and qualitative approaches to select and interview the respondent farmers. About 52 percent of the farmers had moderate knowledge or understanding of climate change and its attendant impact on their livelihoods. Chi-square test revealed that there was an association between six climate adaptation measures and some crops per the data gathered from the field. The association between the farmers' climate adaptation measures and the crops showed a significant difference at 5 percent and 10 percent. The major farmer practices or adaptation measures having significant associations with the crops include shifting planting dates, agroforestry, hired labour, crop diversification, cover cropping, and mulching. Majority of the smallholder farmers had mean production figures of less than 0.5 metric tonnes per hectare for maize, rice, groundnut, cowpea, and sorghum. Most smallholder farmers engaged in off-farm employment to complement their household incomes. Majority of the farmers had between GH¢ 1,001.00 to GH¢ 2,000.00 as their average annual income in the district. The study recommends that government through the Department of Agriculture to take its leadership role and collaborate effectively with the civic and private institutions to impart proven climate adaptation practices to smallholder farmers. Agro-ecology specific climate adaptation practices should be developed for smallholder farmers to use to improve upon their crop yields and household incomes in the district.

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LIST OF ABBREVIATIONS

AEAs	Agricultural Extension Agents
AIDS	Acquired Immune Deficiency Syndrome
CAST	Council for Agricultural Science and Technology
CDKN	Climate and Development Knowledge Network
CEEPA	Centre for Environmental Economics and Policy in Africa
CSA	Climate Smart Agriculture
DFID	Department for International Development
EAP	Economically Active Person
EPA	Environmental Protection Agency
FAO	Food and Agriculture Organization
FASDEP	Food and Agriculture Sector Development Policy
FBOs	Farmer Based Organizations
FC	Forestry Commission
FMNR	Farmer Managed Natural Regeneration
GDP	Gross Domestic Product
GHGs	Greenhouse Gases
GRA	Ghana Revenue Authority
GSS	Ghana Statistical Service

HIV	Human Immune Deficiency Virus
HYV	High Yielding Variety
IFAD	International Fund for Agricultural Development
IPCC	Intergovernmental Panel on Climate Change
KNWD	Kassena Nankana West District
MESTI	Ministry of Environment, Science, Technology & Innovation
MoFA	Ministry of Food and Agriculture
NGOs	Non-Governmental Organizations
OECD	Organization for Economic Cooperation and Development
ORGIIS	Organization for Indigenous Initiatives and Sustainability Ghana
PPFAG	Peasant Farmers Association of Ghana
RELC	Research Extension Linkage Committee
SLWMP	Sustainable Land and Water Management Project
SSA	Sub Sahara Africa
TEP	Total Factor Productivity measure
UNFCCC	United Nations Framework Convention on Climate Change
VSLAs	Village Savings and Loans Associations

CHAPTER ONE

INTRODUCTION

1.0 Background

Many sectors of the world's economy are experiencing adverse impact of climate challenge, and thus affecting sustainable growth. Climate change has come to exacerbate the existing challenges confronting agricultural growth and development (Ozor & Nnaji, 2011). The adverse climate change is increasing global greenhouse gas emissions into the atmosphere. Some agricultural activities contribute to climate change, and according to Ozor & Nnaji (2011) agriculture is ranked high next to energy use and chlorofluorocarbon production in worsening the greenhouse gas emissions. Ozor & Nnaji (2011) said conversion of land for agricultural purposes account for some 8 percent to net greenhouse gas emissions and agricultural sources also account for about 15 percent anthropogenic greenhouse gas emissions.

According to OECD (2009), agriculture is providing livelihood for many Africans living in rural and peri-urban areas, and that contributes about a third of Africa's Gross Domestic Product. African farmers constitute about three quarters of the continent's population that depend on farming as their major source of subsistence (OECD 2009; Mamadou Biteye 2016). Farmers who are engaged in crop cultivation often depend on rainfall in most Africa countries, and delay or failure of rainfall makes their farming highly fragile to climate change. Due to climate challenge, there have been untimely and frequent shift in farming seasons, resulting in low food production. The region is further worsened by low adaptive capacity and the hot air found in the tropics. Some incidences of climate change not in order of importance include soil moisture stress, shifting growing seasons, and low yields of crops, rising atmospheric temperatures, flooding, and severe droughts (Ozor & Nnaji, 2011). Climate change has brought about hardships because of over

reliance on rainfall for farming, poverty, unreliable weather forecast, limited access to finance and technology among others (IPCC 1998). Financial institutions are supposed to take climate change into consideration when vetting applications of farmers who are looking for soft loans to expand their farms. The vetting would afford them the opportunity to caution farmers to use proven practices to avert the adverse impact of climate on their agribusinesses.

Ghana's agriculture has been the major source of employment for many people especially those from rural areas. The agricultural sector slightly increased at a growth rate of 2.8 percent in 2015 to 3.0 percent in 2016. The gross domestic product nonetheless dipped from 20.3 percent in 2015 to 19.1 percent in 2016, and crops dominate other commodities with the largest share of 14.6 percent of nominal gross domestic product (GSS, 2017).

There is enough scientific evidence indicating unexpected changes in climate owing to increases in greenhouse gas emissions (Stern, 2006; IPCC, 2014). The human induced greenhouse gases are increasing global temperatures and changing the amount and spread of rainfall to impact on the livelihoods of people especially those engaged in subsistence farming (Dasgupta et al. 2014; Solomon et al. 2007). Floods incidence, droughts, water scarcity adversely affect farmers' ability to plan on how to sustain or expand their farms (Anderson, et al. 2010). These incidences continue to affect farmers who mostly embrace some of the measures for their livelihoods, without resorting to less risky ventures as their adaptations (Solomon, et al. 2007, Bankoff, 1985-1995, Anderson, et al. 2010).

IPCC (2007) refers to adaptation as "the initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects". Farm level adoption of adaptation strategies can invariably stimulate local decision makers to encourage farmers to adopt measures in reducing risks coming from climate perturbation (Bradshaw et al. 2004).

Adaptation options such as crop diversification, shifting sowing dates, use of climate resilient crop varieties have potential of helping alleviate farmers from adverse impact of climate (Bradshaw et al. 2004).

Agricultural productivity is measure of amount of farm output produced for a given quantity of input or a set of inputs (Wiebe, 2003).

Productivity is usually measured using two methods, partial factor productivity measure which is the amount of output per unit of a particular input like land or labour. According to Zepeda (2001), partial measures are land productivity in the form of quantity per unit of land, and labour productivity also in a form of outcome per economically active person (EAP) or per agricultural person-hour. Partial measures of productivity does not give adequate information as to why production is changing. This can be attributed to range of factors as having contributed to productivity fluctuations. For example, land or labour productivity can increase due to better and more use of fertilizer, power tillers, the use of high yielding variety (HYV), among others. The problems is better resolved by using the second method of total factor productivity measure (TFP) to account for the accurate agricultural productivity (Zepeda 2001). Therefore, total factor productivity indicates total output relative to a more comprehensive metric of all measurable inputs including land, labour, capital, livestock, chemical fertilizers, pesticides and other purchased inputs (Alston et al., 2009).

1.1 Problem statement

The crop sector susceptibility to climate risk, is threatening food security as a result of the projected population increase globally. Increasing millions of people worldwide, including the poor, rely heavily on agriculture as a major source of livelihood (Cervantes-Godoy 2010). The agricultural sector is however, exceedingly susceptible to climate challenge and farmers are already adopting

appropriate climate adaptation practices to face climate consequence. In recent times, adaptation to climate change have been given increasing international recognition as confidence in climate issue projections is gaining higher gravitas (Ole Mertz et al. 2009).

Climate change extreme events of erratic rainfall pattern, droughts and floods, have been very devastating to smallholder farmers in the Kassena Nankana West District, resulting in low crop productivity. This low productivity invariably leads to loss of household incomes of farmers. Several organizations have reported farmers output declines as one of the main consequences, resulting in decreased foodstuffs availability and price hikes (World Bank, 2010; Nelson et al., 2009). The huge adverse impact of climate challenge on crop productivity affects people who subsist on farms for livelihood opportunities (World Bank 2003).

Some years ago, farmers in Kassena Nankana West district used to grow early millet in April, which has cultural significance to the indigenes as well as for food security. The early millet flour is prepared and served to mourners at funerals. Also, during the lean season, it equally fills the hunger gap until food becomes available for the people. This local millet variety is eventually becoming non-existent in the area due to untimely shift in the rainfall pattern from April to late June in the Savanna agro-ecological zone (FAO 2012).

Apparently, most smallholder farmers resort to delay in planting crops with the view of escaping early dry spells or drought until consistent rainfall prevails. Smallholder farmers' adverse experience of climate variability in the district has prompted them to adopt sustainable agricultural practices or climate adaptation measures to curb the menace.

The research questions which the study sought to address were:

1. What are the climate change adaptation measures applied by farmers?

2. What is the impact of farmers' climate change adaptation measures on crop productivity?
3. What are the challenges of sustaining the adoption of the adaptation measures?

1.2 Objectives of the Study

The major objective of the study was to assess the impact of climate change adaptation measures on smallholder farmers' crop productivity in the Kassena Nankana West District of the Upper East Region of Ghana. The specific objectives were to:

1. Identify the climate change adaptation measures known and applied by farmers in KNWD,
2. Determine the extent to which farmers adoption of climate change adaptation measures change the level of crop productivity, and
3. Identify the challenges of sustaining the adoption of climate adaptation measures among farmers in KNWD.

1.3 Relevance of the Study

The relevance of the study lies with the contribution to knowledge for development. First, understanding appropriate climate change adaptation measures that impact on crop productivity of smallholder farmers has provided insight on how to motivate farmers to stay at their respective communities for economic growth. New and improved practices adopted as people engage in serious agricultural activities to enhance their livelihoods and also improve the local economy of the district, than migrating to other cities in Southern Ghana for non-existent jobs. Government would have to partner key institutions to streamline climate sustainable agricultural practices in its agriculture policy. There should be provision of adequate resources with suite of proven climate change adaptation measures specific to the semi-arid ecological zone, building capacity of staff and smallholder farmers in addressing the climate challenge.

Agrawal (2008) posited that, existing institutions do affect how rural people react to environmental challenges and also facilitate the processes that would translate the impact of external interventions to adaptation to climate issues. Hence it is critical in preparing actions that can positively influence the knowledge base and adoption of strategies by the farmers in the district.

The scope of the study was primarily on smallholder farmers' who contribute immensely to the local economy of the district through the cultivation of maize, rice, sorghum/millet, groundnut, cowpea, soybean, pepper, tomato, okra, garden eggs and among other crops. The farmers' often have constraints of getting agricultural inputs such as improved seeds, soft loans and large expanse of cultivable lands to engage in agribusiness.

Kassena Nankana West District was chosen because it is a semi-arid area with over 70 percent of the population being smallholder farmers engaged in farming (Mamadou Biteye 2016). The study topic was chosen owing to agriculture being the leading sector contributing significantly to the gross domestic product of the local economy as well as being the largest means of livelihood for the youth in the district.

1.4 Organization of the Study

The study is organized into five chapters. Chapter one is concerned with introduction; problem statement, objectives of the study, and relevance of the study. Chapter two reviews literatures and some empirical literature of climate change adaptation measures. Chapter three presents the conceptual framework of the study, description of the study area, method of data collection (data source, sample size, and sampling technique), method of data analysis, and scope and limitations of the study. Chapter four presents and discusses the results of data analyses while chapter five presents the summary, conclusions, policy recommendations and suggestion for future research.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter reviews literature relevant to the study. The first part of the chapter reviews literature on evidence of climate change in Ghana, adaptation and mitigation in agriculture, crop adaptation strategies and farmers' micro-level adaptation strategies in selected Asian and African countries**,** The second part presents climate adaptation strategies of labour migration and income diversification; impact of climate change adaptation measures on crop productivity, as well as challenges of sustaining the adoption of climate adaptation measures, and role of institutions in adaptations to climate change. Finally, empirical evidence of changes in productivity due to adoption of adaptation strategies also presented in this chapter.

2.1 Evidence of Climate Change in Ghana

Ghana did its first formal communication to the apex UNFCCC responsible for climate change in 2000, and which culminated into prediction of climate issues (Ghana's Third National Communication Report to the UNFCCC 2015). A study was further conducted by the Centre for Environmental Economics and Policy in Africa (CEEPA) in 2006, which revealed fluctuations in climate variables such as temperature, rainfall and sea levels in Africa, of which Ghana is part.

According to CEEPA (2006) & MESTI (2015), the temperatures in Ghana are supposed to increase by 1.0^{O}C to 3.0 ^{O}C by 2060, 1.5^{O}C to 5.2 ^{O}C by 2090s. This increase in temperature would however differ over the agro-ecological zones in Ghana with the northern inlands and coastal regions being warmer (MESTI, 2015). Daze (2007) further documents that Sudan savannah zone in the Upper East region is predicted to experience maximum temperature of 3^{O}C by 2100, followed by the Guinea savannah in the Northern region of 2.5^{O}C. In contrast, the Sudan savannah is however

predicted to experience the least minimum temperature with the Transitional zone found in the Brong-Ahafo region of Ghana expected to experience the highest minimum temperature of $3^{O}C$ by the year 2100.

Evidently rainfall amount and distribution in Ghana has fluctuated over the years. According to MESTI (2015), there has indeed been a 10 percent increased and 15 percent decreased in the seasonal rainfall pattern and distribution globally. Annual rainfall in Ghana is expected to decrease between 9 to 27 percent by the year 2100. Notwithstanding, the Sudan savannah agro-ecological zone is however predicted to experience the highest decline in the amount of rainfall of 170.0mm by that year, followed by Deciduous Forest, Transitional zone and Guinea savannah, by 99.0mm, 78.0mm and 74.0mm respectively by the year 2100 with rainforest predicted to rise 110.0mm in amount of rainfall by year 2100 (MESTI, 2011).

2.1.1 Climate Change and Food Crop Production in Ghana

Ghana's agriculture low adaptive capacity to climate challenge can be attributed to its dependence on rainfall variability, especially in Savannah areas (Yaro 2010). Climate change also magnifies problems affecting the agriculture sector such as the north south social divide and water allocation disputes between the two regions; cross-boundary water issues; and tensions arising from economic dependence on crops susceptible to changes in climatic conditions (Brown 2008).

Climate change can bring about resources stress, outbreak of pests and diseases, loss of productive lands through the deterioration of pristine land masses, increased post-harvest losses (Nejadhashemi et al 2017). Consequences of climate challenge result in yield reductions of crops, decreased livestock values, and reduced food accessibility culminating in unfair price hikes by middle persons in the food value chain (Vermeulen 2010).

2. 2 Adaptation and Mitigation in Agriculture

Adaptation and mitigation to agriculture are related thoughts that can deal with menace of climate risks, but have important elements or ingredients that may affect farmer attitudes toward action. Adaptation is defined as "initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects" (IPCC, 2007, p. 809). Agriculture adaptation has always been an integral part of farming, and farmers often adapt to ever-changing environment (Organisation for Economic Co-operation and Development [OECD], 2012). Farmers adapt at different levels and their decisions are primarily driven by their selfish benefits with reference to the environment (Jackson et al., 2010). Agricultural adaptations to impact of climate change may stabilize planting dates of crops, drainage systems, and land management regimes to maintain yields and soil fertility for a considerable number years. According to Lal et al (2011) commonly recommended adaptive actions to overcome adverse impact may consider minimization of tillage and use of cover crops to protect soils from erosion, earth bunds to improve soil moisture and build soil organic matter to increase soil organic content. Such practices can reduce vulnerability within the shortest time scale and accrue the benefits to farmers and other land resource users (Walthal et al., 2012). Hence, adaptation strategies have tangible benefits to resource poor farmers and other users who are committed to adopt the practices.

