UNIVERSITY OF GHANA, LEGON

THE EXPERIENCES OF AND ADAPTATION TO CLIMATE VARIABILITY BY FARMERS IN NKWANTA NORTH DISTRICT

BY

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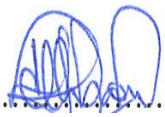
DEDICATION

This thesis is dedicated to my late uncle, Staff Sergeant Anthony Kwabena Ansah for his immense support during the course of this program. To my mother (Madam Monica Appiah Boatemaa), sisters Effeh and Juliet and John-Paul my son.

DECLARATION

I Anthony Kwabena Yeboah, do hereby declare that this work is the result of my own original research work and that no part of it has been presented for another degree in the university or elsewhere.



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ABSTRACT

The study examined the experiences of and adaptation to climate variability by farmers in the north eastern Ghana. A mixed research design comprising of questionnaire, focus group discussions and expert interviews were employed in the collection of data from respondents. In all 180 food crop farm household heads were sampled from four communities in the Nkwanta north district for the administration of questionnaires using the Jensen & Shumway formula. The qualitative data which was collected by the use of expert interview and focus group discussions were manually analyzed through thematic content analysis whiles chi square test, cross tabulation and binary logistic regression components of SPSS version 25 and Microsoft excel 2013 were used in analyzing the quantitative data. The results showed that most of the farmers have been farming for more than three decades. This made the farmers gain enough experience to declare their stance of having observed variation in the climate. An increasing temperature and a reducing trend in rainfall coupled with lengthy drought are the most common variation that most farmers have observed. The study revealed that because most farmers feel vulnerable to the effects of the varying climate, they have adopted measures such as a change in the planting dates, using drought resistant crop varieties, mixed farming, use of herbicides and fertilizers and mulching to make them risk-averse. The main socioeconomic factors that influenced farmers' decision in the choice of adaptation strategy were age and size of household. It is recommended that the Ministry of Food and Agriculture through its agricultural extension department should ensure that more agricultural extension agents are posted into the district and equipped to beef up support, motivate and educate the farmers on modern ways of farming

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ABBREVIATIONS

ATR	African Traditional Religion
DFID	Department for International Development
ENSO	El Nino/Southern Pole
FAO	Food and Agricultural Organization
FGD	Focus Group Discussion
GHC	Ghana Cedi
GoG	Government of Ghana
GSS	Ghana Statistical Service
IPCC	Intergovernmental Panel on Climate Change
LI	Legislative Instrument
MoFA	Ministry of Food and Agriculture
NASA	National Aeronautics and Space Administration
NOA	North Atlantic Oscillation
SLF	Sustainable Livelihood Framework
UNDP	United Nations Development Program
UNECA	United Nations Economics for Africa
UNFCCC	United Nations Framework Convention on Climate Change
WA	West Africa
WTO	World Trade Organization

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

A major problem that presents a significant threat to humanity today is the increase in global temperature, a phenomenon called climate change (Makuvaro et al., 2018). According to UN-Intergovernmental Panel in Climate Change (IPCC), concerted efforts need to be made to reduce global emissions of carbon dioxide, otherwise if the current trend goes on unabated, temperature is expected to rise from 1.4^{o}C to 5.8^{o}C by 2100 (FAO, 2009). Indeed, per the previous report which was published in 2001, IPCC estimated that there has been a rise of global temperature by 0.6±0.2% on land and sea surface within the mid-19th century, indicating that this change has been ongoing over the years (IPCC, 2001). According to Walther et al. (2002), increase in global temperature is the result of increasing emission of greenhouse gases into the atmosphere, especially carbon dioxide, with this situation being attributed to increased human activities such as industrialization and fossil fuel combustion over the years (Sharma, 2015; Majaliwa et al., 2012).

The impact of climate change over the world has been debilitating. There have been changes in the distribution of rainfall patterns, with places either experiencing high or low rainfall amounts that hitherto was not the usual pattern recorded (Kibue et al., 2016). Some latitudes that use to be wetter are becoming drier and vice versa. Another problem, which is also associated with climate change has also been unpredictability of weather patterns (Makuvaro et al., 2018). These situations, including changing and unpredictable weather pattern significantly impact on human activities, especially livelihood activities that depend heavily on climate (Makuvaro et al., 2018). One activity that depends heavily on the climate is

agriculture, and is the case in most developing countries including those in sub-Saharan Africa.

Agriculture remains a key sector in most developing countries and provides a livelihood to close to 70% of the population in Africa (FAO, 2015). Unfortunately, most agricultural households continue to be largely smallholder households with little assets and the activity also characterized by less use of modern technology (Duan & Hu, 2014). This situation increases farmers' vulnerability to climate change impacts. Further, heavy dependence on resources such as rainfall, land richness and other biodiversity resources means that any negative environmental change will have a debilitating impact on most farmers (Nyadzi, 2016). Indeed, some studies conducted in recent times indicate that climate change has reduced agricultural output in some countries in Africa (Porter et al., 2014), with other studies also suggesting that reduced agricultural output will reduce GDP by 2%-7% in some Africa countries.

In developing countries, climate change and variability are perceived to be an immediate threat to family sustenance since it contributes to lower crop yields (Asrat & Simane, 2018; Pidgeon, 2012). Concerns are that climate change and variability will compound existing challenges within the agricultural system in most developing countries. These existing problems include high reduction in arable lands, diminishing household income, increased rural-urban migration and biodiversity loss. Reduced crop production, livestock and water resources in African countries pose a threat to food and nutrition security (Makuvaro et al., 2018). All the above and the dwindling concentration of tree species in the arid and semi-arid areas in Africa (Field et al., 2014) are sequels of climate change and variability with its attendant effect on global agricultural output (Porter et al., 2014; Yiran & Stringer, 2017)

The impact of climate change is not uniform and even in low-income countries where the brunt is felt most, there are differences in climate change experiences. For instance, places within arid and semi-arid or savannah ecologies are impacted most compared to forest areas (Arunrat et al., 2017). This situation makes the experience of climate change a local phenomenon as much as it is a global phenomenon. Thus, experience of the phenomenon and how it is perceived matter a great deal. The main argument here is that how local people perceive and experience the problem is instrumental in shaping strategies to deal with climate change impact at the local level. Several studies conducted on climate change impacts have revealed that farmers' understanding of climate variability has increased over the years and are aware of the potential impact of the phenomenon on their livelihoods (Luni et al., 2012; Simelton et al., 2013). Further, studies have also shown that farmers are also becoming increasingly concerned about the sustainability of their livelihoods, especially in the wake of climate change (Legesse, 2013).

Thus, understanding local experiences from the perspective of local farmers holds the key to unraveling strategies that are appropriate and can suit local situations and context. Further, by understanding farmers' perspective, knowledge and experience of climate change, there is the potential of building on local knowledge and understanding. Further, understanding farmers coping strategies in the wake of climate change and variability are issues that will enhance knowledge in this research area.

1.2 Problem Statement

Studies have shown that climate change is going to have a significant impact on agricultural production (Fagariba et al., 2018; Ndamani & Watanabe, 2015). In particular, there have been concerns over food insecurity in most low-income countries since most agricultural production in these countries depends on resources such water, both rainfall and in-land water for agricultural production. Further, studies by Newton et al. (2010) also indicate that climate

change will increase pest and disease outbreak due to the complex relationship between crop production, climate and pathogen infection. There have also been studies showing how social and economic vulnerabilities of farm households are going to exacerbate the impact of climate change on these households (Juana et al., 2013). These existing vulnerabilities, which include low incomes, decreasing access to land and increasing input cost will worsen the plight of farmers during this era of climate change.

Studies conducted on climate change in Ghana that include Yaro et al. (2015) and Nyadzi (2016) have shown that many farmers are finding it difficult to adjust to challenges posed by variation in the climate. Scholars such as Mugi-Ngenga et al. (2016), Fosu-Mensah et al. (2014) and Yaro (2013) have shown that the inability of most farmers to respond effectively to challenges posed by climate change is due to latent structural problems that include lack of access to important resources such as extension services, education and financial capital. Other related studies on climate change in Ghana show that farmers reported a huge reduction in crop yields, with this development attributed to increased temperatures and decreased rainfall across all agro-ecological zones in Ghana (Antwi-Agyei et al., 2015; Nkrumah et al., 2014).

Whiles understanding of climate change phenomenon and its impact on agriculture has increased, most of our understanding is based on scientific studies that focus on measuring variables of biophysical dimension of climate change impacts (Yengoh et al., 2010; Juana et al, 2012). Further, emphasis on the study of biophysical variables that are affected by climate change has been the preoccupation of policies that intend to feed into proposed adaptation strategies handed down to farmers. As indicated, climate variability impact is also a local problem which is experienced by local people, and in these case farmers. Thus, farmers' experiences, perceptions and how they deal with the problem of climate change are critical and important for the sustainability of strategies aimed at coping with the problem. As

indicated by Kusakari et al. (2014: 517) ‘‘perceptions are not necessarily congruent with reality, they must be considered to address socioeconomic challenges. They have a close association with individuals’ respective environments and link either directly or indirectly with their attitudes, behaviours, and subsequent outcomes’’

This study examines the experiences of and adaptation to climate variability by farmers in the Nkwanta North District. The outcome of the study is expected to provide knowledge and additional information for policy makers to plan for a balanced approach to empowering farmers adapt to climate change and improve agricultural output.

Climate change and its impact has gained much research and policy attention over the years. Major contributions of studies on climate change impact have been in the area of developing analytical frameworks in guiding studies within the research area. Further, most of the studies tend to focus on global, regional and country level dimensions of the problem. Whiles there have been useful conclusions and policy prescriptions from these studies, they are based on few case studies and thus unsuited to some local contexts. The point here is that local practices and understanding shape the way local people adopt and adapt to recommendations from outside. It is within this context that perceptions and experiences of farmers is given attention in this study.

The study will also enhance understanding of the key role of local perception and understanding of environmental changes and how this shapes how local communities can prepare, cope and modify existing practices to handle these changes. By understanding locally-based practices, it will be possible to build on this existing knowledge to introduce more tailored interventions to address the needs of those communities.

1.3 Research Objectives

The main objective of this study is to assess farmers' experiences and perceptions of climate variability and how they adapt to these in the Nkwanta North District.

1.3.1 Specific Objectives

Specifically, the research seeks:

1. To investigate the phenomenon of climate variability as perceived and experienced by farmers
2. To assess the adaptation strategies adopted by farmers
3. To determine the factors that influence their choice of adaptation strategies

1.3.2 Research Questions

1. How do farmers recognize and experience the trends of climate variability in the district?
2. How are farmers adapting to climate variability in the district?
3. What factors motivate farmers to adopt a particular adaptation strategy?

1.4 Organization of the Study

The study is organized into six chapters. The first chapter comprises introduction, statement of problem, justification, objectives of the study, research questions and organization of the study. The next chapter which is chapter two discusses literature related to the study through a review including the conceptual framework supporting the study. Chapter three looks at the study area and research methodology whereas chapters four and five present the results and discussion of the study. The final chapter, six, provides a summary of the main findings of the study, conclusion and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The purpose of this chapter is to provide a comprehensive and up-to-date review of the current literature on the research topic. Literature presented in this chapter is structured along themes such as climate change/variability, perception, and experiences, adaptation and adaptive capacity. Other discussions in the chapter included factors influencing the choice of adaptation strategies and policies aimed at improving farmers' adaptation to climate change. The final part of the chapter presents the conceptual framework developed for the study.

2.2 Definition of key terminologies

2.2.1 Climate

Climate can be defined as the long-term pattern in the weather of a particular environment. The National Aeronautics and Space Agency [NASA], (2008) defines the climate as the average conditions of the prevailing weather in a particular geographical area. According to Ebi, Mearns & Nyenzi, (2003), climate is the average state of the atmosphere and its associated characteristics, in a particular region over a particular time-scale, which is measured over multiple years. The two definitions talk about the inconsistency in the primary elements of the weather, such as wind, precipitation, temperature, humidity and atmospheric pressure and are emphatic on the fact that it should prevail within a specific environment spanning a period.

2.2.2 Climate Change

Climate change refers to the long-term inconsistency in the primary elements of the weather. According to the IPCC (2007, p.30) climate change is "any change in climate over time, whether due to natural variability or as a result of human activity." In its recent publication,

the IPCC defines the climate change as the changes in the conditions of climate, which occur as a result of changes in the mean and or inconsistency in its elements studied over a decade or beyond (IPCC, 2012). As well, the IPCC has provided a detailed definition of climate change as a change of climate, which is caused by nature and human activity that modifies the components of the global atmosphere and is observed over a comparable period (IPCC, 2014).

Indeed, all the above definition points to the fact that climate change occurs as a result of internal variability and external factors that are both natural and anthropogenic by origin. It is important to stress that the human contribution to the changes in the elements of climate far exceed internal or natural process whereby the biotic environment release greenhouse gases (GHG) such as carbon dioxide (CO2), nitrous oxide (N2O) and methane (CH4) into the atmosphere (UNFCCC, 2007). The point of emphasis is that these gases deplete the ozone (O3) layer by changing the composition of the elements of climate, thereby making their occurrences unpredictable and varying. From the above, it is concluded that there is an agreement to the fact that anthropogenic factors are the prime cause of the alarming trends in climate change from the mid twentieth (20th) century (IPCC, 2014).

2.2.3 Climate Variability

According to Ebi, et al. (2003), IPCC (2007), climate variability refers to fluctuation of climate around the mean figure, including seasonal and large-scale discrepancies in atmospheric and oceanic circulations such as the El Nino Southern Oscillation (ENSO) or the North Atlantic Oscillation (NOA). These changes are expected to have been measured or observed for a longer period, mostly spanning a decade or beyond and should show by all indications that the values are either increasing from the mean climate figure or reducing from the mean climate value.

Obeng (2014) also defines climate variability as the annual fluctuation in the average weather of a place that displays how each year's climate value differs from the long-term mean climate normal. This explains the fact that each environment has its own prevailing climate, which differs from another environment and as such, the daily, monthly and yearly rise and fall in the key elements of the weather are pronounced. Climate variability is the way by which the yearly climate value of a particular environment falls above or below the long-term average value (Sarr, 2012). In other words, it is the yearly shift of the average climate value from the long-term climate average value resulting from events such as El Nino, La Nina and vulcanicity.

It can be deduced that while climate change deals with irregularity in the climate system studied over a long period, which spans beyond decades, climate variability can be said to be a short term; daily, monthly and inter-annual deviation of the mean climate value from the "mean climate normal."

In view of the numerous definitions highlighted above, this study defines climate variability as the observed changes in the year to year average precipitation and temperature within a space of less than a decade.

2.3 Farmers perception of climate variability

In the opinion of Forgus & Melamed, (1976) the procedures by which information is obtained constitutes perception. Also, perception is defined as the process of creating psychological awareness from information or stimulus procured from the surrounding environment. This definition in a broader sense considers all the processes involved in using the senses to interpret information from the surrounding. Climate variation is commonly perceived by smallholder farmers, subsequent from their experiences with the local environment although

their interpretations are usually limited to their local world cut-off from the global space (Yaro, 2013).

A lot of farmers throughout Africa have provided innumerable and notable evidences on the variation in rainfall and temperature pattern (Abid et al., 2015). Typically, there are many farmers who, based on their observation have perceived various changes in the key elements of climate. Specifically, Roco et al. (2015) in their evaluation of farmers' perception of climate change in Mediterranean Chile actually asserted that majority (87.6%) of farmers perceived a rise in the occurrence of drought and a little over half also perceived a rise in temperature. In another study conducted in Swaziland on farmers' perception on climate, it came to light that few of the farmers interviewed (10%, 8.1%, 6.7%) perceived a decreased frequency, intensity and duration of dry spell respectively, with the majority of farmers perceiving an increase in the past two decades (Mamba, Salam & Peter, 2015).