While adaptation is a local held practice in farming to assuage the adverse impact of climate, climate mitigation is an older concept employed at institutional levels to sequester carbon (Klein et al., 2007). Mitigation is defined as "technological change and substitution that reduce resource inputs and emissions per unit of output" (IPCC, 2007, p. 818). Agricultural mitigation is primarily to reduce GHG emissions of methane gas, nitrous oxide and or increasing carbon sequestration and storage by physical capture of carbon from the atmosphere (IPCC, 2007). However, immediate

benefits of mitigation action are uncertain, and require substantial lag time, and the potential benefit is globally felt than locally (Walthal et al., 2012). Because the benefits of mitigation actions are global, public discourse on how to reduce GHG emissions is concentrated on governments, civil societies and the private sector to bring collective actions to sharp focus to sequester and abate the harmful emissions (World Bank, 2012). At the national level, some governments are legislating measures in the agricultural sector like emission tax to discourage industries and local stakeholders from unnecessarily polluting the environment with GHG emissions (Council for Agricultural Science and Technology [CAST], 2011).

2. 3 Crop Adaptation Strategies

This involves using appropriate technologies to reduce the adverse impact of climate and or exploit the beneficial occurrence by employing appropriate manipulations (Akinnagbe & Irohibe 2015).

2.3.1 Farmers' micro-level adaptation strategies in selected Asian countries

Adaptation is using local coping measures to tackle predicted and unforeseen climate elements (Smith et al. 1996; Smit et al. 1999). According to Bantilan & Mohan (2014) farmers are empowered by improving their incomes and livelihoods to cushion them from weather aberrations.

In India, improved technologies such as climate smart crops which have shorter duration, requiring less water have been introduced to farmers to ensure improvement in crop management (Bantilan & Mohan2014).

Smallholder farmers in India receive credit/loan on soft conditions and a high subsidy on the interest they have to pay on the loans. Continuation of the package can help marginal farmers to succeed in practicing suitable adaptation measures ((Bantilan & Mohan 2014). Efficient co-operatives are established to address felt needs of farmers such as good marketing of produce,

proper management of their small plots to yield optimal produce. Availing opportunities in the non-farm sector in village environs can help farmers pursue different income streams (Bantilan & Mohan 2014).

In Sri Lanka**,** farmers gradually are shifting from annual crops to perennial drought tolerant plantations like cashew, particularly in rain-fed areas where the potential for irrigation is not available. This change is purposively driven by the urge to avoid the risk of crop failure in the event of dorught. Also, adoption of early maturing varieties, hybrids and drought tolerant varieties is hinged on availability of the seeds. Smallholder farmers are diversifying means of livelihoods as an adaptation strategy (Bantilan & Mohan 2014).

Farmers' difficulty in accessing inputs is a bane to result oriented adaptation of any improved management practice. Establishing kinship ties to aid at difficult times is another adaptation strategy farmers. (Bantilan & Mohan 2014). Migration earnings from service are the major sources of diversification. Currently, income diversification has reduced the risk of rainfall variability via reduced dependence on agricultural incomes (Bantilan, & Mohan 2014).

In Thailand, farmers are reluctant to adopt organic matter incorporation due to poor immediate returns. Local authorities' continuous education can help farmers see reason in adopting the practice to enhance soil fertility and improve water holding capacity (Bantilan & Mohan 2014).

2.3.2 Farmers' adaptation strategies in selected African countries

Planting of drought resistant varieties of crops

Ngigi (2009) asserted that farmers use drought tolerant crops in reducing adverse impact of climate change, however, some farmers are unable to access it due to limited access and ability to afford. Nonetheless, some smallholder farmers are continuously using drought tolerant varieties as

adaptation practice in some African countries to prevent food scarcity as well as increasing household incomes (Ngigi, 2009). Also, strategies like storing crop residues and migrating to resource rich areas are being adopted by nomadic pastoralists as an adaptation against drought in areas prone to drought (Langill & Ndathi, 1998).

Crop diversification

Farmers use crops with inherent qualities of withstanding adverse climate impact as adaptation measure in drought prone communities. In some countries, land is prioritized and converted from say livestock farming to multiple land use to maximize its potential. (Ziervogel et al., 2008). In Darfur, food crops have been prioritized to replace cash crops for the purpose of overcoming the severity of drought or famine faced by the people (DFID, 2004). Contrary, in Tanzania, farmers use different types of crops as a measure to prevent total failure of a mono crop on a particular field (Orindi & Eriksen 2005; Adger et al., 2003). Use of variety of crops on the same piece of land often serve as a good insurance against adverse weather conditions.

Change in cropping pattern and calendar of planting

Adverse impact of climate affects crop growth and development when there is shifting in rainfall pattern. This trend usually results in changes in the crop morphology and physiology. Urama & Ozor (2011) revealed that some farmers have noticed the uncertainties of extreme weather events particularly from 2005 to 2009 and wish to adopt appropriate practices to subdue the impact.

Mixed cropping

This practice is commonly employed to improve soil fertility and productivity by adopting cereal legume intercrop or rotation either every two-year or every three-year on the same piece of land. The merits of mixing crops with varying maturity periods is to prevent crop failure in case unfavourable climate conditions prevail, and also minimize pests and diseases incidence on the

farm. Mendelsohn et al. (2000) revealed that analyzing adaptations in some countries brought to fore that planting of the different crops of the same kind is regarded as an adaptation, and, different planting dates is also considered critical adaptation because when drought sets in either the crops planted early or late would be able to survive and blossom.

Improved irrigation efficiency

Success of irrigation efficiency pertains to minimal availability of water in either the crop or the soil medium. With water becoming a major challenge in farming, improved water efficiency becomes an important adaptation tool to irrigate water distress areas for year round production of crops (Selvaraju et al., 2006). Crops find it physiologically stress up during the dry season when soil moisture becomes highly limited and crop moisture uptake rise due to increased evapotranspiration caused by temperature rise. Therefore, introduction of drought tolerant high yielding varieties would aid farmers to improve crop production (Selvaraju et al., 2006).

Increasing number of farmers are yearning to adopt irrigation farming as governments in Africa are committed to constructing dams and dug-outs in farming communities to engage the farmers in all year round farming to reduce rural-urban drift, thus improving the local economies of the communities (Osman et al. 2005). When precipitation improves, farmers irrigate less often and resort to rainfall. Farms in the deserts reduce irrigation when temperature rises. Similarly, when precipitation increases, farms close to the deserts increase irrigation (Selvaraju et al., 2006).

Adopting soil conservation measures

Conservation practices are being adopted by farmers on their farms to make moisture available to their crops during drought or period of poor rainfall distribution in some African countries. Research carried out by Lema & Majule (2009) revealed that farmers ensure good agronomic practices by incorporating farm residues into the soil to replenish soil fertility, practicing cereal

legume rotation and incorporating organic manure or farmyard manure with the view of improving soil organic matter. Generally, farmers improved their adaptive capacity by using indigenous pruning and fertilizing practices to increase tree cover in Savanna areas and these help in binding soil structure and reversing moisture stress. Nyong et al. (2007) noted that farmers conserve carbon in the earth surface through minimum tilling practices, mulching and other soil management practices.

Planting of trees and agroforestry

Farmers plant trees with the view of creating a conducive climate for crops and themselves in the farmland. They plant trees or shrubs they consider having the ability to improve soil fertility as well as providing shed. Farmers also plant trees to rehabilitate degraded or marginal lands. In silviculture, trees are planted to rehabilitate or restore degraded lands usually caused by harvesting or destruction by fires. Farmers in some Africa countries plant or grow different species of trees to mitigate the effect of climate change.

Agroforestry is a kind of farming system farmers adopt to gain multiple products by integrating beneficial crops, trees and sometimes animals on the farmland for optimal use of the land. Farmers derive products such as fuelwood, medicinal plants, sheds, soil fertility improvement among other benefits as the motivation for practicing it (Adesina et al., 1999). This practice is being used by farmers to establish forest-like stand, as can be evidenced in south western part of Nigeria, where farmers use the practice to grow crops that are shade tolerant such as *Dioscorea spp*., and cocoyam in a farmland (Adesina, 1988). Land management practices in agriculture can be improved to cope with drier conditions and use the resulting biomass to increase the soil organic matter to improve crop productivity. The Sahel region which is mostly drier is planted with *Adansonia digitata* and acacia tree species by local farmers to improve the micro-climate of the area (Nyong et al., 2007).

Labour migration

The role of remittances from distant relatives of farmers provides a significant coping strategy during the challenging periods of the years when adjustments food prices are impacted by interventions from organizations (Devereux & Maxwell, 2001). Nomadic herdsmen intrinsically travel with animals from water scare and degraded grazing lands to areas with some pastures in response to drought. However, the necessity to migrate as a response to environmental distress is not an exclusive preserve of nomadic herdsmen as other natives who are also engage in livestock rearing do same during the periods of drought. In western Sudan, one of the adaptive responses to drought is to send an older male family member to the city to find paid labour to help the family subsist until the drought period is over (McLeman & Smit, 2004).

Farmers in Sub Sahara Africa tend to migrate to towns and cities to look for paid wages during the lean or off-farm season so as to be productive and not idle about. This practice is able to fill the hunger gap until the next farming season. Temporal migration is an adaptive response to climate challenge in some Sahel areas which experiences prolonged drought and resource users have adapted a strategy by sending their young male and female in search of paid wages after each harvest, but how far they travel depends partly on the success of the harvest (Oli, 2008).

Income diversification

Mertz et al. (2010) intimated that some farmers in West Africa adapt to low yield by engaging in diversified sources of income to improve their livelihoods and also increase family incomes. This practice is a key source of livelihood for the farmers who cultivate tomatoes in the dry season and export to neighbouring countries like Ghana to earn income. This was corroborated by Nielsen & Reenberg (2010a, 2010b) that local people in northern Burkina Faso thrive on activities that are less dependent on climate for sustenance.

2.3.3. Farmers' adaptations to climate change in Ghana

Ford et al (2011) revealed that farmers' in Ghana adopt to climate adaptation measures on their fields to curb climate risks. Some of the strategies include intercropping different types of cereals and legumes (Tonah, 1993), use of short duration crop varieties (Dietz et al., 2004; Tonah, 1993), alternative sources of livelihood (Laube, 2007), migration (Nabila, 1987), changing crop planting dates (Fosu-Mensah et al., 2010), and diversifying livelihoods and livestock farming (Whitehead, 2006). Some farmers use labor migration to southern parts of Ghana for off-farm employment. Shifting crop planting dates is also employed by farmers due to erratic rainfall pattern.

2.4 Impact of Climate Adaptation Measures on Crop Productivity

Modifying practices to overcome the adverse impact of climate as well as an economic assessment of adaptations shows returns on financial investment which is likely to exceed returns from baseline figure (Apata et al., 2009: Luna 1998).

Farmers use several adaptation strategies to manage climate risk in agriculture. According to Smit & Skinner (2002), strategies such as an adjustment in sowing time, use of stress-tolerant crop varieties and shifting to new crops (e.g. more stress tolerant, or with shorter or longer crop cycles), could significantly reduce risk to climate challenge. Some agricultural management practices of changes in planting dates, fertilizer used, irrigation, plant breed (Challinor et al., 2014) have crop specific implications for both cop and animal growth and development (Porter et al., 2014). These adaptation practices typically reduce risk and are more likely to minimize the severity of the impact of climate change. Therefore, farm households using adaptation practices are more likely to be food secure compared to those not adopting.

Pakistan experience of extreme weather events of untimely and heavy rainfall and flash floods in hilly regions is causing enormous damage to the crops and properties of farmers. The anticipation

is that these conditions will increase as a function of climate change. Bearing in mind the importance of agriculture to the economy and rural livelihoods, the significance of climate change adaptation strategies is crucial. While the adaptation practices are potentially important, not all the farmers use such practices. Adjustment in sowing time may reduce the adverse impact of increasing weather variability and climate change (Ali & Erenstein 2016). Irrigation use is to enhance food yields by complementing rainwater during drought and also prolonging the farming season (Baethgen et al. 2003; Orindi & Eriksen 2005). Implementing irrigation technologies have to be complemented with crop management practices like use of crops that have the ability to use water more efficiently so as to reap the benefits soonest.

Farmers lack of inputs affect their level of adaptation. Market inputs require different seed varieties, fertilizers, and irrigation technologies to improve farm operations. Also, farmers ease of access to markets can motivate them to produce cash crops that have the potential to improve their resource base to respond to adverse climate change (Mano et al. 2003).

According to Affholder el tal (2013) crop yield is determined by farming systems and not dependent entirely on climate. Fischer (1985) agrees with assertion of Affholder el tal (2013) that when farm management principles are appropriately implemented crop yield respond accordingly.

African agriculture constraint to climate risk is as a result of huge reliance on rainfed agriculture, since many of the smallholder farmers are deprived of financial, and limited farm implements and inadequate access to information (Pereira 2017).

Farmers in African are gradually practicing variety of conservation and agro-ecological practices like agroforestry, contouring, mulching, and no-till to reduce climate adverse impact. The practices have the potential benefits of reducing carbon emissions to check climate challenge and at the

same improving sources of livelihoods for poor farmers (Pereira 2017). However, are challenges to their adoption which range from insecure land tenure to knowledge sharing barriers among others.

Africa is the hardest hit by climate challenge for two reasons: its geographical location on the warm tropics withe huge land expanse, and the limited human, socio-economic issues that affect Africans commitment to tackling adverse impact of climate is suspect due to fundamental constraints of few specialized professionals and funding in the area (Leal Filho et al., 2015). Population expansion would invariably hike demand for water and food resources, but prolonged droughts can exert enormous demand on the already scarce water resources to reduce crop yields (CDKN, 2014). Female farmers are especially susceptible to adverse impact of climate challenge because of their near lack of productive resources from the households and sometimes not considered in decision making process (Viatte et al., 2009).

2.4.1 Temperature impact

Global temperatures are observed to be rising in recent times. Africa is recording rise in extreme temperatures (Seneviratne et al., 2012), and heat waves also rising, resulting in more continuous hot days approaching the year 2100 (Niang et al., 2014). Chmielewshi el tal (2004) stated that there is negative correlation between higher temperature and tree crop development and 1^{o}C rise in temperature makes the fruit trees to flourish.

2.4.2 Rainfall impact

Africa precipitation projections are less compared with the corresponding temperature figures, and can be attributed to a lack of reliable data and inaccuracies between different observed precipitation datasets (Niang et al., 2014). According to Williams & Funk (2011) there is reduction in rainfall over eastern Africa between March and May/June, possibly as a result of rapid warming of the

Indian Ocean, which has invariably contributed to increased rainfall over the ocean and less on land. In Ghana rainfall figures show fluctuations across vegetation zones, thus negatively affecting agricultural production levels (Peprah 2014). The utilization of water by crops is been consistent and different crops record decline in yield due to decreasing rainfall or increasing temperatures or both (Owusu-Sekyere 2011).