In their quest to find out farmer's perception of climate change and responsive strategies in certain parts of South Africa, Elum et al. (2016) established that farmers perceive rainfall to be declining alongside increasing temperature over the years. The authors reported that farmers perceived a rise in the number and frequency of hot days while rainfall variability is on ascendency. In Nigeria Ayanlade et al. (2017) opined that both livestock and crop famers perceived a significant change in the climate characterized by lengthy and frequent dry spells coupled with a delayed arrival of the rains in the last decade than two decades ago. Surprisingly, the farmers explained that for almost half of the decade (i.e. 2005-2015) rainfall coverage over a full month period was hardly experienced and often stopped in the middle till the end of the growing season (Ayanlade et al., 2017).

The situation in Ghana is not different and it cuts across the whole country. For instance, Amadou et al. (2016) compared farmers' perception with historical data of the past two

decades in the Upper East region. They found that more than half (71%) of the farmers perceived a rise in temperature and nearly all the farmers (95%) perceived a reducing rainfall pattern. In a related study in the Vea catchment area of Upper East region of Ghana, Limantol et al. (2016) found that apart from few farmers (10.5%), the rest perceived an upsurge in temperature and a rapid drop in rainfall over the past three decades.

In the Ashanti and Northern regions, Adusei (2016) noted that majority of farmers perceived that current rainfall condition is reducing, unpredictable, delays and comes at the wrong time, and does not even prevail throughout the growing season within the recent past years. Fosu-Mensah et al., (2014) also in a study conducted within the Sekyedumase enclave proclaimed that only a few farmers (18% and 12.8%) perceived a reduction in temperature and an increase in the rainfall patterns, yet the rest perceive the contrary.

Ehiakpor et al., (2016), noted that majority of farmers in the Suaman District of the western region perceived a rise in the mean temperature and a short rainfall season due to delayed inception of the rains. Likewise, Asiedu et al. (2017) reported of unstable rainfall pattern with and rise in temperature over the last half decade in the Sunyani Municipal, Sunyani West and Berekum districts of the Brong Ahafo region.

In the Lawra district of the Upper West region, Ndamani and Watanabe (2015) declared that more than three-quarters of farmers perceived a rising spate of temperature and a degeneration in the volume of rainfall received over the past decade. In the same vein, Williams et al. (2017) recorded that nearly all (82%) smallholder farmers in the Greater Accra, Volta, Eastern and Central regions perceived a drop in rainfall patterns coupled with dwindling of streams and a surge in temperature coupled with extreme heat. The farmers averred that the notable changes in temperatures and rainfall have extremely affected the growth, maturity and yields of their crops; thereby making their livelihoods very vulnerable

(Limantol et al., 2016). Accordingly, adaptation strategies are needed to deal with the situation.

The reviewed literature which is mostly empirical studies in Africa and Ghana shows that farmers are aware of change and variability in climate conditions. This is evidenced by the high perception shown by farmers in regards to changes in the elements of the climate. Key issues that often comes up on farmers perception has been the rise in temperature and the dry spells, with decreasing days of the wet season which normally result in reduced rainfall amount. Further, the unpredictability was a key issue highlighted by researchers such as Edusei (2016) and Fosu-Mensah et al. (2014). Another issue is the uniformity with regards to climate change and variability across ecological zones in Ghana which was demonstrated in the literature reviewed.

2.3.1 Farmers experience of climate variability

Experience may be seen as the manner in which an incident occurs or the process by which people gain understanding of events or issues by involving themselves. The Encarta (2009) defines experience as the process by which people advance in knowledge and skills after being exposed to and actively taking part in an activity over a period of time. This means that, to be referred to as having experience, one must participate in a certain activity for a period of time through their daily encounter. Certainly, the more individuals take part in events, the more knowledge they gain, hence the more experienced they become.

Climate variation is commonly experienced by smallholder farmers, following their daily encounter in the local environment. But their interpretations are usually limited to their local world, which in most cases is cut-off from the global space (Yaro, 2013). African farmers are known to possess much knowledge with regards to changes associated with the climate. Changes in temperature and rainfall patterns have manifested in several ways in the activities

of farmers. Hameso (2018) noted that farmers in Ethiopia experience the outbreak of diseases such as malaria, change in wind direction, sudden appearance of strange insects as well as the recession of certain crop and plant varieties. Again, fall in crop yields, livestock and water resources has also been reported in Zimbabwe by farmers as some of the fallouts associated with climatic changes (Makuvaro et al., 2018).

In Ghana, the experiences of farmers are not different from those in other countries. For instance, Yiran and Stringer (2017), indicate that the prevalence of extreme heat has affected both crops and livestock. Field et al. (2014) also affirmed that famers are experiencing a diminishing trend in several tree varieties. Burning of crops by the sun, dropping of immature fruits from trees, pest and disease outbreak as well as reduction in the quantity of yields have been experienced by farmers as pointed out by Yaro, (2013).

In the assessment of the experiences of climate variability and change on pineapple production, farmers asserted of having experienced a reduction in the size of their pineapple fruits and a change in taste as well (Williams et al., 2017). Additionally, farmers were also reported to have experienced increased crop failures (Tambo, 2016). Further a study by Fagariba et al. (2018) indicate that farmers reported to have experienced a complete loss of soil moisture, and a harsh decline in such tree species as dawadawa, mahogany, shea and neem as a result of excessive heat from changes in the climate (Fagariba et al., 2018).

Apart from the fact that trends in climate may be misconstrued, perceived variation may also not mirror the reality (Niles & Mueller, 2016). However, copious scientific literature offered confirm that there is continuous variation in global climate, which is affecting the health, socio-economic activities, resources and food security of human societies (Clarke et al., 2012). This extensive knowledge cannot be downplayed because it has been acquired through daily encounter with the climatic elements and a careful assessment of the different ways in

which it is manifested. Therefore, they are able to easily point out what changes have occurred and what is responsible for these changes.

The discussion thus far shows that farmers have knowledge about the ongoing climatic changes. This knowledge is born out of years of experience with the phenomenon as was demonstrated in evidence such as decreasing yield, pest infestation, reduced size of fruits to mention but a few. Further, these have significant effect on food security and human health as was indicated by studies reviewed in this section of the review. While experience and knowledge about climate change is useful, the experiences in terms of the impact vary. Thus some groups, though may be aware of the impact of climate change, they may be unable to fully overcome the shock. Thus an assessment of the experiences among groups and how they are able to cope are issues of interest and which this study seeks to interrogate.

2.4. Vulnerability to climate variability and adaptive capacity

In relation to climate, the IPCC TAR (2001) defines vulnerability as the point at which any system can no longer survive or is exposed to the adverse effects of climate change. IPCC regard climate change vulnerability as the extent to which systems are exposed to the effects of climate change, in terms of both magnitude and rate of variation in the climate. The effects of climate variation do not distinguish between which country is developed and which is developing. Although the negative consequences cut across all regions of the world (Porter et al., 2014), the effects are felt most by farmers in developing countries (Yaro, 2013).

It is very essential to appreciate the developing trends in the climate system and the consequences of its associated variation on the environment. This will help prevent or reduce the effects, which can bring untold hardship to humanity (Boyd et al., 2009). In the light of this, Ayal & Filho (2017) study, farmers indicated that climate variation was the cause of

considerable damage in their economic, social and environmental conditions. By implication, these farmers are very vulnerable to changes in the climate.

Since agriculture in Ghana is rain fed (Yaro, 2013; Tambo, 2016; Ehiakpor, 2016) it follows therefore that the slightest change or variation in the climate system is likely to impact severely on food crop production. It is based on this point that majority of farmers surveyed in the Vea catchment area opined that the notable changes in temperatures and rainfall have extremely affected the livelihoods, thereby making them very vulnerable (Limantol et al., 2016). The unprecedented reduction in water resources and animal species as pointed out by Makuvero et al. (2018) as well as high rate of soil erosion and impoverishment (Arbuckle et al., 2013) in the midst of their low adaptive capacity of farmers make them vulnerable to the vagaries of the change in climate.

In another development, farmers have indicated that the incessant rise in temperatures coupled with inconsistency in rainfall is exposing them to the incidence of drought and hunger (IPCC, 2014; Nkrumah et al., 2014). Obviously, the increase in temperatures could not be occurring only during the day but also at night. Likewise, most farmers who have identified notable change in temperatures, rainfall pattern and increase in climatic events stated that their lives are at risk (Menike & Arachchi, 2016; Field et al., 2012). The recent epidemic of pest and diseases (such as the recent surge in fall army worm cases), depletion of soil moisture as well as biodiversity loss as revealed by Babatolu & Akinnubi (2016) could all point to the increased vulnerability of farmers.

Certainly, the situation calls for adaptation measures to fend off or minimize effects associated with changes in the climate and hence strengthen the adaptive capacity of farmers. IPCC (2014) defined adaptive capacity as the ability of systems, institutions, humans and

other organisms to fine-tune to conceivable threat, capitalize on the weaknesses of the threat to create chances and or to react effectively to the results of the threat.

With regard to climate change adaptation, Islam and Nursey-Brown (2017) define adaptive capacity as the ability of any system to make amendments in its ecological, social or economic structures in response to observed or expected changes in climatic stimuli and their effects and impacts in order to alleviate adverse impacts of change or take advantage of new opportunities. By implication, every new condition comes with its own predicaments and prospects, and so if any system is able to absorb the shocks, such that the system capitalizes on the weaknesses of the new condition to survive, then that system is said to be adaptive.

2.5 The concept of adaptation and forms

The Encarta (2009) defines adaptation as the process of building up the social and physical attributes of organisms to enable them survive and breed in their habitat. In other words, it refers to the process of making changes in order to fit into an environment. With regard to climate change adaptation, the UNDP (2005) defined adaptation as a process whereby strategies are developed to moderate, cope and capitalize on the repercussions of climatic events. Similarly, the IPCC further defined adaptation as any modification in the anthropogenic or natural structures in response to a real or expected stimuli or their consequences, such that the damages are reduced or opportunities are exploited (IPCC TAR, 2001a).

According to von Uexkull (2014) most countries in Africa are said to have very low adaptive capacity owing to factors such as economic, demographic, health, governance, technology and natural challenges. Some common adaptation strategies which include but not limited to changing the planting dates, crop diversification as well as watering crops during the dry seasons can lead to bumper harvest (Challinor et al., 2014). Others may include pesticide

application, alley cropping, mixed cropping, bush fallowing, mulching as well as using improved variety of seeds (Ehiakpor, 2016). Accordingly, combining such farming practices as irrigation, mixed cropping, minimum tillage and efficient use of water usually reduce the emission of greenhouse gas and improve crop yields (Sapkota et al., 2015).

Like many other African nations where agriculture is a vital sector in their economic development (Tambo, 2016), Ghana has few irrigation schemes, a situation which impedes the provision of adequate water for farming purposes, and this is more of a challenge especially during the dry season. This situation makes the country's agricultural system very susceptible to variation in climate as evidenced by the increased in mean annual temperatures in Ghana for the past six decades with rainfall pattern also erratic and decreasing (De Pinto et al., 2012).

Although most adaptation strategies are designed based on the prevailing micro-climatic conditions and the socio-economic situation of the people affected, researchers such as by Yaro (2013) and Nakuja et al. (2012) have pointed out that there is a need for a robust adaptation measures, although farmers have adopted some form of measures to cope with the situation.

2.6 Adaptation strategies and factors influencing adaptation

Several factors may influence a farmer's choice of a particular adaptation strategy. Among them are gender, educational attainment, age, access to extension services, size of family as and vailability of capital. Palanisami et al. (2015) assert that these factors have a low influence on farmers' choice. In the farming communities, hindrances to climate variability adaptation are connected in an intricate relationship with perception (Zizinga et al., 2017). This is because farmers can only take a concrete decision to reduce the looming canker if

they are aware of the problem. Several related economic and institutional considerations are basic (Cooper et al., 2013) in determining the choice of adaptation.

2.6.1 Gender of farmers

The gender of farmers and household heads is paramount and one of the factors that may influence the choice of adaptation strategy (Zamasiya et al., 2014). Most studies including Shikuku et al. (2017) and Zamasiya et al. (2017) have indicated that male farmers and households headed by males are likely to develop attitudes towards adoption of new strategies aimed at curbing climate change. For Zamasiya et al. (2017), they attribute this to the inability of females to move over long distances to access services from extension officers who due to resource constraints were unable to come to the villages. Males on the other hand were more likely to use other means of transport such as bicycles to access these services. Thus, males were likely to be more informed about these adaptation strategies. Further to the above, Kristjanson et al., (2012) also found that male farmers have a higher chance of adapting to climate variability because they are quick to adopt tree planting and crop rotation practices. Similarly, Tambo, (2016) stated that male farmers are very quick to switch to new methods in their activities.

Contrary to study by Zamasiya et al. (2017), Kibue et al. (2015) also found in their study that female farmers adhere more to social relations which promote information sharing as compared to the male farmers. Simply put, female farmers receive a lot of climate variation information from their colleagues and are quick to adjust. Kibue et al. (2015) study is further corroborated by Opiyo et al., (2015) who also found that female farmers were more likely to go in for climate adaptation, compared to their male counterparts because most of them are breadwinners in their homes and are better of experienced in countless farm-based production practices.

2.6.2 Educational attainment of farmers

The educational background of the farmers and household heads is key in the choice of adaptation strategy. This is because education broadens the scope of farmers' understanding with regards to changes that are taking place and enable them to develop positive attitudes (Kibue et al., 2015). In respect of this, the higher the educational attainment of farmers and household heads, the easier it is for them to understand and interpret climate variation information (Yong, 2014). If farmers are well educated, they become much conscious of variation in the climate system, the causes and how to reduce or manage the consequences (Shongwe et al., 2014).

Apparently, it is very difficult to sensitize illiterate farmers on climate variation as compared to those who are educated. The reason is that illiterate farmers are difficult to convince on their beliefs and perception about climate variability (Alemayehu & Bawket, 2017). Once more, illiterate farmers are too conservative and do not easily adapt to new ideas. On the contrary, education motivates farmers, broaden their knowledge, and even make them have the desire to readily want to adapt to climate variability (Kibue et al., 2015). Therefore, an attempt to underrate education as a factor which can influence the choice of adaptation will be a misplaced priority.

2.6.3 Age of the farmers

The age of farmers and household heads is relevant in the choice of adaptation strategy. Generally, older farmers are more accustomed to traditional practices and beliefs, and in some cases these practices are long held. Some of these practices are mostly at variance with new methods and as such may prove difficult for older farmers to adapt (Obayelu et al., 2014). In simple terms, younger farmers adapt easily than older farmers. As such, age becomes a determining factor in the choice of adaptation especially for those who have been involved in farming activity for many decades. Accordingly, Adimassu & Kessler (2016) and

Kibue et al., (2015) also agree that since the age of farmers are directly related their level of experience, it informs their perceptions and attitudes, as well as preparedness to easily adapt to climate variability. Contrary to the above opinion, Opiyo et al. (2016) argues that older farmers rather have a better experience of the past and present climatic situation and so they are flexible to adapt to strategies or methods which will help them to reduce the climate associated stress (Opiyo et al., 2016).

2.6.4 Access to agricultural extension services

Agricultural extension officers are professionals who have been trained to provide technical assistance information on farming practices such as the use of improved variety of seedlings, and other agricultural services to farmers (Zamasiya et al., 2014). The availability and accessibility of agricultural extension services partly contribute to a farmer's choice of adaptation strategy. If agricultural extension officers are fairly distributed across farming communities, they can convince farmers to adapt to new methods of farming (Yong, 2014), most especially where these officers can establish demonstration farms.

Extension officers serve as the intermediary between research institutions, government, NGOs and farmers (Fosu-Mensah et al., 2014). They are good at creating awareness on farming related problems, enhancing technological transfer among farmers and can present them in a way that is understandable to these farmers (Alemayehu & Bawket, 2017). It is highly possible that the more farmers are exposed to agricultural extension officers the more convinced they are in exhibiting positive attitudinal change toward adaptation to climate variability (Opiyo et al., 2016).