2.5 Challenges of Adopting Climate Adaptation Measures

Agricultural research in developed countries is often financed by the private sector that is organically associated with the masses (Enete & Amusa 2010). Japan operates for instance operates bottom-top approach in which research decisions are taken at state level without interference from national level. In Mexico also, agricultural research is primarily carried out at the state level without interference from national authority (Enete & Amusa 2010).

The constraint encountered by Africa farmers in adapting to climate is primarily an issue of poverty. Poor farmers habitually would use their limited income to buy basic needs like food, medication, buy agro-inputs in small quantity which invariably culminate in poor yields. They view contour ploughing and drought tolerant crop varieties as expensive inputs for their capacity (Deressa 2008).

Research in agriculture adaptation is an expensive public investment and various governments usually invite bilateral and private organizations to finance the research (Hazell & Haddad 2001; Fan 2000; Fan & Rao, 2003).

Public allocation of resource to agriculture in some Africa countries is woefully inadequate considering the amount invested by industrialized countries. Nigeria allocation of funds for agriculture is very low compared to European countries allocation (Mogues, et al. 2008). The use

of fertilizers on farms in West Africa is generally far below the recommended international rates. A typical example is fertilizer use in Nigeria is woefully 8 kilograms per hectare as against the world average 200kg/ha (Atser 2007).

Remarkably, Malaysia in its quest for development have sustained annual budget allocation of 22 percent on agriculture, and that has accelerated agricultural development (Youngstars Foundation, 2010).

The practice of slash and burn and use of firewood as cooking energy source is aggravating concentration of gases in the atmosphere, that traps heat and causes global warming, sea level rise and climate change (Medugu, 2009). Fundamentally, the major cause of poverty and deprivation among resource poor farmers is destruction of natural resources which leads to environmental degradation, high temperature, drought and reduced productivity (Garba 2006).

As global warming intensifies, it is expected that agricultural adaptation to climate challenge can only be meaningful if irrigated agriculture gains prominence. Unfortunately, agricultural practice in some Africa countries is still predominantly rainfed and still making farming subsistence (FAO, 2008; Medugu, 2008 & IFAD, 2007). The consequences are increasing frequency and severity of droughts to cause: crop failure; high and rising food prices; distress sale of animals; de-capitalization, impoverishment, hunger, and eventually famine.

Land tenure arrangements and disintegration limits farmers' ability to adapt to climate change. Cropland sale rarely occur as a practice, however rental for a period of time with some arrangements of sharing farm produce is known in some Africa countries (Nweke & Enete 1999). Hence, a farmer is not motivated to invest in developing farmlands and adopt innovative farming practices for climate adaptation. A study revealed that chunk of the food is produced by smallholder farmers who cultivate less than one hectare parcel of land per household and depend

on rainfall rather than irrigation systems due to farmers moderate knowledge, access to facilities and poor financing (IFAD 2010; FAO 2008).

According to Enete & Amusa (2010) developing farming systems capable of adapting to the challenges of climate require stable policy environment, which generally has been lacking in successive Africa governments, and even if it exist, new governments would tweak the policy to suit its programme of action. Some of the problems that could result from inconsistent agricultural policies include: high apathy on the part of the farmers regarding anything from government because nobody knows how long such may last; and erratic import policies characterized by frequent changes in import tariffs, hence uncertainty for producers; and failure to set up a satisfactory credit system for farming and agro-processing (Pinto 1987 & Bevan et al. 1999).

Perpetual downsizing of facilities threatens farmers in food storage and processing. Some crop farmers are in a hurry to send farm produce to market immediately after harvest to defray costs, not considering the associated low prices. This is a disincentive in crop marketing and a hindrance to agricultural adaptation (Enete & Amusa 2010).

The sustained dwindling allocation of resources for extension and agricultural training has reduced farmers' access to technology and market information. Unfortunately, the emerging alternative sources of agricultural information like the internet are yet to expand to rural areas, and may be difficult due to language and cost barriers. It is expected that farmers' organizations and the private sector will take the lead towards increased extension, training programmes, internet connectivity, technical and market information provision (Enete & Amusa 2010). The present level of contribution by farmers' organizations and private sector in these areas including research is still very low compared to what is obtainable in developed countries (Enete & Amusa 2010).

In Nigeria and many Africa countries, agricultural research is conducted predominantly by public sector institutions and occasionally with support from bilateral partners to modernize agriculture in Africa (FAO 1996 & Agbamu, 2000), while private-sector activity in agricultural research is negligible, as is the case throughout most of Sub-Saharan Africa (World Bank, 2007).

Notwithstanding women's increasingly prominent role in agriculture, they remain severely deprived in terms of their access to productive resources. African culture largely discriminates against women especially in area of inheriting land. For example, in places where women do not own or inherit land, difficulties have always been experienced in expanding farming activities and reaping the benefits of innovation (Anyanwu & Agu, 1995).

Study conducted by Ndamani and Watanabe (2015) enumerated constraints of adoption to climate challenge in Lawra District in Northern Ghana in descending ranking order as unpredictable weather, high cost of farm inputs, lack of access to timely weather information, lack of access to water resources (e.g., dams), limited access to credit facilities, inconsistency in agricultural subsidies, poor soil fertility, limited agricultural extension officers, limited access to markets, inadequate farm labor, and limited farm size.

2.6 Role of Institutions in Adaptation to Climate Change

Climate change impact is felt globally but adaptation to these impacts would need to be context specific as a result, and therefore the need to develop local adaptation measures to help address the challenge (IPCC 1997). Adaptation to climate change according to Agrawal (2008) would need to occur locally, it is therefore critically significant to understand the role of local institutions in using adaptation to help the most vulnerable social group. Agrawal (2008) said, adaptation to climate change is highly local and its effectiveness depends on local and extra-local institutions through which incentives for individuals and collective actions are structured. Existing institutions

did not only affect how rural people responded to environmental challenges in the past, they were also the fundamental mediating mechanisms that translate impact of external interventions to facilitate adaptation to climate change (Agrawal & Perrin, 2008).

North (1990) defined institutions as "the rules of the game in a society or, more formally, the humanly devised constraints that shape human interaction". According to DFID (1999), institutions are "the organizations, both private and public, that set and implement policy and legislation, deliver services, purchase, and trade and perform all manner of other functions that affect people's livelihood".

These institutions according to Agrawal et al. (2008) intervene and shape adaptation practices in various ways (mobility, storage, diversification, communal pooling, and exchange), and contribute to livelihood outcomes for households through external interventions such as information and training, technology, funds, and leadership. These interventions are regarded as mechanisms to provide resources necessary to enhance adaptive capacity, and whether they actually increase adaptive capacity of resilience depends on the manner in which they become available, the people who gain access to them and the institutional means of their provision (Agrawal, 2008).

Agrawal et al. (2008) asserted that, public institutions are likely to facilitate adaptation strategies related to communal pooling, diversification and storage due to their command over authoritative action and ability to channel technical and financial inputs into rural areas. They asserted further that, public institutions are very relevant in adapting to climate change as they provide external interventions in the form of information, training and technology which builds the adaptive capacity of rural people as well as improve upon their livelihood. This assertion was corroborated by Adjei-Nsiah and Kermah (2012) who in their study concluded that public institutions such as the Ministry of Food and Agriculture (MoFA) and the Forestry Commission (FC) provided

improved cocoa seedlings and training in cocoa agronomy to rural farmers in Wenchi to help deal with the negative impacts of climate variability. Further study done by Egyir et al. (2013) also documented public institutions such as MoFA and FC partnering with informal institutions such as clan heads, family heads, and community leadership groups to implement forest protection regulations aimed at enabling rural households mitigate and adapt to climate change.

Civic institutions are any institution that exists separate from the state and market. It is one that is not engage in governance or business (Agrawal, 2008). Uphoff & Bucks (2006) said civic institutions are voluntary organizations including service organizations and membership organizations. Service organizations may be faith-based or benevolent societies called non-governmental organizations (NGOs), media houses that provide free airtime for discussion of development issues, and other civil society organizations. Membership organizations are NGOs that patronize their own services (Uphoff & Bucks, 2006). Agrawal (2008) asserted that most farmer based organizations or cooperatives assist local communities to adapt to climate change by organizing forums and sensitizing local community members on reducing deforestation and water pollution and engaging in alternative livelihoods such as livestock keeping, bee keeping, handicraft, and agro processing. In some cases they provided a range of inputs (e.g. improved seeds, fertilizers etc.), capacity building in agronomy, and advocacy, to support households in climate change adaptation (Yaro et al., 2010).

UNFCCC has revealed that, private organizations partner with NGOs or the public sector to address climate challenges in vulnerable communities by facilitating in capacity building, education, and training; provision of resources to support food, agriculture, forestry, and fisheries; support for science research, assessment, monitoring, and early warning; and interventions in water resources (www.unfccc.int/adaptation).

2.7 Empirical Literature on Evidence of Changes in Productivity due to Adoption of Adaptation Strategies

Mahouna et al. (2018) revealed that more than 87 percent of smallholder farmers believed climate variability contributed to dip in crop yields, and also about 90 percent of farmers said it resulted in food costs as well. This means appropriate climate adaptation strategies should be used to improve crop productivity and protect households' incomes.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter presents the Conceptual framework, an overview of the study area, method of data analyses for the three study objectives and method of data collection. The section ends with a statement of hypothesis and description of the scope and limitation of the study.

3.1 Conceptual Framework of the Study

The conceptual framework presented in figure 3.1 shows linkages between climate adaptation measures, and crop productivity, resulting in increased smallholder farmers' household incomes. This strong linkage is often negatively affected by lack or inappropriateness of climate technologies or practices. Climate challenge influences adaptation strategies adopted by smallholder farmers. Existing institutions also impact the severity level of climate issue in a particular country. Adaptation measures regulate the productivity and food security status of a household when good agronomic practices are properly implemented or practiced. A lower food production and productivity owing to climate change has implication for food prices and livelihoods of households in a country (Chijioke et al., 2011).

The emergence of climate change as a phenomenon is very devastating to almost every sector of the economy, particularly in Sub-Sahara Africa (SSA) due to its low adaptive capacity as well as inadequate finance. With SSA governments partnering relevant stakeholders to commit resources into adaptation can help address adverse impact of climate change in the agriculture sector. Planned adaptation has greater prospects of reducing vulnerability of farmers when implemented simultaneously by adopting indigenous farmer practices that are climate sustainable practices.

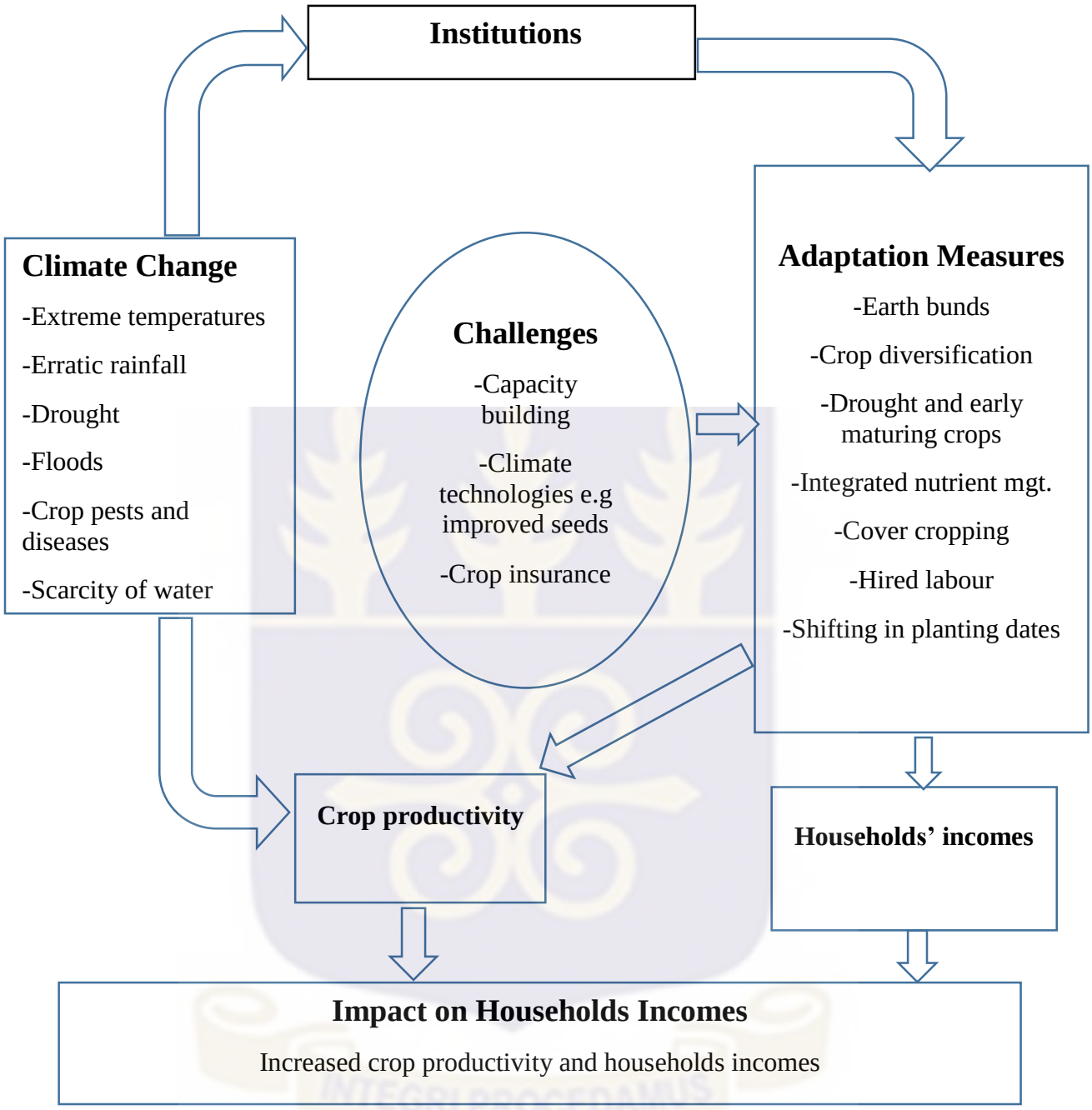


Figure 3. 1: Conceptual Framework: Linking local climate change adaptation strategies to productivity

Source: Modified from (Lautze et al, 2003)

3.2 Method of Data Analysis

3.2.1 Identifying adaptation strategies farmers apply in KNWD

The first objective of the study sought to know the different climate adaptation measures used by smallholder farmers to tackle climate challenge in the district. To achieve this objective, reviewed climate adaptation measures from literature were presented to the smallholder farmers in a semi-structured questionnaire to choose and rank. The farmers gave responses that were in tune with the reviewed ones. This was followed up by 'how long have you used this measure'. The responses were based on the time they started feeling climate change or variability. The next 'why this measure/practice'. The responses matched the structured ones. The last 'how effective are these measures'. Here the effectiveness code or its average score was used. Descriptive statistics was used to analyse and the results presented in a tabular form.

3.2.2 Measuring productivity and determining relationship with climate adaptation strategies

This objective was achieved by using semi-structured questionnaires to gather the smallholder famers' crops grown, mean production, and productivity of the main crops to determine differential impact the adaptation measures have on crop productivity. The data was analysed using Chi-square test and presented the results or findings in tables.

3.2.3 Identifying farmers' challenges in sustaining use of adaptation strategies

To achieve this objective, farmers' challenges of sustaining adoption of climate adaptation strategies were reviewed from literature and the options presented to smallholder farmers to choose and rank. Farmers responded to the different challenges by using the ranking code or its average score to answer. Descriptive statistics was used to analyse and graph to illustrate the results.

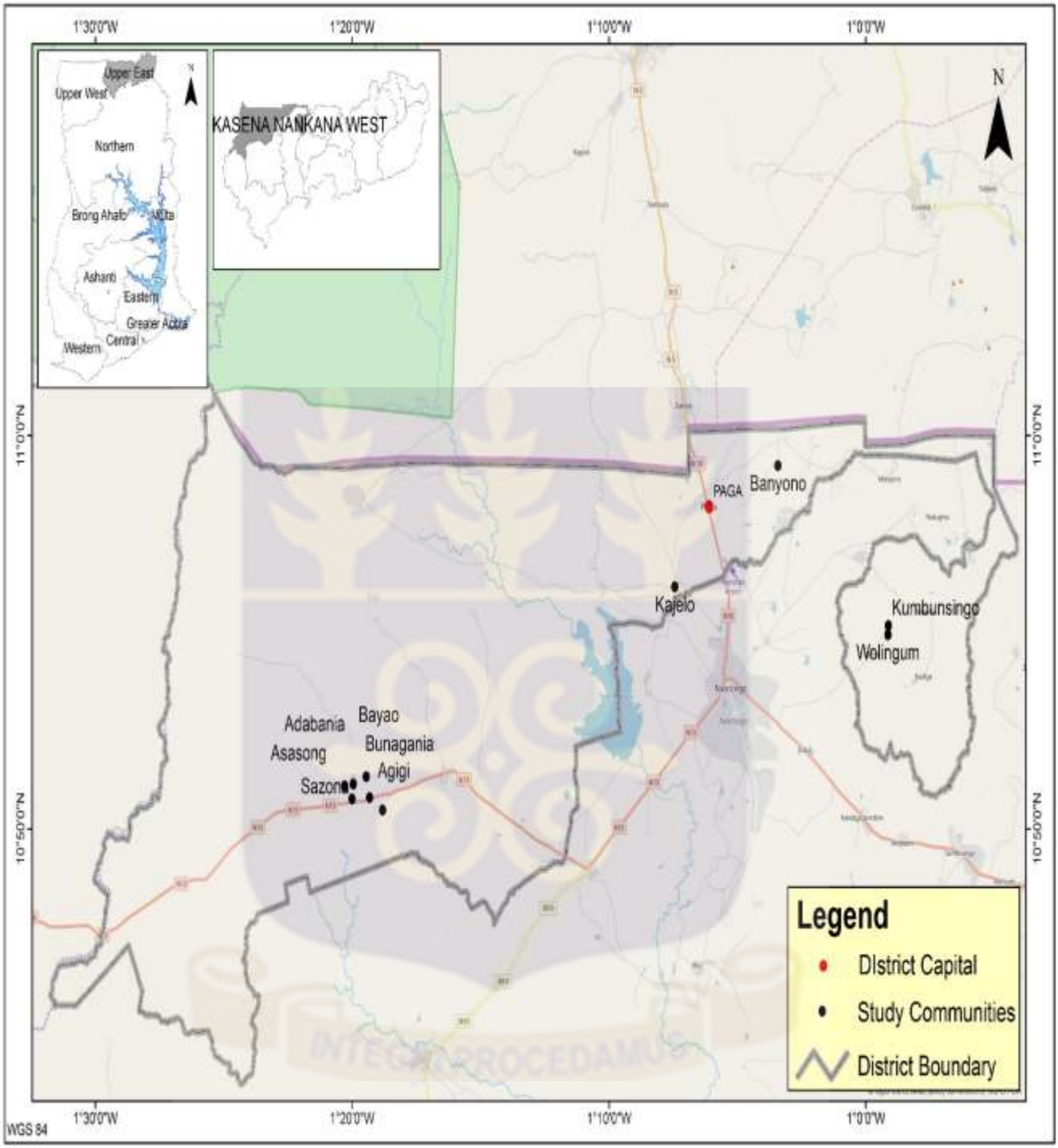
3.3 Method of Data collection

3.3.1The Study Area

The Kassena-Nankana West District is one of the thirteen districts in the Upper East Region of Ghana and it shares boundaries with Burkina Faso, Bongo district, Bolgatanga Municipality, Kassena-Nankana East, Builsa District and Sissala East to the North, North East, East, South, South West and West respectively. Paga is the administrative capital of the district.

It is located approximately between latitude 10.97° North and longitude 01.10° West. The district is made up of 132 communities with net land area of approximately 1,004 km^2 (KNWD Profile 2016).

The relief of the district is generally low lying and undulating with isolated hills rising up to 300 metres in the Western part of the district. Notable among these hills are Fie, (9280 metres), Busono (350metres), and Zambao (360metres) and Atamolga. The district is mainly drained by the Sissili River and its tributaries. There are however some few dams and dug-outs which are used for livestock rearing, vegetable production and for domestic purposes (KNWD Profile 2016).



Source: KNWD Profile, (2016)

Figure 3. 2: Map of Study Area

Farming is the dominant economic activity in the district. The sector employs over 83.7% of households. Crop production represents 96.7% and livestock 82.8%. The major crops grown include maize, sorghum, rice, groundnuts, just to mention a few. Also, livestock reared comprise of cattle, sheep, goat, pigs, and guinea fowls and other domestic animals like donkeys. Maize production 3,825mt, groundnut 5,373mt, and millet 2,976mt. The main livestock produced include cattle 68,456, sheep 94,563, donkey 24,689, goat 24,689 and local birds 58,975 (KNWD Profile 2016).

Apart from agriculture, the local people are also engaged in other livelihood activities like sheabutter extraction, pito brewing, dawadawa processing, weaving, smock making, pottery, soap making, rice processing, and baobab fruit harvesting and processing (KNWD Profile 2016).

3.3.2 Sources of data

Primary data enables researchers to obtain critical first hand data of a particular research issue and compare with existing literature to make an informed position, though subject to specific location and time span. Primary data contributes to researcher's ability to address the most important issues in the research context (Robson 2002). As a result, primary data was used to collect useful data through face to face in-depth interviews and discussions for this study.

Data collected include demographic information; farmer practices; sources farmers heard climate adaptation measures; impact of farmers adaptation measures on crop productivity; off farm activities & other farming activities; and challenges of sustaining adoption of climate adaptation measures. Data of two local Non-Governmental Organizations who facilitate farmers in adapting climate change adaptation measures were also collected. The study interviewed smallholder farmers, lead farmers/key informants and Agricultural Extension Agents (AEAs) representing the

Department of Agriculture at the household level, and also interviewed the local NGOs at the district capital, Paga.

The study also reviewed secondary data from online materials such as journals, articles, books and other related information.

For purpose of obtaining reliable and valid data, a mixed method was employed. This mixed approach has the ability to complement the weaknesses and strengths of each of the qualitative and quantitative methods. The reason or rationale for mixed approach method is that, quantitative method is seen as weak in the context of dealing with people's behavior which qualitative method is able to make up for. On the other hand, qualitative method is deficient because, it has a potential of giving bias interpretation to findings and can even extrapolate such findings to larger groups. So, the strengths of these two methods would be able to make up for the weaknesses of each other.

The qualitative method was used to complement the quantitative method in the study. Specifically, the type of mixed method used was the sequential explanatory, which is characterized by collection and analysis of quantitative data followed by collection and analysis of qualitative data in a single study, with priority given to quantitative data.

Procedure of data collection

The method employed for quantitative data collection was in-depth interviews using semi-structured questionnaires attached as appendix I for the smallholder farmers' to select the most appropriate choices per their understanding of the impact of climate change adaptation measures on smallholder farmers'. Saunders (2000) posited that, the use of questionnaires and in-depth interviews assist researchers to gather reliable and valid data relevant to the research questions and objectives, and at the same time, provide first-hand information regarding the area of study.

Also, the mode of data collection for both quantitative and qualitative methods was face-to-face interviews and discussions with the smallholder farmers represented by either the household heads or representatives who are very conversant with the households farming practices.

An in-depth interview was conducted using interview guides attached as appendix II with the lead farmers/key informants at the farm household level to solicit their views or opinions on impact of climate change adaptation measures on smallholder farmers' crop productivity. Also interview guides attached as appendix III were distributed among the local NGOs and they filled and returned them at their own convenience. The research provides a more in-depth description and understanding of events and it helps the researcher to gain insight into why and how events or actions take place rather than just presenting a phenomenon (Barbie and Mouton, 2007). In the process of conducting the interviews, an observation was made of the demeanour of the respondents regarding the quality of the responses offered. According to Merriam (1998), the observation process involves looking and listening carefully in order to discover particular information about respondent's behaviour. Mixed method was employed for data gathering for the three research questions.

Sample size determination

In determination of sample size for the study, the formula: n = $N/_{\mathrm{N}(1+\mathrm{N})\mathrm{e}2}$ where n = sample size, N = population size (74,120 based on 2010 Population and Housing Census for the district), e=level of precision (0.05), when used would require a sample size of 400, but due to resource constraints of finance and time, 110 respondent farmers were selected and interviewed for the study, representing 27.5 percent of the sample size. Out of the 110 respondents, 35 respondents (Male-26, Female-9) came from the central zone, 40 respondents (Male-22, Female-18) from west zone, and 35 respondents (Male-26, Female-9) also from the east zone. Disaggregation of

communities in the zones include Central zone communities (Kajelo and Banyono), West zone communities (Asasong, Adabania, Agigi, Bayao, Bunagania and Sazona), and East zone communities (Wolingum and Kumbunsingo).

Disaggregation of the 110 respondents: 71 of the respondents were interviewed using quantitative semi-structured questionnaires and the other 39 of the respondents were also interviewed through qualitative interview guides. The 71 respondents comprised of 14 male and 5 female from central zone, 15 male and 14 female from west zone, and 17 male and 6 female also from east zone. For the 39 respondents, 12 male and 4 female from central zone, 7 male and 4 female from the west zone, and 9 male and 3 female from the east zone.

Three institutions interviewed include one public; Department of Agriculture; Organization for Indigenous Initiatives and Sustainability Ghana; and Organization for Sustainable Agriculture and Rural Development in the district.

Sampling technique

Mixed method approach was used to capture data for the study. Firstly, purposive sampling was employed to select Kassena Nankana West District for the study. Two communities each in the central and east zones, and six communities in the west zone were purposively chosen due to similarity in farmer practices, demographic characteristics, farm sizes, sources of livelihood, and types of crops cultivated. Six communities in the west zone because a lot of projects have sensitized farmers there to adopt climate adaptation measures to mitigate the adverse impact of climate change on their livelihoods. The farmers in the central and west zones spoke predominately Kasem, while the two communities in the east zone also spoke predominately Nankani with only one farmer who responded to a questionnaire in Buli dialect. According to Barbie and Mouton

(2007), purposive sampling technique is the best way to elicit rich qualitative data from respondents.

Smallholder farmers were purposively selected from the various communities in the three zones as a result of them practicing some of the climate adaptation measures. The lead farmers or key informants were also purposively chosen due to their adoption of the climate adaptation measures and encouraging other farmers to also adopt in the communities. The interviews with the smallholder farmers and lead farmers was done face to face to elicit their key unique understanding or perspectives on issues pertaining to climate change adaptation.

After purposive sampling of the target farmers, it was realized that the number was huge for the study, and therefore, simple random sampling of quantitative method was further used to sample the required 71 farmers in the various communities for the study in the district. It was done using the semi-structured questionnaires. The remaining 39 farmers were purposively chosen and interviewed using the interview guides in the various communities in the district.

Two Agricultural Extension Agents who facilitate smallholder farmers on climate adaptation measures in the zones were purposively selected because of their experience in climate change facilitation for the study. Interview guides and discussions were used to conduct an in-depth interviews with the Organization for Indigenous Initiatives and Sustainability Ghana (ORGIIS) and Organization for Sustainable Agriculture and Rural Development, the two local NGOs that were available at the time of the study. Thus, they were conveniently sampled and interviewed on the climate adaptation measures they facilitate on for the smallholder farmers in the district. It was realized during the study that, farmers who were thought of not adopting climate adaptation measures, were rather adopting them inadvertently.

Statement of Hypothesis

Hypothesis 1 H_o: Climate change adaptation measure has no differential impact on smallholder farmers' crop productivity.

Hypothesis 2 H_1: Climate change adaptation measure has differential impact on smallholder farmers' crop productivity.

The decision rule is to reject the Null Hypothesis (H_O) in favour of the Alternate Hypothesis (H_A).

Statement of Hypotheses and Significant Test

H_O: There is no difference in climate change adaptation measures used by smallholder farmers' on crop productivity.

H_A: There is difference in climate change adaptation measures used by smallholder farmers' on crop productivity.

Where **H_O** is the Null Hypothesis and **H_A** is Alternate Hypothesis. Significance in agreement in the climate change adaptation measures was tested by use of the chi-square test. This is stated as:

$$X^2 = \sum \frac{(O-E)\,2}{E}$$

Where:

X^2 –Chi-square

∑-Sum of the above frequencies across all cells

O-Observed frequency

E-Expected frequency

3.4 Scope and Limitations of the Study

The assumption behind this study was that, the sampled smallholder farmers were fair representation of farmers in the Kassena Nankana West District due to similarity in their cultural, and socio-economic activities. The assumption may not hold true for some farmers since there were few migrant farmers in the district. More than fifty percent of the farmers interviewed were not educated, and therefore, they found it difficult to keep farm records. Even the educated ones were reluctant to keep farm records. They recalled information from their memories as was evidenced during the interviews with the farmers. Consequently, it could be assumed that the information or data provided by the farmers were not entirely accurate. Nonetheless, the findings and the recommendations emanating from the data should be considered seriously for action.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Introduction

This chapter represents the results analysis of data collected during the study. It covers the method of data analysis, socio-economic characteristics of smallholder farmers in the district. It comprises of sex of respondents, age of respondents, households size of respondents, level of education of respondents, average annual incomes of respondents, and smallholder farmers understanding of climate change in the study area.

The chapter further presents the results analysis of data gathered during the study. The first part covers the climate change adaptation measures known and applied by the farmers, and determines the impact of farmers' climate change adaptation measures on crop productivity. The second part describes challenges of sustaining adopting climate adaptation measures among farmers and role of institutions in climate change adaptation in the Kassena Nankana West District.

4.1 Method of Data Analysis

This section presents the different methods the study used to analyse data on the specific objectives. Data from the study was collected, synthesized and analysed using Statistical Package for Social Sciences (SPSS) version 25, and descriptive analysis.