2.6.5 Size of a farmers family

The number of children one has is an asset and serves as a workforce in most traditional African societies. As such, the size of a farmer's family is capable of influencing their choice

of adaptation (Zamasiya et al., 2017). Adaptation strategies such as short cycle varieties of crops, irrigation schemes, and afforestation are easier for farmers who have large family size (Shikuku et al., 2017). This situation is predicated on the fact that the farming practice is labour intensive and time consuming, hence the smaller the family size, the higher the likelihood of the farmer to be denied this family labour (Zamasiya et al., 2017), which therefore suggests that the farmer would have to employ additional labour to undertake some of these practices. That notwithstanding, the farmer will not adopt such a strategy, no matter the level of its effectiveness.

In another way, farmers with large families require more feed their families and so the family members serve as a cheap source of labour compared to farmers with small family sizes. Granted, the family size of a farmer has a higher chance of influencing their choice of adaptation; however, it applies to most families in different societies?

2.6.6 Availability of capital

The availability of various forms of capital is significant in determining a farmer's choice of a particular strategy. Capital in the form of fiscal cash can help farmer purchase irrigation equipment and other agro-inputs. According to Shikuku et al., (2017), farmers who are well to do (wealthy) can have easy access to credit facilities can acquire different variety of seeds, and fertilizers. Being equipped with capital resources, farmers can incorporate other farming methods with ease, practice crop diversification, plant early and respond better to changes in climate (Tazeze et al., 2012). Yaro, (2013) also attest to the fact that rich farmers easily adapt to change than poor farmers, which suggests that they can buy most of the resources that will enable them to adapt; hence, preventing adverse effects on their livelihoods.

2.7 Conceptual framework

People's perception of events, phenomena or activities influence the way they respond. Perceptions are often not congruent with scientific observations or conclusions, but in so far as it is based on people's experiences, then it constitutes the reality of people and that can shape their understanding (Kusakari et al., 2014). With the broader research area of climate change studies, perception cannot be discounted. The perceptions and experiences of climate change vary across groups, such as gender, social groups and locations. These variations in perception and experience affect people's livelihoods. Livelihoods are critical in the sustenance of families and in most parts of Africa it depends on environmental resources. To be able to comprehend the sustainability of livelihoods, this framework draws on the sustainable livelihood framework.

According to Chambers and Conway (1992), a livelihood comprises the capabilities, assets and activities needed for a means of living. A livelihood is said to be sustainable when it can resist the stress and shocks to which it is exposed to such an extent that it does not also deplete the natural resource base. The sustainable livelihood framework has five key components without which no livelihood can be realized. The five components of the SLF include the vulnerability context in which people are found, the assets they possess, the transforming structures and processes that exist, the livelihood strategies available to them as well as the livelihood outcomes. Below are the details of the various elements (see Serrat, 2017).

The first component involves the vulnerability context or environment in which people find themselves. People become vulnerable when they are exposed to threats and shocks, most of which they have little control or lack the ability to effectively contain. In the framework, vulnerability is defined as the exposure of people to life-threatening conditions (critical trends, seasonalities and shocks) in the environment where they have no capability to

withstand, but which has adverse effects on their livelihoods although they possess some strengths (assets).

In this context, farmers' vulnerability is associated with insecurity of their wellbeing or their livelihood. For instance if drought persist for so long a time such that farmers are unable to cultivate their crops, there will be food shortage which is directly translates to lack of income to the farmers. This situation though may be general, it exposes farmers more to food insecurity. Admission of the above mentioned assertion is and ardent admission of the fact that farmers are very vulnerable and as such are likely to be thrown into perpetual poverty.

This study fits into the domain of the SLF because the farmers whose livelihoods depend on nature are more vulnerable to the variation in temperature and rainfall pattern (climate) to which they are exposed. These variations in climate pose a great threat to the livelihoods of the farmers. As noted by Porter et al. (2014), the effects of climate variation do not distinguish between developed and developing countries. What this means is that when the consequences strike, activities in both developed and developing nations are affected. Similarly, its effects are borne by all categories of farmers. Here, vulnerability could be internal or externa. The external aspect of shocks which is composed of illness, pests, storms, droughts, floods and diseases to which farmers are exposed, result from changes in climate. These usually may happen directly to the farmer (in the case of illness) or to crops in the field. The repercussion is that it could lead to a total devastation of crops that farmers have sown or planted. The other side of external shocks is seasonality, which deals with the unstable price of food crops in both local and international markets. Price fluctuation, especially where there is a continuous downward trend is a major problem that could lead to farmers losing all their investments. The internal aspect of vulnerability has to do with the inability of farmers to defend themselves or cope with the situation in such times due to lack of financial resources and other essential assets.

The second component of the framework deals with the livelihood assets (capitals) that people own or have access to. The livelihood in the SLF comprise assets that people possess to enable them improve their livelihoods and make life comfortable for themselves (livelihood outcomes). Given that people need a combination of several resources to improve their livelihoods, the framework establishes five dimensions of assets or what is also termed as capital resources, which when managed well can transform people's lives. These key resources include financial, natural, human, physical and social capital. Human capital deals with the intellectual endowment of farmers in relation to their skills, good health, balanced diet as well as education. Here lies the case farmers in these study areas only have little or no education alongside the other human resources. This spells doom for the farmers and makes them so handicapped. Social capital encompasses the relations of family support, patronage in group activities and even the neighborhood within which they find themselves. The presence and easy access to all these social groups create an enabling environment for farmers to sustain their livelihood.

Natural capital such as land is key in farming. Easy access to land for free or at a cheaper cost is a great incentive to farming because the tenure agreement in certain rural communities does not favour the farming business. For instance the "abunu" and "abusa" where crop proceeds are shared into two or into three with the land owners goes a long way to make farmers poor. But the good news in the study area is that most farmers own the land on which they farm and this has continued to keep them in business despite their vulnerabilities. Physical capital takes into consideration the availability of good transportation systems and network to facilitate the conveyance of agricultural inputs and produce to and from the farm. The bad road network in the study area add to the plight of farmers because it cost them such a huge amount of money to transport their produce from the farm to the market. When this happens, middlemen and women who come to buy the produce at the farm gate make a lot of

profit at the expense of the poor farmers. Financial capital is said to be the backbone of every serious business and farming is not excluded. If farmers have access to credit facilities at a lower interest rate they could invest and conduct effective maintenance on their farms. Farmers could also have enough to save and to take good care of their families, which will obviously translate into their wellbeing. The third component of the SLF, which is the ‘‘transforming structures and policies" consider the laws, policies, and culture as well as public and private sector institutions which have been put in place. The multifunctional role of institutions, policies and processes is key in improving the livelihoods of people. Undoubtedly, institutions, policies and processes play a key role in accessing various forms of capital as well as influencing decision making. In the same vein, it considers the cultural setting of people and determines whether or not a people can achieve their well-being.

It can be said that the major problem of the vulnerable and poor is the fact that the processes leading to the framing of their livelihoods are the same processes limiting them. Conducive environmental structures and processes go a long way to transform the outcomes of farmers' livelihood strategies. These structures refer to the private and public sector institutions which enact and put into action policies and laws that affect livelihood. They may include MoFA as a whole, agricultural development banks and other financial institutions that give loans and other credit facilities to farmers.

The processes embrace the presence of effective laws and policies as formulated by these institutions. Reliability or efficiency of the processes may lead to easy access to any form of asset and vice versa. This is to say that farmer friendly processes such as easy access to loans from the banks and other financial institutions without any collateral and or at a low interest rate, will not only motivate older farmers to expand their farms and maintain it but will also make farming very attractive to people who otherwise did not regard farming. The results is that the outcomes of their livelihood strategies could be risk averse in the sense that they do

not have to worry over the payment of loans with high interest. It will ultimately lead to improvement in their standard of living.

The fourth element in the framework involves livelihood strategies available from which farmers can select to better their lives. Of great importance is the availability of various activities or opportunities (strategies) from which people can select to make improvements in their lives. In the context of the study, the adaption strategies present this opportunity to farmers to improve their livelihood based on their ability to easily access and use. In the framework, livelihood strategies directly rely on policies, institutions, processes and assets available to people from which they can select to better their lives. This is to say that if there good farmer friendly policies with a flexible process that will grant farmers the easy access to institutions such as the financial institutions, they will be empowered to adopt more sustainable strategies that will lead to successful livelihood outcomes. In simple terms, it considers the combination of various resources (assets, transforming structures and processes) to meet the needs of people which account for improvement in the capabilities (livelihood outcomes) of one household than the other. Therefore, the ability to select the right adaptation strategies is contingent on the assets, policies and institutions.

Finally, livelihood outcomes are successfully achieved when all the above elements are effectively combined and implemented without any hindrances. Generally, livelihood outcomes are the direct results of the ability to choose effective livelihood strategies, thus when they can be easily accessed and using them to the advantage of threatening environmental conditions that are presented by changes in the climate. If farmers are empowered such that they can select the right livelihood strategies supported by the requisite assets, the results are that these farmers can judiciously use their natural resources to reduce their insecurity in terms of food as well as their exposure to risk, thereby giving them more income that finally leads to a complete improvement in their well-being.

The conceptual framework as shown in Figure 2.0 indicates that perception and experience of climate change are shaped by changes in environmental conditions that increase the vulnerability context of farmers. The vulnerability context which also involves level of exposure and susceptibility is also influenced by assets available to farmers, demographic characteristics and institutional support given to farmers to improve their capabilities. Depending on the perception and experiences, farmers can opt to adopt or refuse to adopt strategies introduced to combat climate change. The decision to adopt or refuse to adopt these strategies can lead to outcomes such as sustainable use of resources and food insecurity.

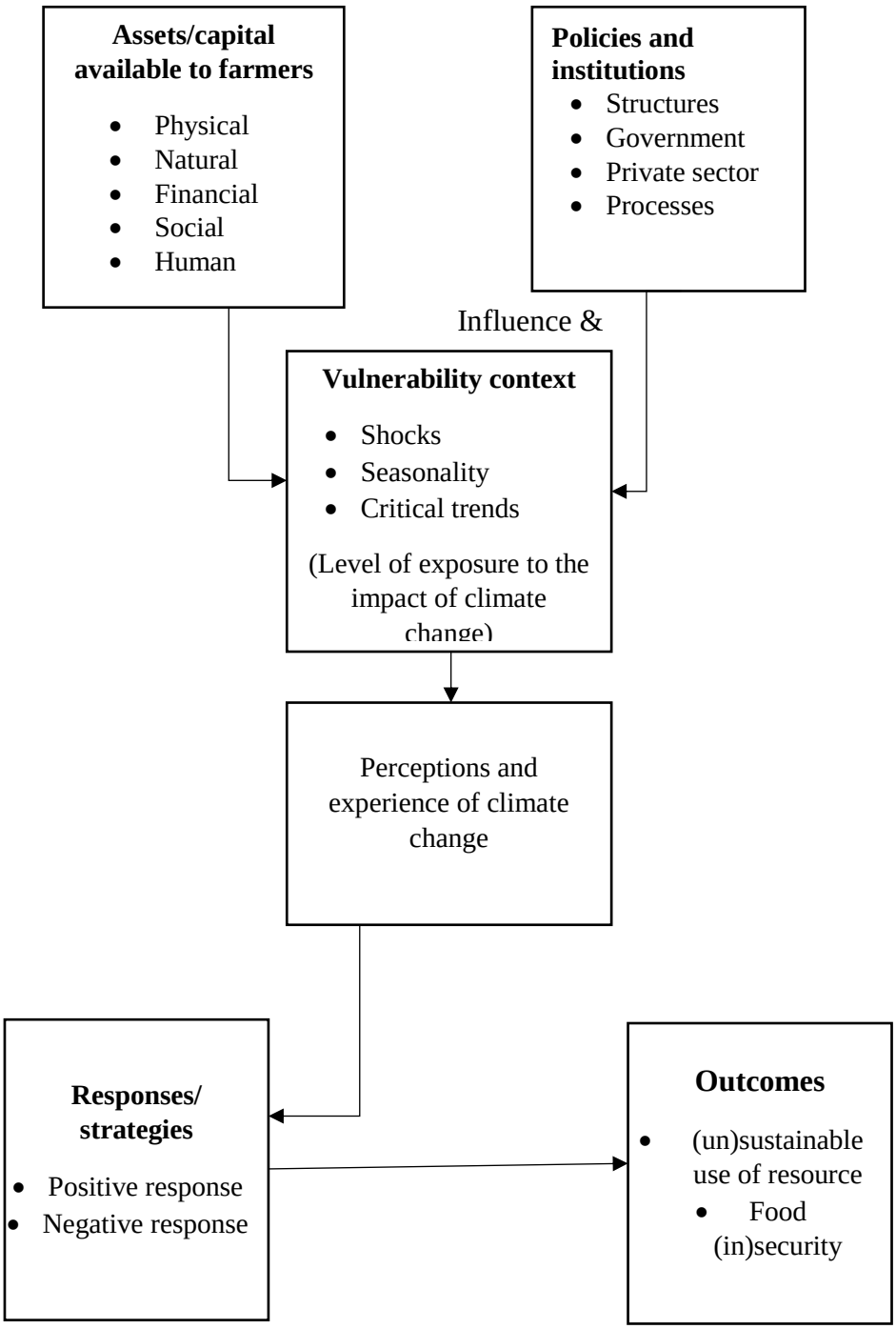

Figure. 2.1 Conceptual framework

Source: adapted from Serrat, 2017

2.8 Summary

The chapter presented the current literature on perception of climate change and variability among farmers. The chapter covers important themes that sought to provide much understanding on climate change phenomenon. These included definitions of key terms such

as climate change and climate variability. Perception, vulnerability and adaptation to climate variability were also reviewed in the chapter. It was noted that perception is shaped by environmental conditions and experiences of these conditions by farmers. Factors influencing climate change were also reviewed. The last section of the chapter is the presentation of the conceptual framework.

CHAPTER THREE

STUDY AREA AND METHODOLOGY

3.1 Introduction

This chapter presents the study area and methodology adopted for the study. Discussions under the study area include the physical geography comprising of relief and drainage, vegetation and climate; geology and soil. Other variables of the study area discussed include the demographic characteristics, the local economy, and the social organization of the people in the District. Themes discussed in the methodology section include research design, types and sources of data, data collection techniques, sampling procedure and sample size, and data analysis.

3.2 The Study Area

The Nkwanta North district is one of the eight Districts in the newly created Oti region which was carved out of the Volta region. The district came into being through the legislative instrument (LI 1846) when the then Nkwanta district was split into two, leading to the creation of the North and South Nkwanta Districts. Kpassa is the capital of the Nkwanta North district. The district covers a total land area of 1,098.9 square kilometers and it is located in-between the following districts: Nanumba South District to the north, Kpadai District to the west, Nkwanta South District to the south and the Republic of Togo to the east. The District is located in-bteween longitudes 0º 10’ West and 0º 45’ East, and latitudes 7º 30’North and 8º 45’North (GSS, 2014).

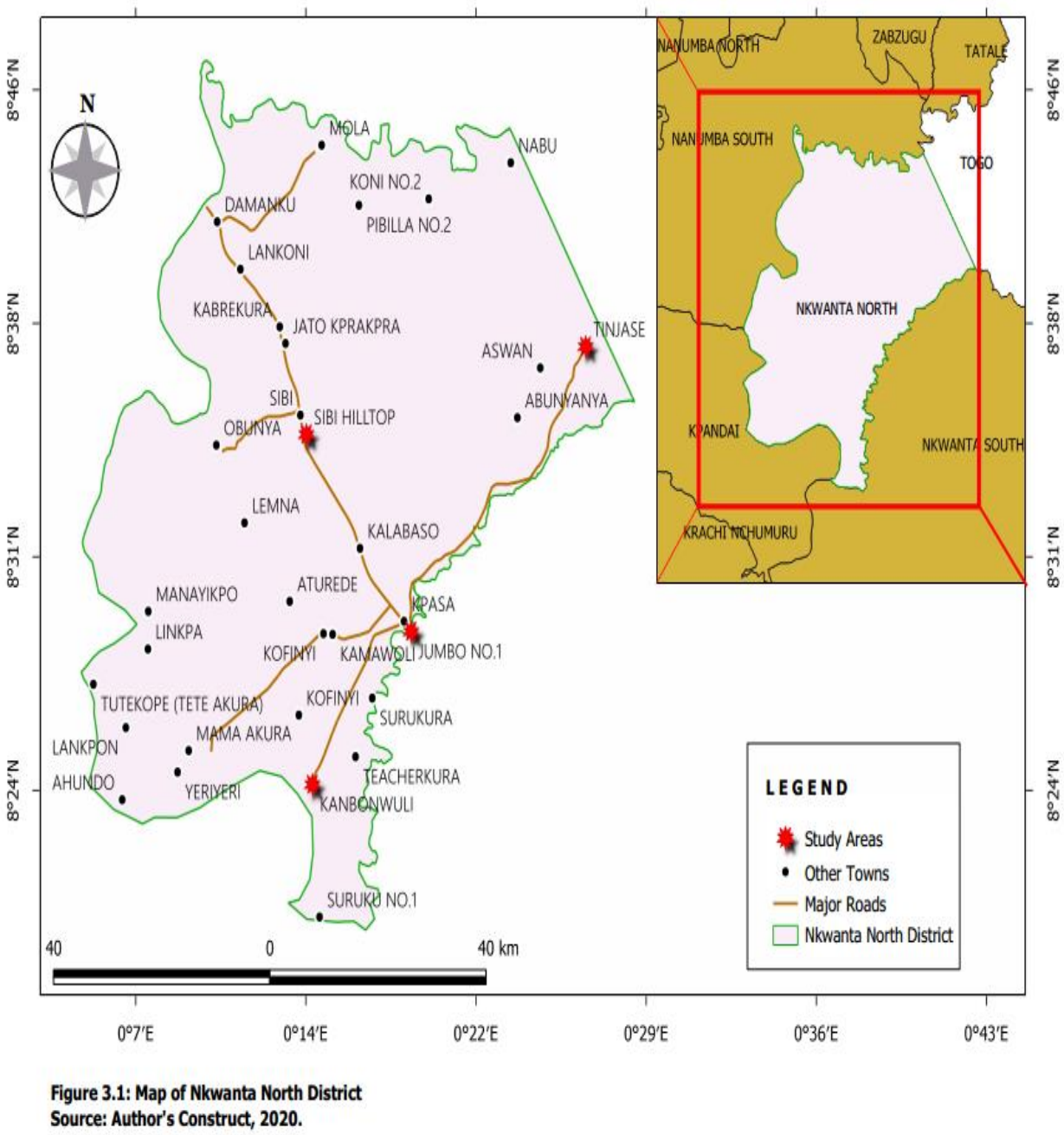

Figure 3.1: Map of Nkwanta North District
Source: Author's Construct, 2020.

Figure 3.1 Map of Nkwanta North District

3.2.1 Relief and Drainage

The general relief of the District is relatively low but has few hilly areas ranging between 100m to 200m above sea level. Dominant among them is the Togo-Buem ranges which forms the eastern boundary between Ghana and Togo. The District is drained by a lot of streams and rivers which generally exhibit the dendritic drainage pattern. Notable among the rivers are the Morla, Kpassa and Oti which are also primary source for inland fishing in the District. The main towns along these rivers that are noted for large scale fishing include Kabonwule, Danladi and Damanko. Though the rivers provide a very good opportunity for large scale irrigation farming, only few sections along their banks are utilized for irrigation farming (GSS, 2014).

3.2.2 Vegetation

The Transitional Savannah Woodland is the prevailing vegetation. This is dominated by scattered short trees throughout the vegetation. These trees are usually drought-resistant but during the harmattan season most of the trees shed their leaves to reduce evapotranspiration, whiles being also affected by perennial bushfires. Also among the scattered trees are few patches of semi-deciduous forest. The commonest economic trees include the *shea tree* which are cultivated for the shea nuts. Other tress found in the zone include *baobab and dawadawa* which are also noted for their medicinal values. The timber species include *odum, wawa* and the *kyenkyen* (GSS, 2014).

3.2.3 Climate

The rainfall pattern of the District is characterised by double maxima rainfall. The double maxima rainfall is usually experienced from April to July which also coincides with the major farming season and August to September which also coincides with the minor farming season. During this period, there is high humidity averaging around 80%, whiles the mean annual rainfall also ranges between 922mm and 1,874mm. Meanwhile the average

temperature ranges between 11°C and 26°C (GSS, 2014). The long dry season begins from November to March and also characterized by high humidity often around 70%. The average temperature around this period ranges between 24°C and 39°C. In December, temperatures are relatively low but the hottest period is experienced from January to early April. The double maxima coupled with its long dry season makes the cultivation of a variety of crops possible, although some crops are destroyed when the dry season prevails more than they are expected (GSS, 2014).

3.2.4 Geology and soil

Basically, the underlying rock formation of the District comprises the Voltain, Buem and Togo formation. There is evidence of mineral deposits such as marble and rock phosphate in the District (MoFA, 2014). This obviously projects the District as a potential ground for the exploration of rare minerals which could be exploited, developed and used in the production of electronic car motors, lithium ion batteries, computer hard drives, wind turbines as well as solar panels and numerous electronic gadgets. The soils in the District are laterite clay, savannah ochrosols and oxysols (MoFA, 2014). These soils which are very fertile for agricultural productivity account for the predominance of agriculture in District.

3.2.5 Demographic characteristics

The total population of the Nkwanta North district is 64,553. Out of this, 50.2% are males and 49.8% are females. The above statistics is slightly at variance with the national figures which indicate that nationally females are about 51%. The population density of the District currently stands at 58.9 persons per square kilometer. Further, the District is predominantly rural, meaning that majority of the population (72%) are rural dwellers. There is a high dependency rate throughout the district as half of the population is below the ages of 15

years, with about 3.6% of the population also above 65 years (GSS, 2014). This implies that 49.7% constitute the labour force of the District.

A little less than a quarter of the population (12,559) is immigrants. The origin of more than three-quarters (84.3%) of these migrants could be traced to the northern region. This is attributed to the close proximity of the District to the northern region, and from all indications, more than half (54.7%) of these migrants have lived in the District for more than a decade (GSS, 2014). There are 9,989 households in the district with more than half (6,875) in the rural areas whereas the rest (3114) dwell in the urban areas. The average household size is 6.4 persons per household but surprisingly only a quarter (1,527) of the total number of households in the district is headed by females (GSS, 2014).

3.2.6 Economic Background of the district

3.2.6.1 Agriculture

Just like the economy of Ghana, the dominant economic activity in the Nkwanta North District is agriculture. The sector employs about 80% of the population who are involved in four types of agricultural production. These include livestock, food crop, forestry or tree growing as well as fishing/fish farming (GSS, 2014). The first two however dominates. This is because almost every household in both rural and urban areas within the District are directly or indirectly involved in one or both farming activities on various scales. The crops that are cultivated include but not limited to yam, cassava, sorghum, maize, and cowpea. The livestock rearing on the other hand is done on subsistence basis and include animals like cattle, goat, sheep, guinea fowl, pig, rabbit, duck, and turkey (GSS, 2014).

Fishing and fish farming are also undertaken in the District especially along the river Oti. The "Battors" of the Ewe origin constitute a large proportion of the people who engage in fishing in the District while their wives serve as the middlemen for the smoking and selling of the

fish to customers and traders. The major towns along the rivers where commercial trading of fish is undertaken include Danladi, Kabonwule and Damanko. Fish species obtained from these rivers include tilapia, mudfish, anchovies, and cat fish (GSS, 2014).

3.2.7 Industry

Due to the rural nature of the district, most of the industries are small scale and cottage-based. They comprise of bakery, pottery, tie and dye and batik, cereal milling, cassava processing, shea butter extraction and carpentry. The District also has five major markets for trading of agricultural produce and other manufactured commoditioes. The market centres are Damanko, Sibi, Nabu, Tinjase near the Ghana Togo border and Kpassa. People from far and near patronize these markets but the most unfortunate issue is the fact that most of these markets fall on the same day of the week amking it difficult for most traders to attend more than one or two markets within a week.

3.2.8 Social and Cultural Structure

Like every traditional/cultural environment in Ghana where the highest power of authority lies in the hands of the paramount chief, the case of the Nkwanta North District is not different. The chief of Kpassa serves as the paramount chief with his sub chiefs, “odikros” and their subjects from adjoining communities. Major ethnic groups in the District include the Konkomba who are in the majority majority, followed by Basare, Ewe, Akans and others in that order. The Konkombas and the Basares are the indigenes of the Land and celebrate their annual yam festival in the District (GSS, 2014). This festival brings the people from far and near to once again renew their family ties and contribute towards the development of the District. The African Traditional Religion (ATR) is the most dominant religion practiced in the District. About half (43.3%) of the District’s population practice this religion, followed by Christianity (33.2%) while Islam and others form the rest 23.5%.

3.3 Methodology

3.3.1 Research Design

Research design is referred to as the blueprint and the logic underpinning the data gathering process which allows a researcher to develop and embark on a research work, considering the topic involved and answering critical questions of why and how the actual problem could be solved scientifically and arrive at a logical conclusion (Creswell, 2014). The type of design that is chosen in a particular research determines the direction of that research. The study adopted the mixed method research design (see Creswell & Clark, 2007; Teye, 2012) for the data collection and analysis of the results. The mixed method research design involves the collection of both qualitative and quantitative data. The qualitative aspect is designed to collect and analyze words (text) whereas the quantitative aspect is designed to collect and analyze numbers. The qualitative aspect usually collect open-ended responses which answers to research questions are not predetermined. Analysis of qualitative data is done using themes and pattern interpretation. The quantitative aspect of the data on the other hand is designed to collect closed-ended responses that are mostly predetermined. Data from quantitative design is analyzed statistical interpretation. It is the case that the different forms of data (qualitative and quantitative) are analyzed separately, but they are integrated into a single research. Even though the researcher was aware that the use of the mixed method was more expensive, time consuming and could be very difficult for a single researcher to undertake (Johnson & Onwuegbuzi, 2004), the researcher found this method appropriate in the context of the study. This is because apart from the fact that the combination of qualitative and quantitative methods in a single study offer a simpler understanding of the research problem in question, the method provides a stronger evidence for a conclusion through convergence and corroboration of findings and could help answer a wide and more complete range of research

questions which is often is not the case when only one research approach is used (Teye, 2012).

3.3.2 Data sources for study

Primary data including both quantitative and qualitative data, and secondary data where used for the study. Primary data was elicited from individual farmers and household heads, agricultural extension workers and District Director of Agriculture (MoFA). The secondary data included reports from the District Assembly including census report. Other secondary sources include recorded annual rainfall and temperature distribution from the Ghana meteorological regional office. According to Flintermann, (2014), secondary data is used to validate and enhance the reliability of the results obtained from the field. Secondary data containing a list of farming communities in relation to food production was also obtained from the Nkwanta North District office of the Ministry of Food and Agriculture (MoFA). This was used to select the communities for the study.

3.3.3 Selection of study communities

The study communities were selected in a manner that covered the entire District. Further, because agriculture is a dominant livelihood activity in the District, there was a high level of uniformity with regards to agricultural activities across the District. To facilitate this process, a demarcation was made on the District map to divide the District into north, south, east and west. Communities were then listed and randomly selected from the list based on the demarcation.

3.3.4 Target population and sample size

The target population for the study was the head of the household. A household include all persons living under one roof or occupying a separate housing unit, having either direct access to the outside (or to a public area) or a separate cooking facility. The heads of the

household was used as the target populations because they are in charge of household livelihood and most decision are taken by them with regards to how the economic life of the family is organized. Thus, they are in much better position to provide insight on the impact of climate change on agricultural activities engaged in by the family.

The sample size for the cross-sectional survey was determined using the formula; $n = N / (1 + N (e)^{2)}$ (see Jensen & Shumway, 2010): where "n" is the required sample size, "N" being the total number of households in the four (4) communities put together and "e" representing the margin of error or level of precision at 5%. Per the formula used, the total household sample size arrived at was 300. This figure was based on the total number of households in the four (4) communities obtained from the 2014 Ghana Statistical Service report. The sample size was adjusted to 180 households with the main reason being time and resource constraints and for convenience. Subsequently, a proportional representational calculation was used to reallocate the sample (180) across the study communities.

3.3.5 Sample size determination

Total number of households (N) = 1,200, level of precision (e) = 0.05,

Using $n = N / (1 + N (e)^2)$

$n = 1,200 / (1 + 1,200 (0.05)^2)$

$n = 1,200 / (1 + 1,200 (0.0025))$

$n = 1,200 / (1 + 3)$

$n = 1,200 / 4$

$n = 300$

The table below gives the breakdown;

Table 3.1 Sample Size Determination

Community	Number of Households (N)	Original Sample Size (n)	Adjusted Sample size (n)
Sibi Hilltop	613	153	84
Tinjase	305	76	50
Kabonwuli	154	39	25
Jumbo No. 1	128	32	21
Total	**1,200**	**300**	**180**

Source: Field Survey, 2020

3.3.6 Sample design

A multi-stage sampling technique was employed in the selection of respondents from the study area. The first stage dealt with the grouping of the district into four clusters, thus North, South, East and West. The second stage involved the random selection of one community each from the clusters to ensure geographical representativeness. In this case the names of all communities in each of the four clusters were written on pieces of papers. Names of communities in each cluster were shuffled on separate tables where one piece of paper was selected from each of the tables. Communities whose names appeared on the four pieces of papers picked were used for the study. The third stage was a random sampling of 180 food crop farm household heads and farmers from 180 households across the four communities. The third stage of the sampling exercise was preceded by a listing exercise. This was a listing of all agricultural households in the study communities to generate a list to serve as a sample frame. At this stage the households in each community were assigned numbers and the required numbers of households were then randomly sampled from the list obtained.

3.3.7 Data collection techniques and tools

3.3.7.1 Cross-sectional survey

The survey is a flexible, useful, non-experimental and descriptive research approach used to investigate a wide range of topics which seeks to describe reality (Mathers et al., 2007). Surveys are appropriate because of their efficiency, flexibility, internal and external validity, ethical benefits and most importantly, its ability to cover a geographically spread samples (Mathers et al., 2007). Most often the questionnaire is employed as a tool for collecting survey data. Respondents of the questionnaire were household heads which comprised of one hundred and forty-nine (149) males and thirty-one (31) females.

The questionnaire which was self-administered was divided into the following sections; A, B, C, D and E. Section A had questions that solicited respondents information on their socio-demographic characteristics, section B solicited respondents information how respondents perceived the phenomenon of climate variability, section C was on farmers' experience of climate variability, section D was on the common forms of adaptation strategies adopted by farmers and finally section E had questions on factors influencing their choice of adaptation. The questionnaire included both structured and semi-structured questions and was translated into Twi and Konkomba to facilitate understanding of the questions for respondents.

3.3.7.2 Qualitative Interviews

Abawi, (2013) defines interview as a means of collecting data from respondents by asking questions and listening, writing, recording in audio, video or a combination of methods (see also Kvale, 1996: 174). Mindful of the fact that interviews are tiresome for large numbers, prone to biases, difficult to analyze and prove validity (Crow & Pope, 2008), they were preferred because of their flexibility, higher response rate, ability to gather complete information with greater understanding and most importantly the ability to introduce necessary changes in the schedule based on initial results (Abawi, 2013). Aside that it is also

compatible with other methods such as the questionnaire to provide insight to participants' values and beliefs (Ho, 2006). Separate interviews were conducted for different participants. For instance, in the case of the extension officers, questions included were assessment of climate situation, assessment of vulnerability of community to climate change, local adjustment to the impact of climate change, current role being played by extension officers and how farmers are coping and adapting to interventions.