4.2 Socio-Economic Characteristics of the Respondents

4.2.1 Sex of Respondents

Sex have a major influence on the way people perceive things and respond to situations due to biological and physiological differences among the sexes (Phuong 2012). Hence, it is important to categorize respondents to be able to get variety of feedbacks from male and female based on their

individual experiences, opinions, and observations. From table 4. 1, men represent 64.8 percent, while women 35.2 percent of the total respondents in the district. Men are decision makers in almost everything at the household level, being it, which land to be used for cultivating what crop, how much to be spent on farming, what quantity of produce should be sold and so on. Female headed households are limited, even in the case of a deceased husband, the eldest son takes control of the households with the support of the household members. However, few female headed households take decisions pertaining the kind of livelihoods they want to engage in, and these category of female are resourceful. They take decision on which crops and hectare to cultivate, and which off-farm activity to practice. Decisions emanating from the farmers are usually guided by the heritance or socio-cultural setting of the area.

4.2.2 Age of respondents

Categorization of respondents' age is very important in helping obtain feedback on cohort experiences and observations. The youngest respondent was 20 years and oldest was 70 years old. From table 4.1, the youth represents the majority with 59.2 percent of the total respondents and the aged constituting the least 40.8 percent. The respondents in the study were dominated by the youth. The youth who participated in the study were predominately the young and middle aged men constituting the household heads, but the total aggregation of all the memberships of the various households would project female as the majority.

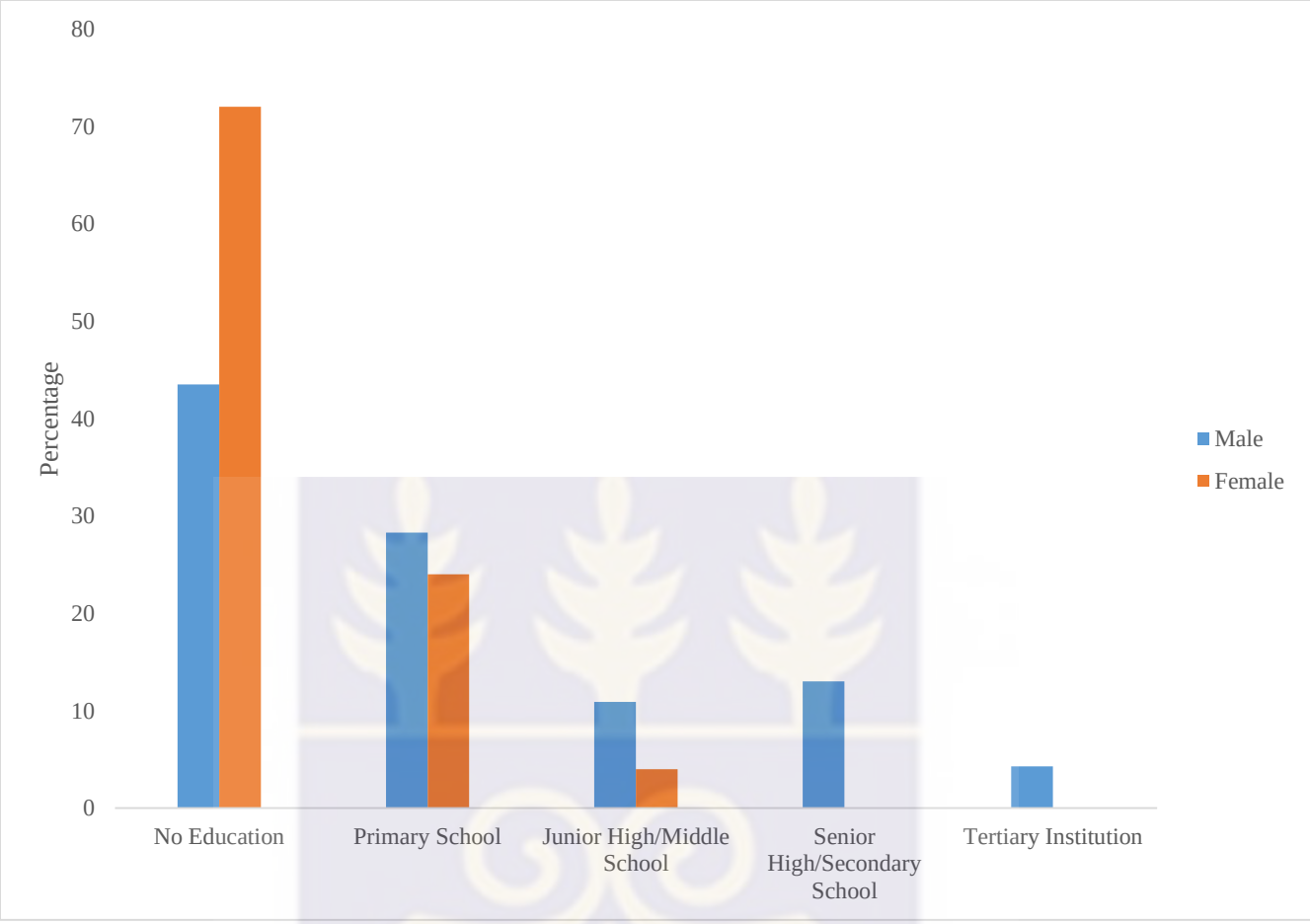
4.2.3 Household size of respondents

Household is the basic residential unit that includes all individuals living in the dwelling (Sullivan & Stevens 2003). It has been said that household size and composition is a key determinant factor for capabilities, choices, and coping strategies available to its members (Rakodi 2002). It can be deduced from table 4.1 that households with persons below 5 constituted 21.1 percent, and

households with persons between 6 to 10 constituted the largest with 67.6 percent of the total respondents, followed by households with persons above 10 being the least with 11.3 percent of total respondents. This implies that households with persons between 6 to 10 may have more labour force to support agriculture and non-agricultural activities. However, in case of extreme weather events, the households with greater members can overcome negative impact of climate perturbation if they are engaged in dry season gardening and other off-farm ventures. This assertion supports Mertz et al. (2010) when they said farmers' ability to adapt to effects of low yield as a result of extreme weather events by doing dry season gardening during the lean period and practicing other non-farm income ventures for their livelihoods enhancement. Therefore, understanding the households' composition of the respondents is imperative in terms of relationship between smallholder farmers, their family members, and livelihoods they have access to, in order to create new ones or sustain the existing ones.

4.2.4 Educational level of respondents

Maddison (2007) asserted that, the number of years of education of smallholder farmers is a major determinant shaping how they perceive their business and changing climate. From figure 4. 1, male respondents who had primary education represented 28.3 percent, while 24 percent represented female who did. Similarly, only 13 percent of the male attended Senior High School/Secondary School with no female SHS student. Those without education constituted majority of the respondents with female dominating with 72 percent as against 43.5 percent for male. These findings imply that more female smallholder farmers are likely to perceive changing in climate than male smallholder farmers in the district. This finding tends to disagree with Maddison (2007) assertion that male are likely to perceive change in climate than female.



Source: Computation from field data, (2017)

Figure 4. 1: Educational Level of Respondents

4.2.5 Average annual incomes of respondents

According to the Ghana Living Standard Survey (round 6), 2.2 million people representing 8.4 percent do not earn annual income of GH¢792.05 and are classified as being extremely poor. This category of people are unable to feed themselves even when asked to spend all their income on food. With respect to the upper poverty line, there are 6.4 million Ghanaians (24.2 %) who do not earn annual income of GH¢1,314.00, are also considered poor. This high poverty rate has been ascribed to the low level of incomes individuals earn from their respective economic activities (Ghana Statistical Service, 2014c).

Table 4. 1 indicates income range of GH¢ 1,001.00-2,000.00 constituting the largest of the smallholder farmer respondents with average annual income representing 39.5 percent, followed by GH¢ 2,001.00-3,000.00 with average annual income (32.4 %) of the total respondents interviewed. The least among them is those with average annual income of GH¢ 4,001.00-5,000.00 of the total respondents having 1.4 percent. Per the Ghana Statistical Service (2014c) figure of 24.2 percent of Ghanaian who do not earn annual income of GH¢ 1,314.00, then it can be said that 39.5 percent of the smallholder farmers in the district are mildly above the upper poverty line.

Smallholder farmers invest in farming with the hope of getting good returns on their investments, but unfortunately, this does not reflect in most incomes of farmers. However, only few smallholder farmers committed to their investments by employing appropriate agricultural practices or good agronomic practices of procuring improved crop varieties, land preparation that conserves moisture on the fields, timely seeding, weeding, and fertilizer application and harvesting, are able to get good yields, culminating in appreciable average annual incomes. Off-farming activities play a vital role in enhancing incomes of smallholder farmers. Some of the farmers related that they aggregate their harvested crops and sell them later when the prices are good on the open markets.

Those farmers with artisanal skills also do off-farm businesses like dry season gardening, selling of some livestock to supplement their households' average annual incomes, by engaging in non-agricultural activities that depend less on the climate. These findings agree with a study done by Mertz et al. (2010), when they said farmers adapt to low yields of crops involving themselves in off-farm activities that have the potential to improve their livelihoods. This was supported by another study, which said farmers concentrate on off-farm activities that are less dependent on the climate, thus are not adversely affected by consequences (Nielsen & Reenberg 2010a, 2010b).

Table 4. 1: Socio-economic characteristics of the respondents

Variable	Frequency	Percentage
Gender		
Male	46	64.8
Female	25	35.2
Age		
Youth	42	59.2
Aged	29	40.8
Household size		
Below 5	15	21.1
6-10	48	67.6
Above 10	8	11.3
Average annual income		
Less than GH¢ 1,000.00	11	15.5
GH¢ 1,001.00-2,000.00	28	39.4
GH¢ 2,001.00-3,000.00	23	32.4
GH¢ 3,001.00-4,000.00	5	7
GH¢ 4,001.00-5,000.00	1	1.4
Above GH ¢5,000.00	3	4.2

Source: Computation from field data (2017)

4.2.6 Farmers understanding of climate issues

Farmers hearing of climate challenge does not necessarily imply understanding of the issue. It is critical to establish farmers' understanding and perceptions of climate issues. Farmers' understanding of climate issues is important in determining which strategies to use to reduce climate adverse impact on them (Gwambene et al. 2015). Table 4.2 shows smallholder farmers degree of understanding of climate change by those who chose indicators combination of ([water scarcity, increased rainfall, reduced rainfall, high temperatures, low temperatures] & [water scarcity, high temperatures, high incidence of pests and diseases] & [water scarcity, high temperatures, low temperatures] & [reduced rainfall, high temperatures, low crop productivity]) as having good knowledge of climate change representing 22.5 percent, those who chose indicators combination of ([water scarcity, reduced rainfall, high temperatures, high incidence of pests and diseases] & [increased rainfall, low temperatures, low crop productivity, high incidence of pests and diseases] & [water scarcity, reduced rainfall, low crop productivity, high inputs cost, heat waves, high incidence of pests and diseases]) as having moderate knowledge of climate change with 52.1 percent, and those who chose indicators combination of ([water scarcity, reduced rainfall, high temperatures, low temperatures, high incidence of pests and diseases] & [water scarcity, reduced rainfall, high temperatures, low crop productivity, heat waves] & [water scarcity, high temperatures, high incidence of pests and diseases] & [reduced rainfall, high temperatures, low temperatures] & [reduced rainfall, low temperatures, high incidence of pests and diseases] & [reduced rainfall, high temperatures, low crop productivity]) as having little knowledge of climate change also with 25.4 percent. This was because farmers who were more impacted by climate change tend to remember the events that affected their activities, and they remember in their memories (Gwambene et al. 2015). Little understanding or knowledge of climate change gives rise

to low adoption of climate change practices. Farmers understanding or awareness on climate change, help them select adaptation measures appropriate for climate change impacts and the factors influencing the choice of adaptation measures (Antle, 2009: Aune, 2012).

Table 4. 2: Farmers understanding of climate issues

	Frequency	Percent
Good Knowledge	16	22.5
Moderate Knowledge	37	52.1
Little Knowledge	18	25.4
Total	71	100.0

Source: Computation from field data (2017)

4. 3 Climate Change Adaptation Measures Known and Applied by Farmers

As stated by Akinnagbe and Irohibe (2015), smallholder farmers adapt to negative impact of climate by employing climate smart strategies to abate the impact on their livelihoods as well as exploiting positive impact by those who are adequately positioned to capitalize on the availed opportunities. According to Bantilan and Mohan, (2014) adaptation options empower farmers to enhance their incomes and livelihoods, and this can cushion them from various shocks and extreme weather conditions. The activities undertaken by smallholder farmers help to identify the different adaptation measures.

FAO (2008) stated that about 90 percent of commodities are produced by smallholders who cultivate small fields and depend on solely on rainfall for production rather than irrigation systems due to knowledge challenge, inaccessible facilities and poor financing. The issue was earlier summarized by Garba (2006), who said the major cause of poverty is as a result of limited knowledge among the local farmers and unreliable government subsidies on agricultural inputs.

Table 4.3 presents analysis for the ranking of the adaptation measures employed by the farmers in the district.

There was difference in the listed five adaptation measures adopted by the farmers in the district. The most adopted adaptation measures among the farmers include integrated nutrient management with an average rank score of 18.3, followed by cover cropping with an average rank score of 16.9, and the least adopted hand-dug irrigation with an average rank score 10.2. The low adoption of hand-dug irrigation is because the high cost involved for the farmers use.

Table 4. 3: Ranking of Climate Change Adaptation Measures

Measures	Very effective	Moderately effective	Effective	Less effective	Average score
Adoption of drought tolerant crop variety	32.4	5.6	5.6	2.8	11.6
Irrigation (Hand-dug well)	18.3	8.5	11.3	2.8	10.2
Cover cropping	33.8	21.1	5.6	7	16.9
Integrated nutrient management	8.5	42.3	15.5	7	18.3
Minimum tillage	2.8	11.3	22.5	16.9	13.4

Source: Computation from field data (2017)

4.3.1 Sources farmers heard about climate change adaptation measures

Smallholder farmers receive information on climate change adaptation measures through variety of ways (Dinshawn 2012). The source used by many respondents was radio, researchers, extension officers and NGO. Other methods used in disseminating climate adaptation measures include school, books, elders and witness, own observation, Television and newspapers as well as village

meetings (Gwambene et al. 2015). In discussions with the smallholder farmers during the study, they confirmed that, they do listen to climate change practices usually organized by Non-Governmental Organizations in conjunction with the Department of Agriculture on URA Radio in Bolga and Nabina Radio also in Navrongo in the evenings after they have returned from their farms. The radio programme is to sensitize the smallholder farmers on relevant adaptation strategies they can employ to minimize the negative impact of climate on their agribusinesses.

Under Research Extension Linkage Committee (RELC), a platform where researchers, extension officers and farmers meet to share ideas and experiences on farming issues for redress. Newly released improved varieties of crops especially drought tolerant varieties are demonstrated to farmers at the community level and the challenges emanated during the demonstrations are shared in a RELC meeting for researchers and extension officers to find solutions to. Example is farmers investing in grafted mango plantations and after five years and beyond, the grafted mangoes fail to fruit.

It can be observed from table 4.4 that the source farmers get to hear of climate adaptation measures in the study area was farmer friend (80.3 %), followed by local radio station (71.8 %), Agricultural Extension Agent (69.0 %), and the least being farmer exchange visit (9.9%). The findings of the study agree with Gwambene et al. (2015) assertion that, the sources of climate adaptation measures are through NGOs and agricultural extension agents, and among others in reducing adverse impact of climate change on livelihoods. The findings also revealed that, one of the major sources of adopting to the climate adaptation measures was through farmer friend or farmers learn by observing the successful practices of others, which affirms the findings of Gwambene and Majule (2010) and Lamboll et al., (2011). The farmer exchange visit was the least heard partly due to the cost of transporting and refreshment for the farmers.