3.3.7.3 Focus Group Discussion (FGD)

A focus group discussion (see Abawi, 2013), was held with food crop farmers. Farmers were purposively selected from the communities in the course of administering the questionnaires. The discussion was recorded using pen and paper to take notes. In all, four (4) FGDs were held in the district; thus one from each of the four communities. Each group was composed of three male farmers and one female farmer, making four (4) participants (see Sherraden, 2001) and was moderated by the researcher. This is because most household decisions were taken by males, besides it was not customarily right for their women to be among men for decision making or certain discussions and even if they were present they would just be observers or listeners. Although the researcher was informed that groups could be difficult to assemble, influence of settings on the responses and the difficulty in analyzing data from FGD (Krueger, 1994) , this method looked appropriate because it was good for people with lower literacy levels, less expensive, provided quick results, very flexible, enhanced participant comfort and more importantly was suitable for obtaining several perspectives and insight into people's understanding of issue (Freitas et al., 1988; Azumah, 2011) such as the one being researched.

3.3.7.4 Field observation

Another technique used in gathering data from the field was field observation. The kind of observation used was participatory observation. This kind of observation involves the researcher fully or partially taking part in the activity that they are observing (Ciesielska et al., 2018) This allowed the researcher to take note of important happening in the study area. To facilitate data gathering using this method, a checklist was developed to help the researcher focus on things necessary in understanding the problem more in-dept. some of the things observed included specific practices used in coping with climate change, crops grown in the farms, new faring methods being adopted social lives of the people and quality of the life of the people.

3.4 Data Analysis

The data which was collected from the field was verified to make sure that errors were kept to the barest minimum. The data collected from respondents by means of questionnaire were coded and entered into the Statistical Product and Service Solution (SPSS) version 25. Socio-demographic characteristics which included age, gender, education and marital status were analyzed using frequencies and percentages. Cross tabulation and Pearson chi square test were performed to find out the relationship between respondents' age, gender and annual farm income.

In addition to the descriptive statistics such as frequencies, percentage and charts which were used to analyze objectives one and two, focus group discussion and expert interview reports were also used to support the data that was analyzed. However, objective three which sought to find out the determinants of farmers choice of adaptation strategy was analyzed using the binary logistic regression. The binary logistic regression was employed due to its uniformity in providing meaningful explanation of the determinants of adaptation strategy of farmers, simple nature, mathematically convenience (Hosmer et al., 2013).

Further, data from the interviews (in-depth and expert) and Focus Group Discussions were analyzed through detailed thematic content analysis. This was done by subjecting the field notes to intensive reading to ensure clarity. The notes were then scrutinized for key ideas, consistency of ideas, and categorization into themes. Direct quotations from respondents were also used to support information obtained from analysis of the quantitative data.

CHAPTER FOUR

THE PERCEPTIONS AND EXPERIENCES OF CLIMATE VARIABILITY

4.1 Introduction

This chapter is divided into two sections. The first section provides a description of the socio-demographic characteristics of respondents and farm level characteristics. The second section examines farmers' perception and experience of climate change and variability. The result is compared with secondary data on rainfall and temperature records obtained from the meteorological department.

4.2 Socio-Demographic characteristics

This section presents results on the socio-demographic. Variables described include age, gender; marital status, the highest level of educational attainment, size of household and residential status (see Table 4.1). The data shows that farming business in the study area is male dominated. The result is not surprising and can be attributed to the fact that most females are not usually heads of households, which were the criteria used to select respondents. It even came to light that the few women who headed the households were either widows or had husbands who were indisposed and so the women had to take up the mantle of responsibility.

Concerning the age of respondents, although there is a higher number of young farmers the older farmers prefer new methods of adjustments. Age has again played a critical role here in the sense that older farmers in the nkwanta north have shown that because of the experience of harsh weather conditions on their livelihoods, they are ready to accept any alternative that could reduce the losses incurred in their business. This corroborate the assertion of Opiyo et al. (2016) who argued that older farmers have a better experience of the past and present climatic situation and so they are flexible to adapt to strategies or methods which will help

them to reduce the climate associated stress In terms of marital status, the majority of the farmers were married. The few women (widows) who were not married assumed that status as a result of the death of their husbands. In view of the fact that they have decided not to remarry, they have remained in that condition until the time of the research.. The fact that most farmers are indigenes could be because they have easy access to assets like land which could make them engage freely in the farming business without hiring Concerning education, certainly the level of education greatly influence farmers' perception of variation in climate in the sense that educated farmers are better placed to adapt as opined by Kibue et al., (2015). Out of the few respondents who have had formal level education, about half of them had completed the second cycle education, whereas less than half completed junior high or middle schools. It could be that they were not interested because of the number of years it takes to complete school at least up to the junior or senior high school level before one could get a job which is not even assured.

In relation to household size characteristics, the large number of people in a household could be attributed to the relevance kinship ties in rural areas. This is to say that buildings in rural areas are put up to accommodate both the nuclear and extended families. It could also be that the large family size provide labour in the farm as espoused by Shikuku et al., (2017) see (Table 4.1).

Table 4.1: Demographic characteristics of respondents

Variable	Categories	Frequency	Percentage
Gender	Male	149	82.2
	Female	31	17.2
	Total	180	100
Age	Less than 21	1	0.6
	21 – 35	45	25
	36 – 50	66	36.7
	51 and above	68	37.8
	Total	180	100
Marital status	Single	12	6.7
	Married	144	80
	Divorced	12	6.7
	Widow/Widower	12	6.7
	Total	180	100
Level of education	None	152	84.4
	Basic	13	7.3
	Secondary	15	8.3
	Tertiary	0	0.0
	Total	180	100
Residential status	Native	169	93.9
	Migrant	11	6.1
	Total	180	100
Household size	1 – 5	39	21.7
	6 – 10	53	29.4
	11 – 15	54	30
	Above 15	34	18.9

Source: Field Survey, 2020

In terms of income earned by the farmers, it is obvious that male farmers earn or get higher income from their produce as compared to their female counterparts. This may be attributed to the fact that male farmers are able to cultivate larger farm sizes than female farmers. Outcome of the chi-square test performed proved that there was a significant relationship between gender and the annual farm income as earned by the farmers ($X^2 = 36.76$, $P < 0.05$) (Table 4.2).

Table 4.2: cross-tabulation between gender and annual income

Gender	Below 1000	1000-2000	2100-3000	3100-4000	4100-5000	Above 5000	Total
Male	35 (19.4)	53 (29.4)	16 (8.9)	15 (8.3)	20 (11.1)	10 (5.6)	149 (82.8)
Female	24 (13.3)	7 (3.9)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	31 (17.2)
Total	**59 (32.8)**	**60 (33.3)**	**16 (8.9)**	**15 (8.3)**	**20 (11.1)**	**10 (5.6)**	**180(100.0)**

Source: Field Survey, 2020

Considering the annual income of respondents, a few farmers earned above higher income of above GHC5000. It is clear that most of the farmers who receive this amount and above from the sale of their produce fall within the youthful bracket. This could be as a result of the fact that people within their youthful ages have enough strength and other resources required in farming and so they are able to effectively maintain their farms well. It could also be that because of the high level of illiteracy among the youth in the said areas, they are unable to secure any other form of formal employment to earn a living except farming . The results as obtained from the chi-square test done indicated a significant relationship between the age of farmers and their annual farm income ($X^2 = 35.0$, $P = 0.002 < 0.05$) (Table 4.3).

Table 4.3: cross-tabulation between age and annual income

Age	Below 1000	1000-2000	2100-3000	3100-4000	4100-5000	Above 5000	Total
Less than 21	0 (0.0)	1 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.6)
21 – 35	7 (3.9)	27 (15.0)	4 (2.2)	5 (2.8)	2 (1.1)	0 (0.0)	45 (25.0)
36 – 50	26 (14.4)	20 (11.1)	3 (1.7)	2 (1.1)	10 (5.6)	5 (2.8)	66 (36.7)
51 and above	26 (6.7)	12 (6.7)	9 (5.0)	8 (4.4)	8 (4.4)	5 (2.8)	68 (37.8)
Total	59 (32.8)	60 (33.3)	16 (8.9)	15 (8.3)	20 (11.1)	10 (5.6)	180(100.0)

Source: Field Survey, 2020

4.3 Farm level Characteristics of farmer

Crops such as yam, rice, cowpea, guinea corn, oil palm, maize, cocoa, groundnut, cashew and cassava were the major crops that were cultivated in the District. Out of these cassava was the common crop that was cultivated by farmers. This was obvious as observed by the researcher in the course of the data collection. This is because almost every household was either busy with the peeling of cassava, the drying of cassava (Kokontey), processing of cassava into dough and or processing the cassava dough into gari. It was followed by yam, maize, guinea corn, rice, groundnut in tht descending order of cultivation. Thus the result indicate that food crop rather than cash crops were most cultivated by farmers.

A cross-tabulation of size of farm and years of experience in farming is shown in Table 4.4.

Inferring from the data as presented, it could be said that farm size reduces with increasing age. This is to say that as farmers advance in age, the size of their farms reduce. This could be as a result of their perception of variation in climate. In other words they do not want to invest scarce resources in the farming business again considering their experience on the negative influence of variation of climate in farming. It must also be noted that children and for that matter large family size is a critical resource to rural folks as thy serve as labour force in the farm. The large family size is supposed to help parents expand and maintain their farms well but this may not be the case here. Reduction in the size of farm by the aged could mean that the children would no longer want to work on their parents' farms as thy have grown old and started making their own families.

Table 4.4 Cross-tabulation between size of farm and years of experience in farming

		Years of experience in farming				
		1 – 9	**10 – 19**	**20 – 29**	**≥ 30**	**Total**
Size of farm	1 – 5	2 (1.1)	9 (5)	11 (6.1)	19 (10.6)	41 (22.8)
in acres	6 – 10	0 (0.0)	10 (5.6)	26 (14.4)	23 (12.8)	59 (32.8)
	11 – 15	0 (0.0)	2 (1.1)	15 (8.3)	24 (13.3)	41 (22.7)
	16 – 20	0 (0.0)	1 (0.6)	9 (5)	16 (8.9)	26 (14.5)
	21 – 25	0 (0.0)	2 (1.1)	1 (0.6)	4 (2.2)	7 (3.9)
	26 – 30	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.6)	1 (0.6)
	≥ 31	1 (0.6)	0 (0.0)	0 (0.0)	4 (2.2)	5 (2.8)
Total		3 (1.7)	24 (13.3)	62 (34.4)	91 (50.6)	180 (100)

4.4 District average annual temperature and rainfall patterns

4.4.1 Average temperature patterns

This section of the chapter presents official temperature and rainfall records of the District and this information was collected from the regional meteorological department office. Temperature and rainfall information gathered span a ten year period beginning from 2008 to 2018. Figure 4.1 shows that between 2006 and 2020 average temperature has increased from 27^0C to 29^0C. However, in between these years, the temperature has been oscillating. For instance, in 2009 the average temperature rose to 28^0C and then 29^0C in 2011 and 2012. It then dropped to 27^0C in 2013 and 2015. This annual change clearly indicate variability in temperature and is in sync with IPCC (2007) definition of climate variability as fluctuation of climate around the mean figure, including seasonal and large scale discrepancies in atmospheric and oceanic circulations.

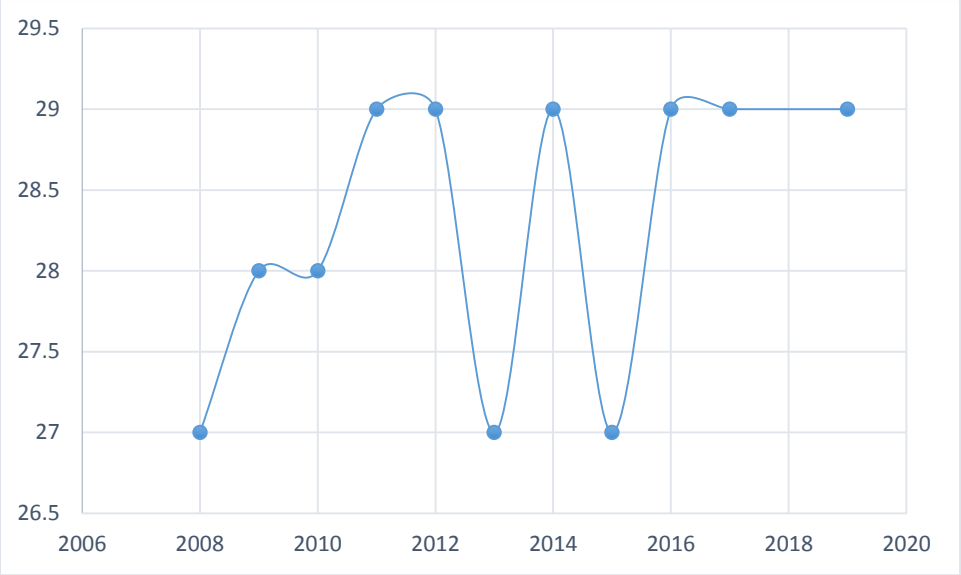

Figure 4.1: Average temperatures between 2008 and 2018

Source: Ghana meteorological agency, 2020

4.4.2 Average rainfall patterns

With regards to rainfall records, it can be observed from Figure 4.2 that between 2008 and 2018, rainfall amount has reduced from 1854mm to 1422mm. Similar to the temperature figures; the average amount of rainfall has been fluctuating. The lowest average amount of rainfall was recorded in the year 2015 which was 994mm. In the following year i.e. 2016 it increased to 1096mm and since then there has been an upward recording of rainfall figures. This result also shows the variability of rainfall amount over the decade in question (Figure 4.2).

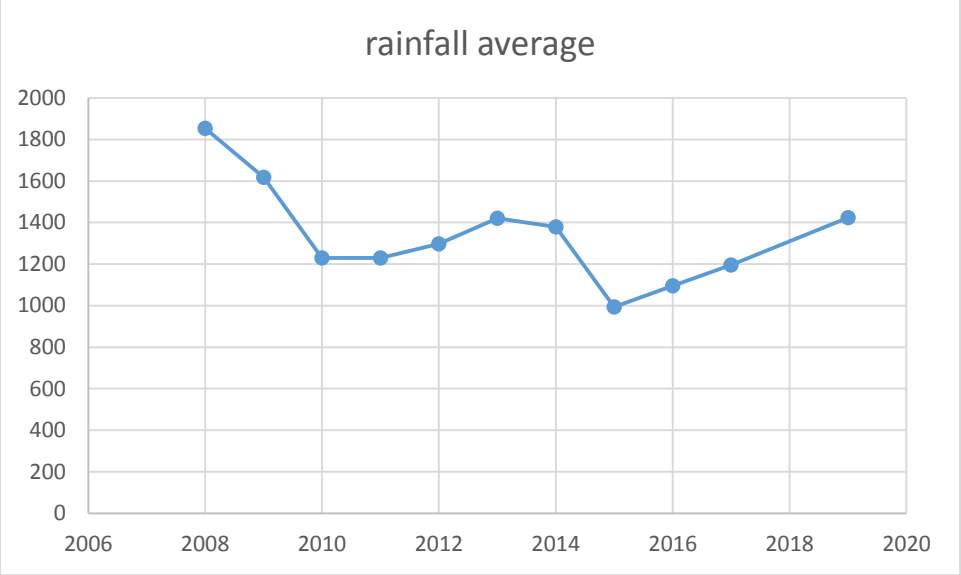

Figure 4.2: Average rainfall amount between 2008 and 2018

Source: Ghana meteorological agency, 2020

4.5 Farmers' Perception of Climate Variability

This section of the results presents farmers and key informants perceptions and experiences of climate variability in the District. The results as shown in Figure 4.3 indicate that about 98.3% aware of the variation in climatic situation in the District. Similar opinion was expressed by experts interviewed. The quote from one key informant highlights this point:

> *"The district is endowed with a lot of agricultural opportunities which have been left untapped. Even though agriculture used to be a very lucrative business it is not doing too well these days due to the current trend of variation in climate. Variation in climatic elements, especially rainfall is the major challenge with which farmers are seriously grappling" (Interview with district director (MoFA) February, 2020).*

The above result is in sync with Hameso's (2018) view that farmers are quite aware that there has been variation in the climate, that their interpretation reflects their locale. Indeed, the interpretation of the perception shows that it matches with records of the Ghana

meteorological agency. Further, Clarke et al. (2012), also mention that the availability of numerous scientific data proves that there has been a continuous variation in the global climate over the past three decades (Figure 4.3).

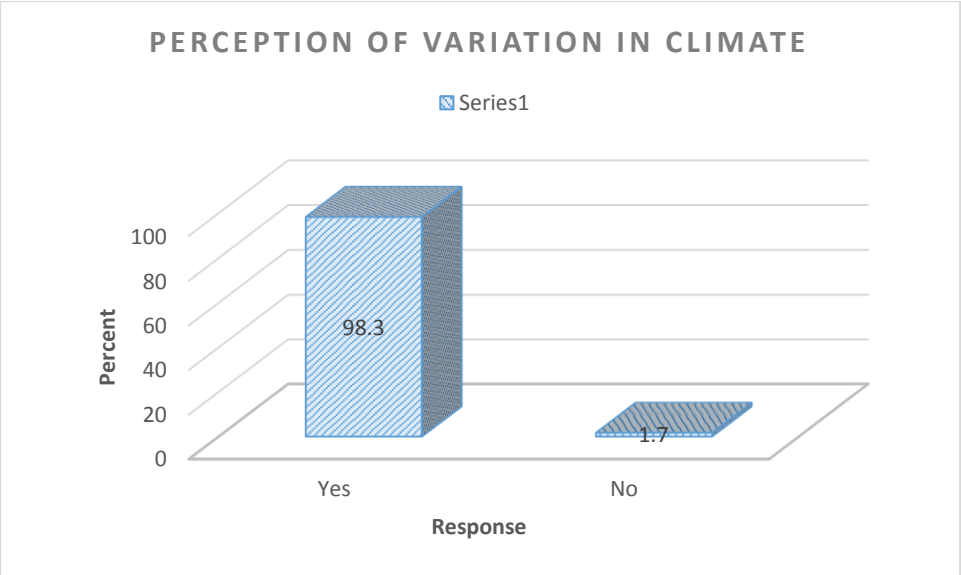

Figure 4.3 Variation in climate as perceived by farmers

Source: Field Survey, 2020

4.5.1 Perception of rainfall variability

With regards to farmers' perception on the variation in rainfall pattern, Table 4.4 shows that about 99.4% of respondents pointed out that they were aware of the changes in the rainfall patterns over the decade. These responses further support the official records as shown in Figure 4.2. The perception about the sudden change in rainfall as perceived by the farmers cannot be underestimated and provide insight on localized observation. The above findings corroborate Asiedu et al. (2017) findings which indicated that rainfall has been unstable over the last half decade. The unpredictability of rainfall annually has implications on farmers' ability to prepare for the farming season and also the yield from their farms. In situations where rainfall recorded is very low, this can increase food insecurity among farming households**.** Highlighting this point, one farmer stated:

"*As for the rainfall, it is not following any formula. Unlike those days when were able to predict when the rain will start and when it will stop, the current trend is too different" (participant in the FGD, February, 2020).*

Table 4.5: Variation in Rainfall as Perceived by Farmers

Response	Frequency	Percentage
Yes	179	99.4
No	1	0.6
Total	180	100

Source: Field Survey, 2020

Figure 4.4 Low harvest of a farmer as he displayed and attributed to poor rains

Source: Field survey, 2020

Further, Figure 4.4 shows that about 77.2% stated a shortening duration of rainfall as the most noticeable trend in the rainfall pattern with just 1.1% of the respondents indicating that rainfall was increasing in duration. Again, about 8.9% of respondents were of the opinion that rainfall was increasing in volume, with about 6.7% and 6.1% of respondents indicating a decline in volume and change in the timing of rainfall respectively as shown in Figure 4.4.

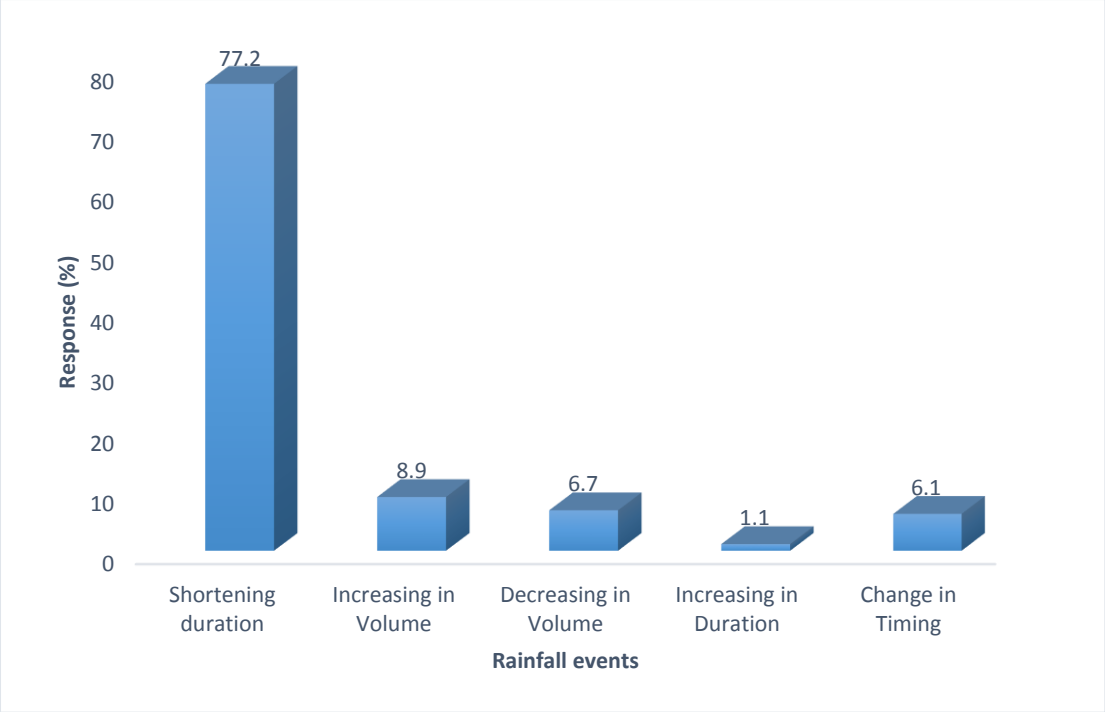

Figure 4.5 Form of variation in rainfall as perceived by farmers

Source: Field Survey, 2020

The results on variation in rainfall duration is consistent with Antwi-Agyei et al. (2015) and Nkrumah et al., (2014) who opined that the duration of rainfall has been decreasing across all the agro-ecological zones in Ghana. The authors assert that though rainfall is the major determinant of the success or failure of crops, the quantity does not matter but the evenly distribution over the cropping season is key. From the result above (Figure 4.4), it can be suggested that farmers are not getting adequate rainfall from the time of land preparation and throughout the period of cultivation in the right amount. This point was highlighted by one of the farmers:

"In the days of our forefathers when we were young the rains started and ended at times that were predictable. It didn't always fall too heavy but it was uniformly distributed throughout the cropping season. In that era, a farmer could have enough time to prepare the land, cultivate crops, control weeds and even have some time to rest before harvesting. These days because the rainfall pattern has changed, one has to do everything within a limited period of time without proper weed control, let alone time to rest before harvesting. Trends in rainfall are no longer being predicted as compared to those days" (participant in the FGD, February, 2020).

4.5.2 Perception of temperature variability

Wherever the researcher went it was observed that even though a lot of the men and women were seated under trees, most of the men had either their shirts or singlets hanged on their shoulders. In short, most of the men were encountered bare-chested. Very few respondents opined that there was no change in temperature, whereas a large proportion of respondents said there was a change in temperature as can be observed from Table 4.6.

Table 4.6 Variation in Temperature as Perceived by Farmers

Response	Frequency	Percentage
Yes	179	99.4
No	1	0.6
Total	180	100

Source: Field Survey, 2020

The quote below provides further insight into the above responses from the farmers:

"*As you see us now, you can see that we have removed our shirts right, do you think we are happy sitting here or like to walk bare-chested? It is because of the*

> *heat. These days the heat is too much. This is not only during the day, if you like come here in the night and you will see the number of people sleeping outside. As for our rooms, it looks as if the heat from the sun is being stored there during the day. Some of us cannot remember the last time we slept in the room"* (*participant in FGD, February, 2020*)

The above results on farmers' perception of increased temperature are in sync with the official records from the meteorological agency which is shown in figure 4.1. This finding has implication on farming and other agricultural activities. For instance Fagariba et al. (2018) note that increased temperature leads to a complete loss of soil moisture, and a harsh decline in such tree species as dawadawa, mahogany, shea and the neem as a result of excessive heat. In a similar vein, Yiran and Stringer (2017) assert that the prevalence of extreme heat has affected both crops and livestock.

In terms of the form of the temperature change, about 91.7% of respondents claimed that the form of temperature change was an increase in trend. Only 6.7% of respondents opined that temperature was rather reducing, with 1.7% also perceiving that temperature was normal as can be observed in Figure 4.5

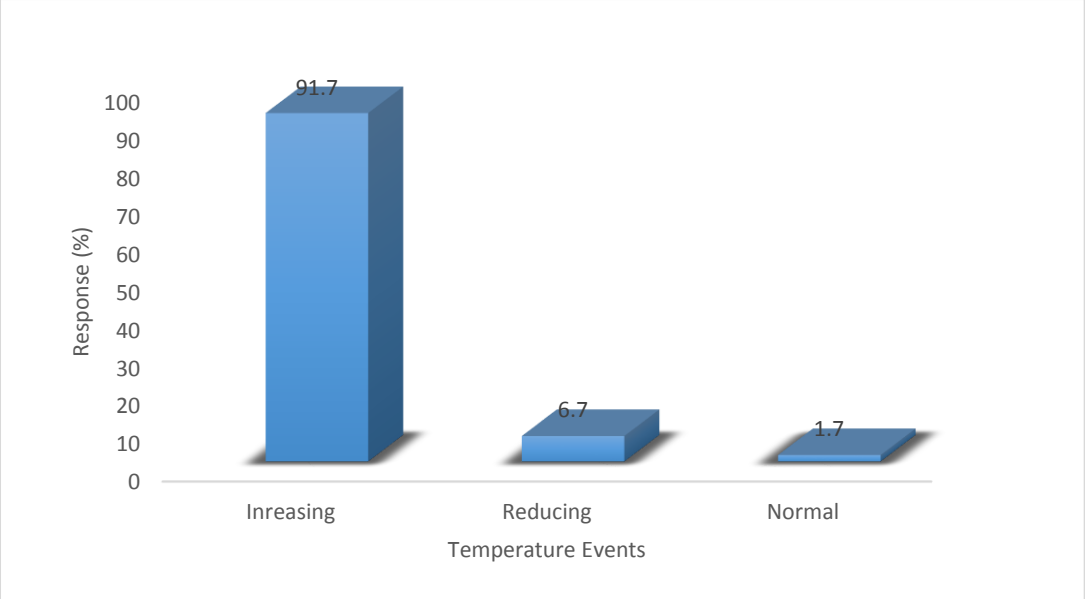

Figure 4.6 Form of variation in temperature as perceived by farmers

Source: Field Survey, 2020

Figure 4.7 Yams getting rotten in the barn as a result of excessive heat

Source: Field Survey, 2020

4.6 Perception of farmers' vulnerability to climate change and variability

Climate change and variability presents significant risk to farmers which threatens their livelihood. This situation also places them in a vulnerable situation. It was important therefore to find out from farmers their perception with regards to vulnerability to climate change and variability. Results in Table 4.7 shows 98.9% of the respondents indicated that their farming activities were vulnerable while only 1.1% indicated that their activities were not vulnerable to climate change and variability. Providing perspectives on vulnerabilities of farmers to climate change and variability, a key informant interviewed noted:

> "As *it stands now, the livelihood of most food crop farmers is in danger as a result of variation in the climate. It is against this background that the district directorate (MoFA) has initiated a program to educate farmers on the need to consider incorporating crops such as maize and cashew in their businesses" (Interview with district director (MoFA), February, 2020).*

Table 4.7 Perception of Vulnerability by farmers

Response	Frequency	Percentage
Yes	178	98.9
No	2	1.1
Total	180	100

Source: Field Survey, 2020

The above (Table 4.7) results resonates with findings form the IPCC (2014) and Nkrumah et al. (2014) who reported that a lot of farmers opined that vulnerability of their farming was due to the continuous rise in temperatures coupled with inconsistency in rainfall. According to the reports mentioned above, the situation has exposed farmers to the incidence of drought and hunger. Indeed, if the trend continues without an alternative or any adaptation measures being put in place, a time will come when huger will turn into an executioner. According to

Ehiakpor (2016), the slightest change or variation in the climate system is likely to impact severely on food crop production. Adding to the above, Ayal & Filho (2017) also in their crop and livestock production in Ethiopia indicated that climate variation was the cause of considerable damage in their economic, social and environmental conditions.

The study further sought to find out specific climatic change effects that increases the vulnerability of farmers. 69.4% of farmers opined that their farms were vulnerable to floods. Approximately 96.7% of farmers indicated that they farms were vulnerable to the intense heat by the weather. The quote provides insight on the increasing flood situation associated with climate change and variability:

> "*The only farmers who experiences flooding in this district are those who have their farms near river bodies and streams. Even those farmers experience the flood only when the rivers and streams overflow their banks but not regularly" (participant in FGD, February, 2020).*

4.7: Climate events experienced by farmers

Apart from a few farmers (2.2%) who reported experiencing an early onset of rainfall, an overwhelming majority of the respondents (97.8%) observed a delay of rainfall during the past three decades. Also, majority of farmers (83.3%) observed an early truncation of the rains but a small number (16.7%) have observed otherwise. Further, most farmers (76.1%) opined that they have observed an increase in rainfall intensity over the past three decades whereas less than a quarter saw the rainfall intensity to be reducing. On the other hand, more than half of the respondents (66.7%) have observed an increase in flooding events as compared to a little over a quarter (33.3%) who have observed the contrary as shown in Figure 4.6.

Further, while a large number of the respondents (87.8%) have observed a prolonged duration of the drought, only a few (12.2%) have observed a shortened duration in the length of drought over the past three decades. In addition, a lot of the farmers (92.8%) have observed rainfall with storm over the past three decades as against just a handful (7.2%) who have said the rainfall was normal without storm (see Figure 4.6).