Table 4. 4: Sources farmers heard about climate change adaptation measures

Response	Farmer Friend	Relative	AEA	SLWMP	FBO	Local NGO	Farmer Exchange visit	Local Radio Station
Yes	80.3	39.4	69.0	12.7	19.7	26.8	9.9	71.8
No	19.7	60.6	31.0	87.3	80.3	73.2	91.1	28.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Computation from field data (2017)

4.4 Determine the Impact of Farmers' Climate Change Adaptation Measures on Crop Productivity

Adjusting farmer practices to specific society can overcome adverse impacts of climate on smallholder farmers (Apata et al., 2009). An economic evaluation of adaptation strategies on farming reveals that in some instance the returns on financial investments made in farming yields better outcome when compared to the initial investment made by the investor (Luna J. 1998). Such evaluations or audits can help farmers to adopt adequate climate strategies in both on and off-farm ventures.

The use of short duration crop varieties and adjustment in sowing time may reduce the adverse impact of increasing weather variability and climate change. (Ali & Erenstein 2016). Smallholder farmers make use of various agricultural practices to overcome several environmental problems like low soil fertility, climate variability, and farmers practicing of strategies which are feasible and can increase yields and food security (Gwambene et al., 2015). The main crops considered for the study include maize, rice, sorghum, groundnut, soybean, and cowpea.

Table 4.5 shows results of Chi-square tests conducted on the fourteen different climate adaptation measures vis-a-vis the farmers grown crops, revealed that, there was an association between six adaptation measures and their associated crops. The association between the farmers' adaptation measures or practices and the crops showed a significant difference at 5 and 10 percent. The major

farmer practices or adaptation measures having significant associations with the crops include shifting planting dates using maize and groundnut, agroforestry using cowpea and maize, hired labour using soybean and groundnut, and crop diversification using rice and maize.

The findings tend to agree with Apata et al., (2009) assertion, who said, adjusting climate adaptation practices to specific area may offset the adverse effect of climate change on smallholder farmers livelihoods. Climate adaptation measures are location specific in agriculture, and perhaps, different adaptation measures may reveal different Chi-square tests results at different locations. Also, the findings agree with Luna (1998) assertion, who posited that economic assessments of adaptation measures in some cases yielded return on financial investments and likely to exceed returns on initial investments.

Zai planting technique is a climate adaptation measure that is very good in moisture and nutrient conservation/improvement in a pit like-field usually in semi-arid areas, but smallholder farmers do not find it feasible and friendly to use due to it drudgery nature to practice, or very difficult to practice. As a result, none of the interviewed smallholder farmers' practice it. This corroborates Gwambene et al., (2015), who said smallholder farmers make use of various agricultural practices to overcome several environmental problems like diminishing soil fertility, drought, and farmers practice measures they perceived to be feasible and can increase yields and food.

Irrigation, cover cropping, and mulching also had significant associations with some of the crops when the Chi-square test was used. However, irrigation use is limited in the district, especially in the west and east zones of the district. Another reason for its limited use was its being capital intensive to construct, even as a hand-dug well for dry season gardening and domestic use. The findings agree with Selvaraju et al., (2006), who reported that adverse climate impact is anticipated to decrease fresh water supply for farming and domestic use as well as decrease soil moisture

during the dry season, while the crop water demand is expected to increase because of increased evapotranspiration caused by rise in temperature.

Table 4. 5: Chi-Square Tests of Association between Farmer Practice and Crop Productivity

Farmer practice	Crop	Test Value	df	Sig. (2- sided)
Shifting planting dates	Maize	5.92	2	0.05
Shifting planting dates	Groundnut	5.26	2	0.07
Agroforestry	Cowpea	6.40	2	0.04
Agroforestry	Maize	12.20	2	0.00
Irrigation	Rice	11.40	2	0.00
Hired labour	Soybean	5.27	2	0.07
Hire labour	Groundnut	5.54	2	0.06
Crop diversification	Rice	5.79	2	0.06
Crop diversification	Maize	5.12	2	0.08
Cover cropping	Groundnut	10.12	2	0.01
Mulching	Groundnut	9.33	2	0.01

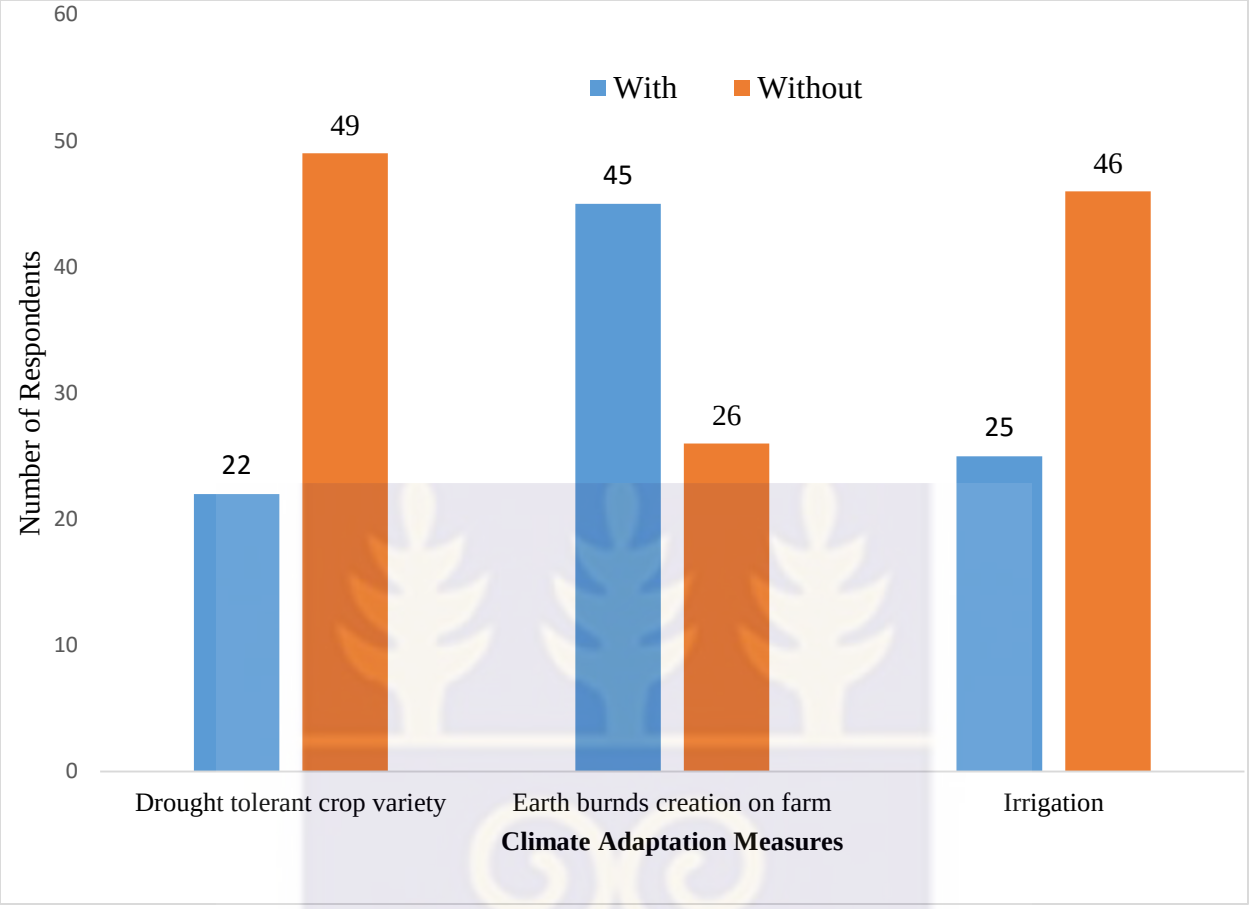
Source: Computation from field data (2017)

4.4.1 Practicing adaptation measures for the past 5-10 years

Drought tolerant crop variety, earth bund creation, and irrigation (hand-dug well) are gradually being embraced by smallholder farmers to check adverse climate impact in the district. Among the three climate adaptation measures, earth bund creation is catching up with the smallholder farmers due to the ability of the measure or strategy to prevent soil erosion and soil moisture conservation especially during the dry season. Forty-five (45) smallholder farmers interviewed said they are already practicing earth bunds as against twenty-six (26) who are yet to adopt. Hand-dug well irrigation technique is a popular practice among smallholder dry season farmers who grow chilli or pepper as cash crop in the district. Twenty-five (25) farmers interviewed are already practicing hand-dug well irrigation as against forty-six (46) farmers. The determined farmers try to use manpower to construct the hand-dug well as a source of water to irrigate the pepper fields, which is a major cash crop for dry season farmers in the district. Market queens come from Accra,

Kumasi, Takoradi, Techiman and other urban areas across the country come to purchase pepper in the district. Even, some form of contract farming is established in the pepper value-chain approach. The market queens or buyers pre-finance the agro-inputs to the farmers with the assurance of having the first right to purchase the produce during harvesting, and trade-offs made among the financier and the famer. Use of drought tolerant crops are also catching up among the smallholder farmers, but the major challenges are the cost and accessibility of the varieties in the district. Out of the seventy-one respondents, only twenty-two (22) have adopted the use of drought tolerant crop varieties as against forty-nine (49) smallholder farmers who genuinely cannot afford the high cost of the seeds to mitigate adverse climate change impact.

Most smallholder farmers' ability to practice the adaptation measures was low, but the willingness to practice and adopt is high. The low adoption of climate adaptation practices or climate smart agriculture (CSA) can be likened to socio-economic, and other issues. The major factors for low adoption of CSA practices by most smallholder farmers as contained in literature (Nyanga et al., 2011; Taneja et al., 2014) are, but not limited to, less mechanization within the smallholder farming practices; shortage of appropriate implements; inappropriate soil fertility management options; inappropriate technical information, limited/poor access to credit.



Source: Computation from field data (2017)

Figure 4. 2: Practicing adaptation measures for the Past 5-10 Years.

4.4.2 Mean production of crops

The mean production of the grown crops of the smallholder farmers reflects their level of productivity and economic livelihoods in the district. This has the ability to translate into increased family incomes or otherwise. Most of the smallholder farmers cultivate a land area usually less than two hectare due to limited availability of resources like land, finance, agro-inputs, farm implements, storage facilities, poor marketing of produce, and difficulty or reluctance to keep farm records. Table 4.6 describes the mean production of the main crops grown by the smallholder farmers across the district. Typically, the highest mean production figures of the smallholder farmers were found in the range between 0 to 0.5 tonnes for maize, rice, sorghum, groundnut, cowpea, and sorghum. Cowpea had the highest mean production figure of 98.6 percent, followed

by soybean 94.4 percent, sorghum 90.1 percent, and the least maize with 38.0 percent. The analysis or figures tell us that, crops requiring the right quantity and timely application of fertilizers were performing poorly due to resources constraint of smallholder farmers in the district. Low yields of the farmers tend to agree with findings of Affholder el tal (2013) when they said crop yield is influenced by farming systems and not dependent entirely on climate. Fischer (1985) also supported the assertion of Affholder el tal (2013) that when farm management principles are implemented appropriately crop yields respond accordingly.

A good number of smallholder farmers are now venturing into maize cultivation, as evidenced by the production output of maize in the range more than 1.0 tonnes.

Table 4. 6: Percentage of Mean Production Outputs of Crops

Output levels	Maize	Rice	Sorghum	Groundnut	Cowpea	Soybean
Up to 0.5 tons	38.0	67.6	90.1	69.0	98.6	94.4
0.51 to 1.0 tons	39.4	26.8	9.9	23.9	1.4	5.6
More than 1.0 tons	22.5	5.6	0.0	7.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Computation from field data (2017)

4.4.3 Production level of the main crops

Crop production is related to the quantity or yield produced per the area in hectare. According to OECD (2018) maize yield in Ghana in 2017 is 2.836 tons/ha juxtaposed to the mean yield of maize in the study area 1.209 tons/ha. This yield figure is far below the recommended yield and it cuts across for rice, sorghum, groundnut, soybean, and cowpea in the study area. The low yields of the crops can be attributed to poor agronomic practices employed by the farmers and not dependent entirely on the climate of the area. The findings agree with assertion of Affholder el tal (2013) when they said crop yield is determined by the farming systems and not dependent only on the climate.

Table 4.7: Summary Statistics of the Mean and Standard Deviation of the various Crops

Crops	Area (Ha)	Quantity (Tons)	Productivity (Tons/Ha)
Maize	0.611 (0.458)	0.881 (0.863)	1.209 (0.676)
Rice	0.310 (0.292)	0.373 (0.381)	0.898 (0.813)
Sorghum	0.299 (0.270)	0.228 (0.240)	0.521 (0.525)
Groundnut	0.524 (0.360)	0.528 (0.547)	0.919 (0.640)
Soybean	0.118 (0.210)	0.097 (0.211)	0.219 (0.411)
Cowpea	0.138 (0.243)	0.070 (0.152)	0.169 (0.298)

The standard deviations are in brackets.
Source: Computation from field data (2017).

4.4.4 Off-farm activities and other farming ventures

Off-farm activities are essential component of livelihood strategy among rural households in developing countries. When farming becomes less profitable and more risky due to population growth, crop and market failures, then households moved into off-farm activities. Farm households engage in alternative off-farm ventures when the returns are higher or less risky than in crop farming (Babatunde et al., 2010). Survey conducted by Mertz et al. (2010) indicated that farmers adapt to low yields of crops by making alternative arrangements to engage in dry season gardening and other livelihood venture that are less dependent on climate.

Table 4.7 indicates poultry rearing (97.2 %) as the major off-farm activity, followed by livestock rearing (94.4 %), fuelwood collection (66.2 %), and pito brewing (2.8 %) as the least off-farm activity among the smallholder farmer interviewed in the district. Often smallholder farmers would like to engage in off-farm activities after harvesting their crops. Farmers in the east zone of the district are noted of migrating to the Sissala East District in Upper West during the peak of farming to offer hired labour for paid wages to complement their household incomes. Others also engage

in fuelwood collection to supplement household incomes. Generally, the young farmers after harvest migrate in January to the south for hired labour and return in June when farming season starts. According to McLeman and Smit, (2004) research have shown that one adaptive response to drought is to send and adult male to cities and towns to look for paid labour to help the family until the drought is over. This is predominately practiced in Khartoum in western Sudan. Before the start of the farming season, some farmers would sell out their poultry or livestock to raise money for farm inputs and other family commitments. These findings are in tune with Babakunde et al. (2010), when they asserted that households are pushed into off-farm activities or employment when the returns are higher or less risky than in farming.