Expectedly, all the farmers (100%) opined that the day and night temperatures have never been reducing but rather increasing (Figure 4.6). the quote below seems to emphasize the prevailing climate events as experienced by farmers:

> "*Please you are also a bit matured, kindly watch the ground and the grasses around and tell all of us here if you can see any sign of rain on the ground. What I want to say is that, the dry season has stayed for too long. By this time we should have at least one rainfall but till date not even a drop. When it happens this way you see these worms chewing the leaves of our crops. The worse thing is when the rains want to fall, it falls as if all the rains in the sky must finish before it stops. You can ask my colleagues here, when it happens like that some people's farms become flooded and those of us whose farms were not affected can also not go to farm because we cannot cross the streams and rivers" (participant in FGD, February, 2020).*

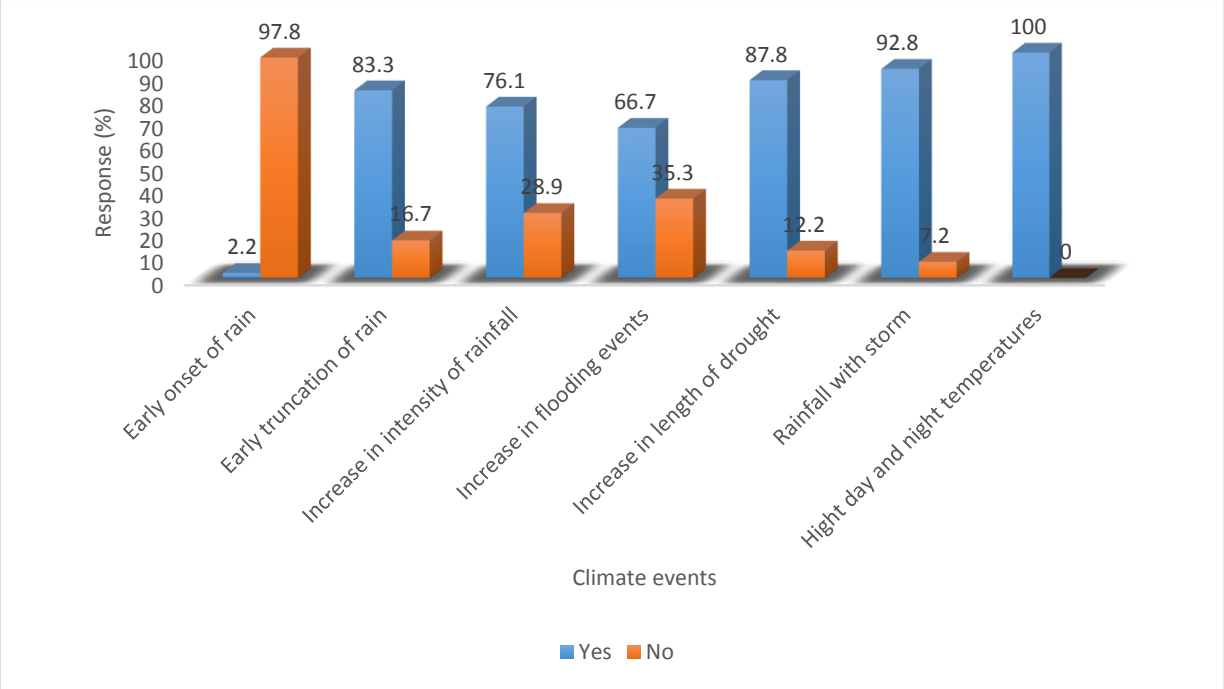

Figure 4.8 Climate Event as Experienced by Farmers

Source: Field Survey, 2020

4.8 Conclusions

. Discussions from this chapter showed that most households were headed by males. Most of the farmers too were old and have been farming decades with just a handful of them having basic and secondary education. Most households were composed of more than ten people with yam being a common crop in the area. This is because almost every farmers cultivated yam in addition to other individual crops.

It is proven that farmers have identified the unpredictable behaviour of rainfall and sudden rise in temperature. This is in conformity with the proclamation by Limatol et al., (2016) who stated that most farmers perceived an increase in temperature and a rapid drop in rainfall. To buttress their claim, farmers were able to point out specific events of rainfall to that effect. For instance farmers pointed to the fact that rainfall was not stable, was shortening in duration and was not equally distributed throughout the year as it used to be some decades back. Again this claim confirms the assertion of Mamba et al., (2015) who declared that

farmers perceived a decrease in the frequency, intensity and duration of rainfall. To this end, there is no doubt that the inability of the rains to start early during the cropping season was a big source of worry to farmers as they recognized the fact that whenever the rains came it fell too heavy at a time such that it led to flooding in those places.

As if that was not enough, it is crystal clear that the rains always stopped suddenly which often led to drought and the prevalence of heat over a long period causing certain diseases on crops in the field to wilt and some eventually dying. This claim is supported by Hameso, (2018) who blamed climate variability for the outbreak of certain diseases and the sudden appearance of strange insects. This often caused farmers to experience huge postharvest losses in crops. Considering farmers' experiences with the climatic events as espoused above, it can be concluded that farmers perceived that there were variation in the climate.

CHAPTER FIVE

ADAPTATION STRATEGIES AND FACTORS INFLUENCING CHOICE OF STRATEGIES

5.1 Introduction

The chapter presents results on adaptation strategies of farmers in the wake of climate change and variability, and also the factors that influence the choice of these adaptation strategies.

5.2 Adaptation strategies

Table 5.1 revealed that most farmers (97.8%) have resorted to the use of one or more strategies available to them to reduce the negative impacts of the changing climate. The overwhelming response of farmers on the adoption of new farming strategies in dealing with climate change is consistent with the assertion by Yiran & Stringer, (2017) that rural populations have resorted to several strategies to respond well to the threats posed by the changing climate. In view of the unstable nature of the climate and fact that farmers' livelihood depends on the climate, it was expected that farmers would adopt one or more strategies to cope with changes in the climate. However, their ability to adopt also depends on the fact that the options are available.

Table 5.1: Do you use adaptation strategies

Response	Frequency	Percentage
Yes	178	97.8
No	2	2.2
Total	180	100

Source: Field Survey, 2020

5.3 Common Forms of Adaptation Strategies

Adaptation strategies adopted by farmers in the area included the use of drought-resistant crop varieties, mixed farming, changing planting dates, weedicides, alley cropping, irrigation,

mulching, ploughing, and fertilizer application. Figure 5.1 shows that the most widely used adaptation strategy by farmers is mulching with approximately 99.4% of farmers sampled using this method. The use of mulching was popular among the farmers because most of the farmers do mixed cropping with yam being the commonest crop cultivated in these farms. After planting the yam the ridges are mulched to keep it moist and to aid sprouting. A detailed discussion is presented on some of the adaptation strategies adopted by farmers in the subsequent sections.

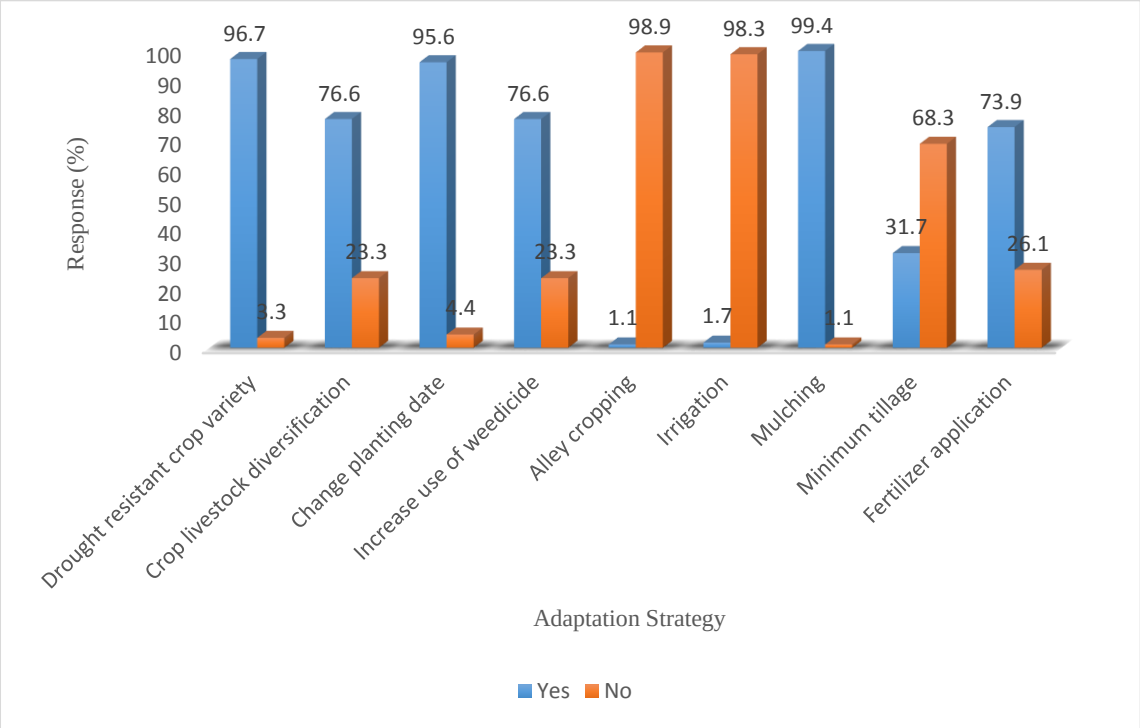

Figure 5.1 Adaptation Strategies adopted by Farmers

Source: Field data, 2020

5.3.1 Drought resistant crop variety

About 96.7% of respondents adopted this adaptation strategy. The use of drought-resistant crop variety was popular among maize and rice farmers. Rice has been cultivated in the area for a long time but the changing climate had reduced yields. In view of this, many farmers with advice and support from extension officers adopted this strategy to reduce crop damage.

Maize was a crop that was not produced in commercial quantities but in recent times many farmers are cultivating maize because of the commercial viability of the crop and the introduction of new breeds, which are drought resistant. This situation has made it possible for them to adopt varieties that can withstand the shocks of the changing climate, with increasing yields also cushioning families as they can consume at the household level and sell some for income. This point confirms the assertion by Ehiakpor, (2016) that improved seed varieties are high yielding and the use of these seed varieties is one of the essential adaptation strategies to variation in the climate and a key step to increasing food production, as they are resistant to the shocks associated with the changing climate. This assertion has been given credence in the quote below:

"A lot of the good yam species cannot withstand current variation in the weather. Some of the yam varieties that are no longer in existence include "kike", "jetiba", "nyareba"' and "bibiala". These species no longer exist due to the variation. In our area here, the production of maize is a new thing that a lot of people are now doing. Because the rainfall is failing us and destroying certain species of our crops, many of us are adding maize and rice production to our farming business. This is because most of these varieties that are coming into the system can do well to give a good harvest even with little rainfall" (participant in FGD, February, 2020).

5.3.2 Change in planting date

Figure 5.1 shows that about 95.6% of farmers sampled resorted to change in planting date as a one of the adaptation strategies. Indeed, it was the third most used strategy based on responses from farmers sampled. As noted earlier, rainfall is instrumental to the success or failure of crops, but the pattern has become so unpredictable that farmers do not have any specific date that they start planting, unlike the past three or four decades. The problem now is, farmers must shift from their original months and dates that they use to plant their crops to

such a time when the rain begins. This change in the planting date is the only way that farmers can harvest a large proportion of their produce. This finding is consistent with Challinor et al. (2014) who found that changing planting dates to suit the changing climate can lead to a bumper harvest. Similarly, Ehiakpor, (2016) also found that most farmers have changed their planting dates as a result of changes in the pattern of rainfall. A participant in one of the focus group discussions recount:

"All of us who do farming here depend on natural rainfall to produce our crops. In some twenty to thirty years back when we were able to predict rainfall with certainty, we did land preparation to meet the onset of rainfall so that we could plant our crops within certain range of dates. As we are here now, that time is gone and so there are times that we clear the land in anticipation for rain but before we realize we have been disappointed and this makes us to do double work because as for grasses here, whether it rains or not they will grow. The situation has forced all of us to change our planting dates to suit whenever the rains set in" (participant in FGD, February, 2020).

5.3.3 Crop and livestock diversification

Crop and livestock diversification was also common as about 76.6% of farmers adopted this strategy. According to the farmers who combined both crop cultivation and animal rearing, this practice was necessary so that if the crop failed because of unreliable rains, at least they can depend on the animals being reared. Indeed, sharing their experiences, some farmers' recounted situations where they had low crop yields and had to sell some of their livestock to cater to their households. This system of farming is a practice that has been with rural communities for a long time as indicated by Yaro, (2013), however, the adoption has intensified due to the effect of climate change and variability on farming activities. Apart from using surplus crops to feed animals, their droppings are also plowed back into the soil to increase soil fertility, which also boosts crop yields. One aged farmer stated:

"As for the fowls, goats, sheep and other domestic animals, we have been taught to keep them since our childhood. Usually before you learn how to farm we were given one or two female animals to take care of, as our own. This we did diligently and used the proceeds to purchase our needs and so we are used to it. Today, it is doing us a lot of good because now that the crops are not doing well as a result of variation in the climate, do you think the animals will refuse to grow? Obviously no, so the animals support us to get money and food. At my age now, I cannot do any serious farming again so my animals serve as my farm that provides food and money to support my small farm" (participant in FGD, February, 2020).

5.3.4 Application of Weedicide

The use of weedicides was found to be part of strategies adopted by farmers in coping with climate change and variability. Indeed, 76.6% of farmers reported using this strategy. Farmers sampled for the study explained that when the grass dies, they serve as mulch to the soil surface, which apart from keeping the soil moist, also helps the soil gain some nutrients. This point goes to confirm Yaro (2013) view that the switch to the use of herbicides was to help improve soil fertility and to cool the soil surface through the mulching effect of the debris. Again, respondents indicated that using the weedicides helped them get good yields by killing some of the disease that attacks their crops. This point affirms Ehiakpor, (2016) argument that without the use of these pesticides they would experience poor harvest and increase in post-harvest losses. A farmer in one of the discussions specified that:

"If these herbicides were not common, some of us would have stopped farming. This is because the physical labour involved in farming is not as easy as people see it. These herbicides help us to clear a large expanse of land compared to weeding. The work that a labourer could do for one week, you use a day or two to finish if you are doing spraying. Because the grasses die to the roots, they loosen the soil particles and also add to the soil nutrients" (participant in FGD, February, 2020).

5.3.5 Fertilizer Application

It was also found that close to two-third (73.9%) of farmers adopted the use of fertilizer to boost their yields. The use of fertilizer was common among rice and maize farmers as in the case of the use of improved seed variety. Farmers claimed that because the climate was unpredictable, it was necessary to apply fertilizer to their crops so that if some form of rainfall was experienced, the crops can grow faster and produce a good harvest. According to them, this practice was one of the major ways of adapting to the unpredictable rainfall pattern. This declaration by the farmers is confirmed by Fagariba et al., (2018) who aver that the uncertain rainfall pattern which often led to drought and high temperatures compel some farmers to adopt the use of fertilizer as a means of coping with challenges associated with the changing climate. In response to the benefits of using fertilizers, this is what one farmer said:

"Most of us use the fertilizer as soon as we receive the slightest rainfall. We did this so that the fertilizers can dissolve very fast for the crops to absorb within that short period. When this happens the crops grow at a faster rate than normal and are able to mature with bumper harvest in good time" (participant in FGD, February, 2020).

5.3.6 Minimum Tillage

It was reported that less than half (31.7%) of the farmers adopted minimum tillage (ploughing) as a means of coping with the shocks associated with variation in the climate. Most farmers however did not adopt the use of minimum tillage because they claimed the cost involved in ploughing was high and besides the measurement used by the tractor operators to tilt the land was not up to the standard as compared to the size of an acre of land. That notwithstanding, the farmers who agreed to having resorted to the use of tractor services to plough the land explained that the lengthy nature of the drought has removed moisture and nutrient from the surface of the soil so it was necessary to overturn the soil. To the farmers, ploughing helps loosen the compacted soil as well as restore soil nutrients, hence leading to

improved yields. This declaration by the farmers is supported by the assertion of Sapkota et al., (2015) minimum tillage promote the efficient use of water and nutrients which eventually reduces the emission of greenhouse gas and improve crop yields. In emphasizing this assertion a farmer said:

"*Ploughing is very good and people like me would be very happy if I can plough my land with the tractor. When you plough the land the soil become loose and the crops can do very well but the amount of money the tractor operators charge is too much. Do you know that they don't even use any formal measurement of the land with a rope or stick? They only look at the land and tell you what the size is and you have to pay because they have already done the work meanwhile they are wrong. Anytime you say you want to measure before they do the ploughing they will refuse because they have an agenda to cheat" (participant in FGD, February, 2020).*

5.3.7 Irrigation Farming

The report revealed that just a few farmers (1.7%) resorted to irrigation farming as a means of adapting to variation in the climate. Most of the farmers did not see irrigation as a means of adapting to the variation in the rainfall pattern because it was expensive to produce dug out wells because it was difficult to dig and get water. Also, apart from the fact that most of the stream easily dried up, the major rivers were far from the farms and it would cost them huge amounts of money to acquire the irrigation machine. These conditions made irrigation farming unpopular as a means of adaptation, even though it would have yielded much better result. This situation is not different from the national situation confirmed by Tambo, (2016) that there are few irrigation schemes in Ghana. In answering a question on why most of them do not use irrigation farming, one farmer said:

"Master, do you need irrigation when the rain is falling normal? No because the natural rains are already here to water the crops. In the dry season when you need the rains to do irrigation or like this drought season, all the rivers and streams close to our farms are dried such that you have to even fetch water from the house to the farm before you can drink. Aside that, the machines are expensive which we cannot buy and even if you are able to buy, where will you get the water? So you see we are really suffering" (participant in FGD, February, 2020).