Table 4. 8: Percentage of off-farm activities and other farming ventures

Off-Farms activities	Yes	No
Tailoring	19.7	80.3
Masonry	14.1	85.9
Carpentry	5.6	94.4
Bee Keeping	4.2	95.8
Fuelwood collection	66.2	33.8
Sheanut picker / Sheabutter processor	62.0	38.0
Food Vendoring	19.7	80.3
Provision Selling	22.5	77.5
Pito Brewing	2.8	97.2
Crop Aggregator	25.4	74.6
Livestock rearing	94.4	5.6
Poultry rearing	97.2	2.8
Pig rearing	46.5	53.5

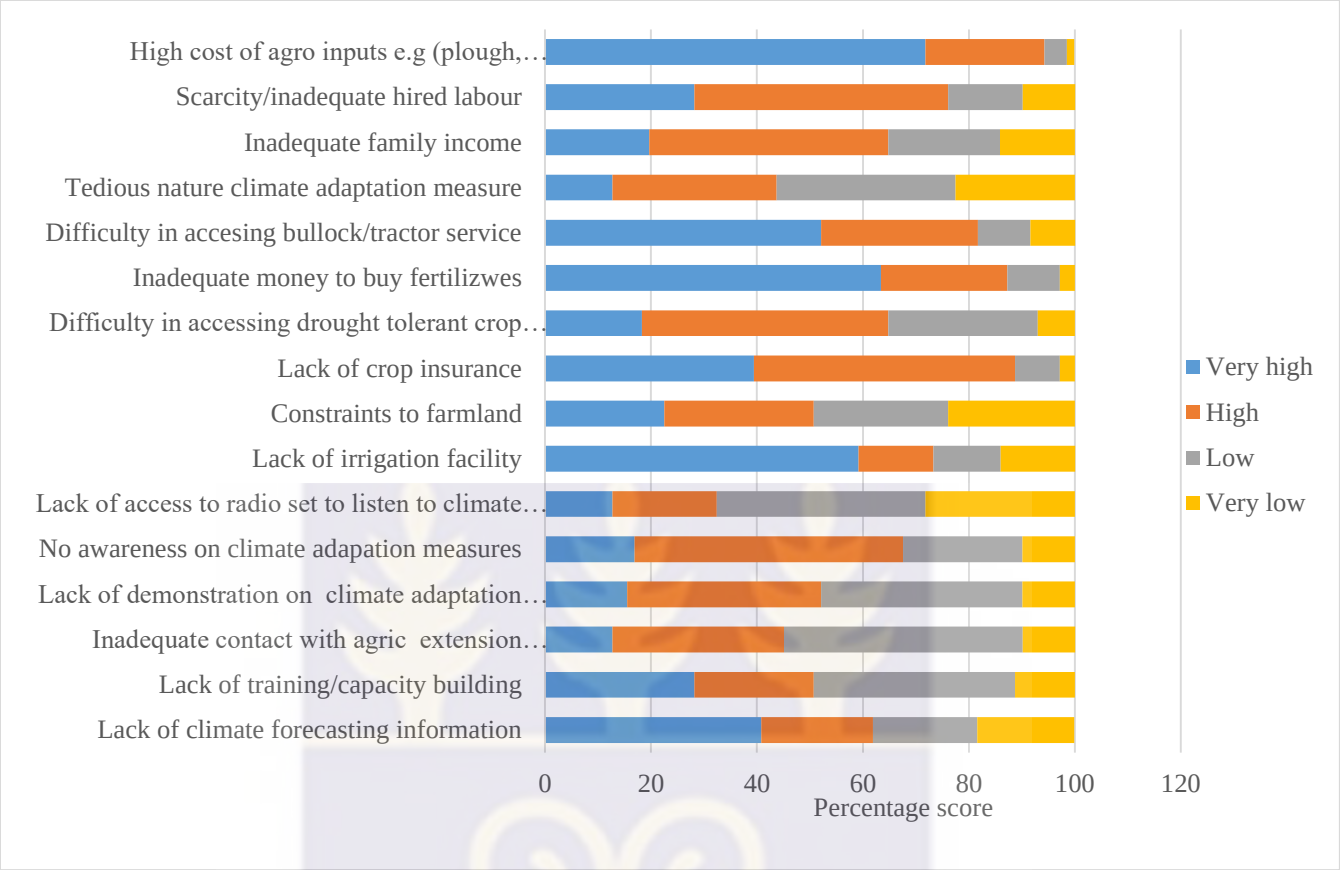
Source: Computation from field data (2017)

4.5 Ranking Challenges of Sustaining Adaptation Measures

The reasons or factors contributing to low adoption of climate adaptation practices by most smallholder farmers as expressed in literature (Nyanga et al., 2011; Taneja et al., 2014) comprise, however not limited to, less mechanization within the smallholder farming system; shortage of

appropriate implements; inappropriate soil fertility management options; inadequate technical information, and limited/poor access to credit. Some other challenges include wholesale recommendations without considering the resource status of rural households, availability of labour and inadequate extension services as reasons affecting farmers' willingness to adopt the adaptation practices (Nyanga et al., 2011; Taneja et al., 2014).

Figure 4.3 identified high cost of agro-inputs (71.8 %) with the highest score, followed by inadequate money to buy fertilizer (63.4 %), irrigation facility (59.2 %), difficulty accessing bullock/tractor service (52.1 %) and the ones with the least scores being, AEAs, lack of access to radio set to listen to climate issues and tedious nature of practicing climate adaptation measure (12.7 %) per the results gathered from the respondents as the underlying reasons thwarting smallholder farmers' willingness to adopt the practices to improve yields and increase household incomes of smallholder farmers in the district. These findings agree with some of the issues in (Nyanga et al., 2011; Taneja et al., 2014) literature espousing factors affecting low adoption of climate adaptation measures in the district.



Source: Computation from field data (2017)

Figure 4. 3: Ranking challenges of sustaining adaptation measures

4.5.1 Ranking problems encountered before Adoption of adaptation measures

Table 4.8 shows no difference in the average scores of the problems encountered before adoption of the climate adaptation measures per the data gathered from the responded. However, further observations and discussions with farmers revealed that the underlying challenge identified was the cost and how to access particularly the drought tolerant crop varieties by smallholder famers to ensure improved crop yields and increased households' incomes in the district. Ngigi (2009) said drought tolerant crop varieties have been embraced by smallholder farmers as adaptation strategy to combat negative climate impact in West and Central Africa sub-regions.

Table 4. 9: Ranking problems encountered before adoption of adaptation measures

Problems	Very high	Moderately high	High	Low	Very low	Average score
Difficulty in dealing with drought	85.9	5.6	2.8	2.8	2.8	20.0
Drought tolerant crop varieties	23.9	39.4	14.1	7	15.5	20.0
Awareness on adaptation measures	14.1	23.9	46.5	7	8.5	20.0
Drought tolerant crop varieties	31	19.7	19.7	14.1	15.5	20.0
Contact with agric. extension agents	16.9	16.9	21.1	26.8	18.3	20.0
High cost of agro inputs	46.5	28.2	9.9	8.5	7	20.0
Adoption of adaptation measures	19.7	19.7	21.1	15.5	23.9	20.0

Source: Computation from field data (2017)

4.6 Role of Institutions in Climate Change Adaptation

The institutions interviewed while conducting the study were the Department of Agriculture of Kassena Nankana West District Assembly, and two local Non-Governmental Organizations operating in the district. The NGOs include Organization for Indigenous Initiatives and Sustainability Ghana, and Organization for Sustainable Agriculture and Rural Development. The institutions were interviewed on the climate adaptation measures disseminated to smallholder farmers and other related services provided to farmers to improve upon their farm productivity in the district.

Analysis from the study indicates that government primarily led by the Department of Agriculture of the Kassena Nankana West District Assembly was mandated in helping the smallholder farmers in the communities to adopt climate challenge adaptation measures. The Department of Agriculture implements sustainable management of land and environment, which is one of the core objectives of Food and Agriculture Sector Development Policy (FASDEP II) in the district to ensure agricultural productivity and environmental resilience. Implementation of this objective helps in addressing the relations between agriculture, climate challenge and biodiversity loss.

Agricultural Extension Agents disseminate and train smallholder farmers and Farmer Based Organizations (FBOs) on the use of drought tolerant crop varieties, crop diversification, cereal legume intercrop, and integrated nutrient management, compost preparation and manure management, creation of earth bunds, tree growing, and agroforestry to improve crop productivity and ensure environmental resilience. The implementation of the FASDEP II Policy is in line with DFID (1999), which states that institutions are "the organizations, both private and public, that set and implement policy and legislation, deliver services, purchase, and trade and perform all manner of other functions that affect people's livelihood".

The Department of Agriculture in collaboration with MESTI & EPA is implementing SLWMP in communities in the western zone of the district for improved crop productivity and environmental resilience. Groups of smallholder farmers are supported with agro-inputs including ploughing to engage in sustainable agricultural practices like tree growing on degraded lands, use of drought tolerant crop varieties (e.g. wangdata seeds), legumes intercrop with trees, cereal legume rotation or intercrop with earth bunds, fodder banks establishment, and planting of bamboos along streams. The smallholder farmers are required to use their skilled labour to turn the free support to tangible benefits for themselves and the environment at large.

The Department of Agriculture also collaborated with World Vision Sirigu Area Development Project in 2014 to train communities on Farmer Managed Natural Regeneration (FMNR) to tender their existing vegetation as a way of promoting natural regeneration of indigenous tree species. This silvicultural practice has a greater potential of creating a community of trees/forest within the shortest period than planting trees, which survivability is not assured due to prevalence of bushfires, livestock browsing, water scarcity during the dry season (Gheewala 2017). The pruned branches of trees are used as firewood, or fodder for livestock, and also promotes biodiversity

within the communities. These findings agree with Agrawal et al. (2008) when they said, public institutions as part of their mandate is to facilitate adaptation strategies in building capacity of members in communal pooling, diversification and storage of produce as a result of institutions command over local action and commitment to channel technical and financial inputs into rural areas for rural economic growth. It further went on to say that, public institutions are very relevant in adapting to climate change as they provide relevant interventions in the form of information, training and technology dissemination which builds the adaptive capacity of rural people as well as improve upon their livelihoods.

Organisation for Indigenous Initiatives and Sustainability Ghana (ORGIIS) is a local Non-Governmental Organization that collaborates with the Department of Agriculture in facilitating smallholder farmers on the use of compost, promotion of climate resilient seeds (sesame), and natural regeneration and woodlot establishment among other interventions in the district. It develops viable FBOs and facilitate them in good agronomic practices to improve crop yields and household incomes. As a result, farmers are getting good yields. ORGISS has organized the FBOs to practice Village Savings and Loans Associations (VSLAs) where the individual farmers contribute periodically into a common pool of funds and the proceeds kept safely and loan it among themselves. This saving concept has assisted the smallholders to engage in other income generating activities and also procure farm inputs on their own and not relying perpetually on financial institutions for credits to farm. These findings agree with Agrawal (2008) who asserted that most farmer based organizations or cooperatives assist communities to adapt to climate risks by organizing forums and sensitizing local members of the communities on reducing deforestation and water pollution and engaging in alternative livelihoods such as livestock keeping, bee keeping, handicraft, and agro processing. Yaro et al. (2010) when they also said, in some cases farmer

groups or cooperatives provided services like provision of inputs, training in agronomy, and advocacy, to support households in climate change adaptation.

One of ORGIIS's major off-farm activity is facilitating smallholder farmers on baobab fruits, powder, seeds and oil business in the district. It has facilitated some communities in establishing woodlot plantations as a climate change mitigation measure to check negative impacts in the district. It is advocating support for marketing of organic products of smallholder farmers across the three regions of the north.

Organisation for Sustainable Agriculture and Rural Development is also a local Non-Governmental Organization that has just started operations in the district. It facilitates smallholder farmers on integrated nutrient management, agroforestry, adoption of early maturing crop varieties, bee keeping, mushroom farming, and other off-farm activities in the district. It is currently providing farm input support for smallholder farmers who have registered with the Peasant Farmers' Association of Ghana (PFAG) in the district. It supported its members during the 2017 farming with certified sorghum seeds and other inputs to cultivate sorghum, and the produce later sold to Guinness Ghana limited for production of malt products.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

This chapter presents the conclusion and policy recommendations based on the findings of the study in section 5.1 and section 5.2 respectively.

5.1 Summary of the Study

Climate change is a phenomenon impacting on every aspect of our existence. Its impact on agriculture is rather exacerbating the already existing challenges confronting farmers especially smallholders who are highly susceptible to the adverse impact of climate challenge. For that reason, it is imperative to adopt appropriate adaptation measures or climate resilient practices to address climate challenge to ensure improved crop productivity and increased household incomes of smallholder farmers in the district. The major objective of the study was to assess the impact of climate change adaptation measures on smallholder farmers' crop productivity in the district. The study employed mixed methods of quantitative and qualitative approaches to select and interview the respondent farmers. The first and third objectives of the study identifies the adaptation measures known and applied by smallholder farmers and the challenges of sustaining adoption of the climate adaptation measures in the district respectively. Modified Lautze et al, (2003) conceptual framework guided the analyses of the climate change adaptation measures on livelihoods of smallholder farmers in the district. 52.1 percent of the farmers had moderate knowledge or understanding of climate change and its attendant impact on their livelihoods. The Chi-square test was used to analyse the impact of adaptation measures on smallholder farmers' livelihoods. Descriptive analysis in a form of table and graph was used to rank the types of climate adaptation measures used and the challenges of adopting the measures by farmers respectively in

the district. Majority of the smallholder farmers (39.4 %) had their annual average income between GH¢ 1,001.00-2,000.00.

The major farmer practices or adaptation measures having significant associations with the crops include shifting planting dates, agroforestry, hired labour, and crop diversification. Majority of the smallholder farmers had their highest mean production figures in the range between 0 to 0.5 tonnes for maize, rice, sorghum, groundnut, cowpea, and sorghum.

With the off-farm employment, poultry rearing (97.2 %) as the major off-farm activity, followed by livestock rearing (94.4 %), fuelwood collection (66.2 %), and pito brewing (2.8 %) as the least off-farm activity among the smallholder farmers. Ranking challenges of adopting adaptation measures identified high cost of agro-inputs (71.8 %) as the highest score, followed by inadequate money to buy fertilizer (63.4 %), irrigation facility (59.2 %), difficulty accessing bullock/tractor service (52.1 %) and the ones with the least scores being, AEAs, lack of access to radio set to listen to climate issues and tedious nature of practicing climate adaptation measure (12.7 %).

Government institutions like Department of Agriculture, projects and non-governmental organizations are facilitating and supporting smallholder farmers with climate resilient inputs to tackle adverse impacts of climate variability and change on their livelihoods.

5.2 Conclusion

The vulnerable smallholder farmers are committed to adopting location specific climate adaptation measures to transform crop farming into a more productive business. The climate resilient measures are economically feasible, environmentally friendly and socially acceptable for ease of adoption by smallholder farmers. The climate resilient measures have lower carbon emission as a means of reducing the greenhouse gas emissions into the atmosphere. Awareness creation among smallholder farmers about the benefits of climate resilient measures to reducing extreme weather

conditions like drought, floods, water scarcity could facilitate easy adoption. This could be done through extensive extension education to demonstrate the tangible benefits of the different climate adaptation measures.

The major climate adaptation measures of the smallholder farmers identified include integrated nutrient management, cover cropping, minimum tillage, adoption of drought tolerant crop variety, and hand-dug well irrigation for dry season gardening. Factors such as cost of adoption, good economic return, user friendliness, good soil fertility, and environmental friendliness influenced the smallholder farmers' choice of the climate adaptation measures in the district.

The findings indicate, some of the adaptation measures had significant positive impact on productivity of some crops, and have the potential to impact livelihoods and food security in the district. Adaptation strategy which is possible for the smallholder farmers' adoption is diversification of livelihoods since not all sources of incomes are adversely impacted by climate. Example of such livelihood diversification is off-farm employment.

For purpose of achieving sustainable benefits, planned adaptation should be simultaneously implemented with indigenous practices of farmers and factored into agricultural development panning by government. Creation of viable social safety net like crop insurance can convince and encourage farmers to adopt climate adaptation measures.

5.3 Recommendations

From the key findings of the study, a number of policy intervention and recommendations are identified for action. These are:

The major climate adaptation measures identified in the study area include integrated nutrient management, cover cropping, minimum tillage, adoption of drought tolerant crop variety, and

hand-dug well irrigation for dry season gardening. Departments of Agriculture of the various Assemblies should be empowered with human, logistical, and financial resources to effectively disseminate and train smallholder farmers' in sustainable land management practices as climate change phenomenon is here to impact on every livelihood, especially the agricultural sector of the economy. Government agricultural subsidy programme should invest massively in climate resilient inputs and practices to sustain livelihoods of the vulnerable smallholder farmers.

The need to intensify the collaboration between government and civic institutions who are actively involved in ameliorating adverse climate impact on farmers in the district. Government should take its leadership role and incentivize other stakeholders to conduct research to develop agro-ecology specific climate adaptation practices for farmers' use to improve upon their crop yields and household incomes.

The major farmer practices or adaptation measures of shifting planting dates, agroforestry, hired labour, and crop diversification had significant associations with some of the crops. A well-engineered dam with irrigable areas for all year round crop production could address the quagmire of shifting planting dates and migrating labour in most of the rural districts dependent on agriculture. Subsidizing climate resilient agro-inputs like drought tolerant and early maturing crop varieties with their accompanying recommended fertilizers to motivate farmers adopt them to further enhance crop diversification.

The singular major challenge in adopting climate adaptation measures is high cost of agro-inputs. Unfortunately, farmers are not keeping proper farm records which they can use to access soft loans. The need to identify creditworthy farmers or FBOs and support them with the necessary agro-inputs and farm implements, and the harvested produce used to defray their debts and trade-offs made for the farmers to receive good return on their bought produce. Close monitoring of such

model farms can ensure prompt payment of debts and such schemes can serve as revolving package for all the districts.

Government should prioritize implementing a social safety net programme like crop insurance policy as a safeguard to cushion farmers in the event of extreme climate impact.

5.4 Suggestions for Future Research

It is suggested that future research should investigate:

- the impact of climate elements on smallholder farmers' crop productivity in the district;
- the impact of climate adaptation practices on smallholder farmers' livestock production in the district.

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Appendix I

SAMPLE QUESTIONNAIRE FOR FARM HOUSEHOLDS

ASSESSING THE IMPACT OF CLIMATE CHANGE ADAPTATION MEASURES ON SMALLHOLDER FARMERS' PRODUCTIVITY IN THE KASSENA NANKANA WEST DISTRICT (KNWD)-UER.

Background

The specific research objectives for the study include: Identify the climate change adaptation measures known and/or applied by farmers; determine the impact of farmers' climate change adaptation measures on crop productivity; and identify the challenges of sustaining the adoption of the adaptation measures.

Ethical statement-This questionnaire administration is to enable the student to elicit data or information from farmers/farm households in the district for the purpose of academic long essay/thesis as a partial fulfillment for the award of Master of Science (MSc.) degree in Climate Change and Sustainable Development in the University of Ghana. The engagement with the farmers will not yield any financial reward to the farmers. The data is strictly for academic exercise and will be kept as confidential.

Section A-Demographic Information

District……

Zone……. [Central zone-1; West zone-2; East zone-3]

Community……..Sex…… [Male-1; Female-2]

Age…….

Household size……

Level of education completed…….. [No education-1; Primary school-2; Junior High/Middle school-3; Senior High/Secondary school-4; Tertiary institution-5]

Religion…… [Christianity-1; Islam-2; Traditional region-3]

Marital status……. [Married-1; Single-2; Widowed-3; Divorced-4]

Ethnic group…… [Kassena-1; Nankani-2; Frafra-3; Buli-4; Specicy others…….-5]

What is your average annual income? [Ghc Less than 1,000.00-1; Ghc 1,001.00-2,000.00-2; Ghc 2,001.00-3,000.00-3; Ghc 3,001.00-4,000.00-4; Ghc 4,001.00-5,000.00-5; Ghc Above 5,000.00-6]

Section B-Farmer Practices

1.1. B. What is your understanding of climate change? [Water scarcity-1; Increased rainfall-2; Reduced rainfall-3; High temperatures-4; Low temperatures-5; Low crop productivity-6; High inputs cost-7; Heat waves-8; High incidence of pests and diseases-9]

1.2. B. What are some manifestations of climate change? [Increased rainfall-1; Reduced rainfall-2; High temperatures-3; Low temperatures-4; Drought-5; Increased pests and diseases-6; Increased water demand-7; Shift in farming seasons-8]

1.3. B. Farm size ……ha

1.4. B. Crops grown [Maize-1; Rice-2; Sorghum/Millet-3; Groundnut-4; Soybean-5; Pepper-6; Cowpea-7; vegetables-8]

1.5. B. Main season crops [Maize-1; Rice-2; Sorghum/Millet-3; Groundnut-4; Soybean-5]

1.6. B. Dry season crops [Pepper-1; Tomato-2; Garden eggs-3; NA-4; Okro-5]

1.7. B. Farmer practices

No.	Measures	How long have you used these measures	Why	How effective is it?
	Land preparation			
1	Creation of earth bunds on farms			
	Soil fertility			
2	Integrated nutrient management			
2	Cereals intercrop with cover crops			
3	Mixed farming			
4	Mulching			
5	Minimum tillage			
6	Cover cropping			
7	Zai planting			
	Crop variety			
8	Use of drought tolerant crop variety			
	Wangdata variety			

9	Use of early maturing crop variety			
10	Crop diversification			
	Labour			
11	Hired labour			
12	Irrigation			
13	Agroforestry			
14	Shifting planting dates			
	Others? Specify			

Effective code: Very effective-1; Moderately effective-2; Effective-3; Less effective-4

1.8. B. What factors affect the effectiveness of the adaptation measures?

[Good economic return-1; User-friendliness-2; Good soil fertility-3;

Environmentally friendly.-4]

1.9. B. How did you get to know or hear of these climate adaptation measures?

No.	**Sources**	**Yes**	**No**
1	A farmer friend		
2	Relative		
3	Agricultural extension agent (AEA)		
4	Project? name		
5	FBO/Farmer group		
6	Local NGO		
7	Farmer exchange visit		
8	Local radio station		

1.9.1. B. Inputs cost and outputs of the main crops grown for 2017

No.	**Crop**	**Plough cost (ghc)/ha**	**Seed cost (ghc)/ha**	**Fertilizer cost (ghc) /ha**	**Labour cost (ghc)/ha 1+2+3+4+5+6**	**Yield/ha**
1	Maize					
2	Rice					
3	Sorghum					
4	Groundnut					

5	Soybean					
6	Pepper					
7						

[Sowing-1; Weeding-2; Fertilization-3; Harvesting-4; Threshing-5; Bagging-6]

Section C-Climate Adaptation Measures

1.9.2. C. What were some of the earlier climate change farming practices?

Climate farming measures	**Rank**
Mixed farming	
Cover cropping	
Crop diversification	
Agroforestry	
Change in planting date	
Integrated nutrient management	

[Very High-1 Moderately High-2 High-3 Low-4 Very Low-5]

1.9.3. C. What are some of the current climate change farming practices?

Climate change farming measures	**Rank**
Adoption of drought tolerant crop variety	
Irrigation	
Cover cropping	
Integrated nutrient management	
Conservation agriculture (Minimum tillage)	

[Very High-1 Moderately High-2 High-3 Low-4 Very Low-5]

Section D-Impact of Farmers' Adaptation Measures on Crop Productivity

2.0. D. Relationship between adaptation measures and crop productivity

No.	**Crop**	**Quantity produced (tons)**	**Area (ha)**	**Productivity (ton/ha)**
1				
2				
3				
4				
5				
6				

2.1. D. Practicing adaptation measures for the past 5-10 years

No.	Measures	With	Without
1	Drought tolerant crop varieties (e.g.)		
2	Earth bunds creation on farms		
3	Irrigation (e.g. Hand dug-well)		
4			

[With-1: Without-0]

2.2. D. Mean production

No.	Crop	Input (GHc)	Output (tons)
1			
2			
3			
4			
5			
6			

2.3. D. Do you incur additional cost for the adaptation measures?
[High cost of land preparation-1; High cost of seeds-2; High cost of labour-3; High cost of irrigation-4; No additional cost incurred-5]

2.4. D. Has the adoption of the adaptation measures been productive for you? [Yes-1: No-2]

2.5. D. Are you engaged in any off-farm activity in the community?

No.	Off-farm activities	Yes	No		Other farming ventures	Yes	No
1	Tailoring				Livestock rearing		
2	Masonry				Poultry rearing		
3	Carpentry				Fisheries		
4	Bee keeping/honey making				Pig rearing		
5	Fuelwood collection				Others? specify		
6	Shea nut picker/shea butter processor						
7	Food vendor						
8	Provision seller						
9	Pito brewing						
10	Crop aggregator						
11	Others? Specify						

Section E-Challenges of Sustaining Adoption of Adaptation Measures

3.0. E. Challenges of sustaining adoption of adaptation measures. Tick applicable ones in the boxes.

No.	Challenges of sustaining adoption	VH	H	L	VL
1	Lack of climate forecasting information				
2	Lack of training/capacity building				
3	Inadequate contact with extension agent				
4	Lack of demonstration on adoption of climate adaptation measures				
5	Inadequate awareness on climate adaptation measures				
6	Lack of access to radio set to listen to agricultural issues				
7	Lack of irrigation facility				
8	Constraint to farmland				
9	Lack of crop insurance				
10	Difficulty in accessing drought tolerant crop varieties				
11	Inadequate money to buy fertilizers				
12	Difficulty in accessing bullock/tractor service				
13	Tedious nature of climate adaptation measure				
14	Inadequate family labour				
15	Scarcity/inadequate hired labour				
16	High cost of agro-inputs (e,g. plough, seeds and fertilizers)				
17	Others? specify				

[Very High (VH)-1 High (H)-2 Low (L)-3 Very Low (VL)-4]

3.1.E. Problems encountered before adoption of adaptation measures.

No.	Problems encountered before adoption of measures	Rank
1	Difficulty in dealing with drought	
2	Lack of drought tolerant crop varieties	
3	Lack/inadequate awareness on climate adaptation measures	
4	Difficulty in accessing drought tolerant crop varieties	
5	Inadequate contact with extension agent	
6	High cost of agro-inputs (e,g. plough, seeds and fertilizers)	
7	Lack/inadequate demonstration on adoption of climate adaptation measures	
8		

[Very High-1 Moderately High-2 High-3 Low-4 Very Low-5]

3.2. E. How has the adoption of the adaptation measures addressed the challenges?

[Increased crop production/increased farm income-1; Improved soil moisture-2; Able to hire farm labour-3; Farmland size expanded-4; ……...-5]

Appendix II

INTERVIEW GUIDE FOR KEY INFORMANTS/LEAD FARMERS

ASSESSING THE IMPACT OF CLIMATE CHANGE ADAPTATION MEASURES ON SMALLHOLDER FARMERS' PRODUCTIVITY IN THE KASSENA NANKANA WEST DISTRICT (KNWD)-UER.

Background

The specific research objectives for the study include: Identify the climate change adaptation measures known and/or applied by farmers; determine the impact of farmers' climate change adaptation measures on crop productivity; and identify the challenges of sustaining the adoption of the adaptation measures.
Ethical statement-This questionnaire administration is to enable the student to elicit data or information from farmers/farm households in the district for the purpose of academic long essay/thesis as a partial fulfillment for the award of Master of Science (MSc.) degree in Climate Change and Sustainable Development in the University of Ghana. The engagement with the farmers will not yield any financial reward to the farmers. The data is strictly for academic exercise and will be kept as confidential.

Section A-Demographic Information

District……

Zone……. [Central zone-1; West zone-2; East zone-3]

Community……..Sex…… [Male-1; Female-2]

Age……

Level of education completed…….. [No education-1; Primary school-2; Secondary school-3; Tertiary institution-4]

Religion…… [Christianity-1; Islam-2; Traditional region-3]

Marital status……. [Married-1; Single-2; Widowed-3; Divorced-4]

Ethnic group…… [Kassena-1; Nankani-2; Frafra-3; Buli-4; Specify others-5]

What is your average annual income?

……

Section B: Climate Change Adaptation Measures

What are the climate change adaptation measures known and/or applied by use?

1. ……
2. ……

3. ……

4. ……

5. ……

Which of these climate adaptation measures are being adopted by use and how effective are they?

No.	Climate adaptation measures	How long have you used these measures	What factors contributed to their effectiveness
1			
2			
3			
4			
5			

Section C: Impact of Adaptation Measures on Crop Productivity

What is the impact of climate change adaptation measures on your crop productivity?

……

……

……

Section D: Challenges of Sustaining the Adoption of Adaptation Measures

What are the challenges of sustaining the adoption of the climate adaptation measures?

1. ……

2. ……

3. ……

What role do institutions play in climate change adaptation?

……

……..

Appendix III

INTERVIEW GUIDE FOR LOCAL NGOs

ASSESSING THE IMPACT OF CLIMATE CHANGE ADAPTATION MEASURES ON SMALLHOLDER FARMERS' PRODUCTIVITY IN THE KASSENA NANKANA WEST DISTRICT (KNWD)-UER.

Background

The specific research objectives for the study include: Identify the climate change adaptation measures known and/or applied by farmers; determine the impact of farmers' climate change adaptation measures on crop productivity; and identify the challenges of sustaining the adoption of the adaptation measures.

Ethical statement-This questionnaire administration is to enable the student to elicit data or information from NGOs operating in the district for the purpose of academic long essay/thesis as a partial fulfillment for the award of Master of Science (MSc.) degree in Climate Change and Sustainable Development in the University of Ghana. The engagement with the NGOs will not yield any financial reward to either parties. The data is strictly for academic exercise and will be kept as confidential.

Section A-Demographic Information

Name of NGO……

District……

Operational zones……...

Section B: Climate Change Adaptation Measures

What are some of the climate change adaptation measures you disseminated or trained farmers on in the district?

1. ……
2. ……
3. ……
4. ……
5. ……

6. ……

7. ……

Which of these climate adaptation measures are being adopted by the farmers' and how effective are they?

No.	Climate adaptation measures	How long have they used these measures	What factors contributed to their effectiveness
1			
2			
3			
4			
5			

Section C: Impact of Adaptation Measures on Crop Productivity

What has been the impact of farmers' climate change adaptation measures on crop productivity?

……

……

……

……

Section D: Challenges of Sustaining the Adoption of Adaptation Measures

What are the challenges of sustaining the adoption of the climate adaptation measures?

1. ……

2. ……

3. ……

What role do institutions play in climate change adaptation?

.....

……..

Any other pertinent issues on farmers' adoption of climate adaptation measures in the district?

……

……

……

……