5.4 Factors influencing adoption of coping strategies

Tables 5.2, 5.3, and 5.4; show results of binary logistic regression of predictor variables and dependent variables. Concerning the relationship between the predictor variables and adoption of drought-resistant crop variety, result in Table 5.2 shows a significant relationship between the predictors and adoption of drought-resistant crop varieties.

Regarding the relationship between predictor variables and crop and livestock diversification, age significantly influenced crop and livestock diversification. Here, the results can be interpreted as, aged farmers were more likely to undertake both crop and livestock farming. The reason that can be proffered for this result is that, older farmers have been using this method of farming as a strategy for survival for decades.

Further, results in Table 5.2 shows that been education increases the likelihood of diversifying farming activities through the combination of crop cultivation and livestock rearing. This finding support Shongwe et al (2014) argument that educated farmers are able to understand the trend and situation very well and assess combination of strategies that will help them juggle through difficult environmental stress situations.

Table 5.2: Relationship between predictor variable and drought resistance crop variety and crop livestock diversification

	Drought Resistance Crop variety			Crop and livestock diversification		
	Odds ratio	SE	P-value	Odds ratio	SE	P-value
Age						
Youth (Ref)						
Aged	2.045	0.788	0.362	0.410	0.427	0.037*
Gender						
Female (Ref)						
Male	1.035	1.114	0.975	0.651	0.472	0.363
Level of education						
None (Ref)						
Educated	0.000	7434.544	0.998	2.160	0.461	0.055
Access to extension services						
No Access (Ref)						
Have Access	0.000	13997.48	0.999	0.598	1.191	0.666
Household size						
0 – 5 (Ref)						
6 – 10	1.672	1.147	0.654	0.466	0.450	0.089
More Than 10	1.347	0.892	0.738	0.783	0.448	0.585
Availability of capital						
No (Ref)						
Yes	19556073.59	17257.880	0.999	310294705.6	19102.216	0.999
	Pseudo R^2 = 0.083, N = 180			Pseudo R^2 = 0.124, N = 180		

Table 5.3: Relationship between predictor variable and adoption of changing planting dates and use of weedicides

	Adoption of changing planting dates			Use of weedicides		
	Odds ratio	SE	P-value	Odds ratio	SE	P-value
Age						
Youth (Ref)						
Aged	0.571	0.848	0.509	0.953	0.382	0.899
Gender						
Female (Ref)						
Male	0.518	0.870	0.449	2.435	0.456	0.045
Level of education						
None (Ref)						
Educated	3.671	0.790	0.100	0.786	0.551	0.662
Access to extension services						
No Access (Ref)						
Have Access	0.000	13635.226	0.999	0.000	17749.395	0.998
Household size						
0 – 5 (Ref)						
6 – 10	3.224	1.140	0.304	1.720	0.525	0.302
More Than 10	1.616	0.875	0.583	0.813	0.411	0.813
Availability of capital						
No (Ref)						
Yes	6219328 5.19	17194.001	0.999	0.000	12538.997	0.999
	Pseudo R^2 = 0.098, N = 180			Pseudo R^2 = 0.121, N = 180		

Another significant relationship is observed in Table 5.3 between gender and use of weedicides. The result indicates that males were more likely to use weedicides compared to females. This result support the assertion of Shikuku et al. (2017) and Zamasiya et al. (2017) who found that male farmers were likely to develop positive attitudes towards adoption of

new strategies aimed at reducing the negative effects variation in the climate. Although some women are beginning to practice spraying, we argue that the usage of weedicides requires some level of skills in handling the spraying, and it is possible that females in the study area may not be used to or have these skills.

Table 5.4: Relationship between predictor variable and adoption of alley cropping and adoption of irrigation farming

	Adoption of alley cropping			adoption of irrigation farming		
	Odds ratio	SE	P-value	Odds ratio	SE	P-value
Age						
Youth (Ref)						
Aged	1022626.37	3575.308	0.999	0.134	1.620	0.214
Gender						
Female (Ref)						
Male	5.000	1.789	0.368	10.399	1.524	0.125
Level of education						
None (Ref)						
Educated	0.000	2688.166	0.995	0.220	1.553	0.330`
Access to extension services						
No Access (Ref)						
Have Access	123756954.2	11124.610	0.999	0.209	1.699	0.357
Household size						
0 – 5 (Ref)						
6 – 10	0.000	5112.459	0.997	0.000	5564.637	0.997
More Than 10	0.000	4181.967	0.997	0.000	4855.141	0.997
Availability of capital						
No (Ref)						
Yes	0.000	14893.578	0.999	0.000	17427. 422	0.999
	Pseudo R^2 = 0.642, N = 180			Pseudo R^2 = 0.404, N = 180		

5.5 Conclusion

Having been exposed to the threatening condition in the variation of temperature and rainfall it is obvious that farmers saw their livelihoods as being vulnerable to these variation. It therefore was not a surprise when majority of farmers said they made some form of adjustments in their farming. Some strategies that were common to farmers in the area included the use drought-resistant crop varieties, crop and livestock diversification, changing planting dates, use of weedicides, irrigation, mulching, ploughing, and use of fertilizer. The commonest used strategy was mulching because almost every farmer produced yam and as a cultural practice, the ridges needed to be covered with grass to keep it moist and to enhance quick germination.

The use of fertilizers and drought resistant crop variety was popular but only among farmers who cultivated maize and rice. Even though rice was a popular a cereal in the area, the harvest was low due to variation in the climate until farmers started receiving taking advice from the extension agents to adopt resistant maize and rice varieties and also resort to the use of fertilizers to boost their yields. The resort to fertilizer application was to make use of the little rainfall to facilitate the growth and maturity of crops. Apart from a few, almost all crop farmers have changed their planting dates for the crops that they produced to suit the onset of the rainfall. This therefore means that the planting dates of various crops change from one year to another.

Crop and livestock diversification was also common but among the older farmers who have used it a means of survival for a long time as asserted by Yaro, (2013). Most farmers also used herbicides to control of weeds on their farms as that was not much time and labour consuming even though it involved some level of financial cost. Its adoption was based on the fact that it made the soil lose and allowed crops to make judicious use of soil nutrients. Ploughing and irrigation were yet another strategy but did not receive much participation as

the cost involved was high for farmers to bear. In all it can be concluded that the major factors that influenced the decision of farmers to make adjustments in their farming businesses were age, gender and educational attainment.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

The main objective of this study was to assess the experiences of and adaptation to climate variability by farmers in the Nkwanta North district. This chapter presents a summary of the key findings of the study and draws conclusions and some recommendations.

6.2 Summary of Findings

Results from the study uncovered the fact that because most farmers have been farming for more than three decades, they have experienced certain occurrences that gave them the impression that there were variation climate.

Objective one of the study sought to investigate the phenomenon of climate variability as perceived and experienced by farmers in the study area. Results from the study left no doubt that farmers were aware of the phenomenon of climate change and variability. This was because farmers were able to point out to specific events which made them proved their assertion. Notable among them was the sudden change in the rainfall pattern. In this regard, farmers identified that fact that rainfall was not only reducing in terms of volume but also shortening in the duration. Farmers did this by comparing the current rainfall pattern to the trend in about two decades ago and were sure about their observation. It was also clear that farmers have experienced a drastic change in temperature. This change as outlined by the farmers was negative in the sense that there was an increase in temperature which brought so much heat. They attributed the rotting of their crops in-field and a short period after harvesting to the current increase in day and night temperatures. The most common climate events as experienced by farmers included late onset of rainfall, early stoppage of rainfall, increase in flood events, increase in the duration of drought, rainfall with storm and high day

and night temperature. This unstable condition of the climate in the said duration which has led to low crop yields, wilting of crops, decrease in the length of cropping season, invasion of pest, smaller crop size and rising cost of farming made farmers to perceive that indeed the climate was changing. From the numerous evidence pointed out by the farmers, one cannot but to conclude that local farmers are aware of the phenomenon of climate change and variation.

The second objective of the study sought to assess the adaptation strategies adopted by farmers within the study area. As a result of the changes in the temperature and rainfall pattern as perceived and experienced by farmers, it was clear that farmers have realized that the earlier they adopted some coping strategies the better it would be for them. It was therefore apparent that most farmers adopted some form of strategies in order to cope with the changing climate. Common forms of adaptation strategies as was evident within the district included the use of drought resistant crop variety, mixed farming, changing planting dates, use of weedicides, mulching, ploughing, and fertilizer application. In the midst of all the common forms of adaptation strategies available to the farmers, the most adopted strategy among the farmers were mulching, use of drought resistant crop variety, changing of plating dates, fertilizer application, crop and livestock diversification and the use of weedicides. However, irrigation, minimum tillage and alley cropping were not adopted by many farmers. This was attributed to the fact that those strategies came with huge financial cost which were already a burden to them.

The final objective sought to determine the factors that influence their choice of adaptation strategy. It was crystal clear that even though most farmers in the study area adopted one form of strategy or the other, they did not take full advantage of the strategies that were available to them as a result of certain militating factors. In this study the factors that were considered to be able to influence farmers' decision to adopt certain adaptation strategies

included age, gender, size of household, level of educational attainment, access to agricultural extension agents and availability of capital. While availability of capital was a general problem, the age of farmers and their educational attainment influenced their decision to adopt crop and livestock diversification. Also, the gender of farmers was most likely to influence their decision to adopt weedicides. From the above discussion it could be concluded that age, level of educational attainment and gender were the most likely factors that influenced farmers' decision to adopt specific coping strategies in the study area.

6.2 Conclusion

Based on the findings, it could be concluded that farmers in the Nkwanta North district are very observant, experienced and have a clear understanding of variation in the climate. This is as a result of their long period of involvement in the farming business considering the fact that most agricultural activities in the Nkwanta North district and Ghana as a whole depend on natural rainfall. Due to this, farmers in the district are able to give specific variations that have accompanied the varying trend in the climate of the district for the past three decades alongside the negative effects on their farming. These occurrences have the potential of ruining farmers of most or all or their livelihood. Although this phenomenon posed a serious threat to farmers, it also has the potential of enhancing their ability to embrace strategies that may help them ward off the negative effects associated with the changing climate. It is against this background that farmers in the district have adopted some forms of measures ranging from changing planting dates, mulching, and use of weedicides, drought resistant crop varieties and fertilizers as well as ploughing to make them risk-averse to the challenges associated with the changing climate. The successful adoption of strategies in the district to deal with farmers' vulnerability to the changing climate is influenced by factors such as age, gender household size and most importantly the availability of capital.

Although the sustainable livelihood Framework (SLF) cannot be said to be a complete panacea, it has helped to recognize real-world main concerns, views and interest of the farmers involved. For instance it has helped to outline and exposed the lack of assets by farmers in the study area, how poor they are and even how it is for them to access financial. How difficult it is for farmers to access institutions such as the banks and agricultural extension agencies have also been espoused alongside the lack of or complex policies from both public and private sectors which are not farmer friendly. In view if these experiences farmers have become stranded because they are unable to effectively contain or respond to the shocks associated with changes in the climate, thereby making them very vulnerable. Indeed due to these experiences, farmers perceive and have come to the realization that because they lack the essential resources to respond adequately to the shocks their livelihood outcome is unsecured. Thus SLF has helped to link the farmers and a myriad of factors that sway the outcomes of their livelihood strategies.

6.3 Recommendations

It is recommended that the district department of agriculture should work in collaboration with the district assembly to lure investor in agriculture to come and invest in the district's agricultural opportunities. This way, farmers can be assisted with the provision of subsidized tractor and other services required to cultivation their crops on a larger scale.

Since most farmers experience post-harvest loses due to high temperatures, it is also recommended that the district MoFA branch and other NGOs into climate change and food security should come to the aid of farmers in the district to educate them on modern and effective ways of storing farm produce.

The Ministry of Food and Agriculture through its agricultural extension department should also ensure that more agricultural extension agents are posted into the district and equipped to

beef up support, motivate and educate the farmers on modern ways of farming. This will also give farmers in the district some form of insurance against the outbreak of pest and diseases due to climate change and variability.

Since one of the major factors militating against farmers' ability to adopt climate change adaptation measures is capital, it is recommended that government through the agricultural development banks comes to the assistance of farmers in the district by giving loans at a reduced interest rates. This will enable farmers to increase the size of their farms and secure the necessary inputs for bumper harvest.

It is again recommended that buffer stock companies should be given the necessary urgent financial assistance by government to decentralize their offices and warehouses to rural food producing areas. This phenomenon could lead to the establishment of warehouses which will serve as market for the farm produce for onward submission to the national Buffer Stock agencies. This way, farmers in the district will have ready market for their produce. There should be the provision of more social infrastructure such as irrigation schemes, rural roads and market places which are essential for successful adaptation to climate change and variability

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APPENDICES

UNIVERSITY OF GHANA - LEGON

DEPARTMENT OF GEOGRAPHY AND RESOURCE DEVELOPMENT

TOPIC: THE EXPERIENCES OF AND ADAPTATION TO CLIMATE VARIABILITY BY FARMERS IN NKWANTA NORTH DISTRICT

QUESTIONNAIRE FOR FARMERS

NUMBER ……..……...

NAME OF COMMUNITY …….

Dear respondent this research questionnaire is purely for academic purposes with the aim of assessing the experiences of and adaptation to climate variability by farmers in the Nkwanta North District of the Volta Region. You are therefore assured of confidentiality of any views that are expressed during and after this research. On this note, I kindly ask that you offer information that is accurate and such that when analyzed would reflect the true situation in your community. Thanks for your kind co-operation.

SECTION A

FARMERS SOCIO-DEMOGRAPHIC CHARACTERISTICS

Please tick [√] where appropriate

1. How old are you in years? (a) ≤ 20 [ ] (b) 21 – 35 [ ] (c) 36 – 50 [ ] (d) Above 50 [ ]
2. Gender of respondent (a) Male [ ] (b) Female [ ]
3. Marital status (a) Single [ ] (b) Married [ ] (c) Divorced [ ] (d) Widow/Widower [ ]
4. What is your highest level of educational attainment? (a) None [ ] (b) BECE [ ] (c) SSSCE/WASSCE/MSLC [ ] (d) Diploma/Degree [ ]
5. Are you a native of this community? (a) Yes [ ] (b) No [ ]
6. What is the size of your household? (a) 1–5 [ ] (b) 6–9 [ ] (c) 10–14 [ ] (d) Above 14 [ ]
7. What is the size of your farm in acreage? .....
8. For how long have you been farming? ……

9. What major crops do you cultivate? ……
10. What is your annual farm income (GH₵)? ……

SECTION B

FARMERS PERCEPTION OF CLIMATE VARIABILITY

1. Are you aware that the climate is changing? (a) Yes [ ] (b) No [ ]
2. If yes, how did you get to know? (a) Media [ ] (b) Extension agents [ ] (c) own observation [ ]
3. What do you think is the cause of the change in the climate? (a) God[ ] (b) Man[ ] (c) I don't know[ ]
4. Is there any major change in the rainfall pattern (a) Yes [ ] (b) No [ ]
5. How is the change with respect to rainfall? (a) Increasing in volume [ ] (b) Decreasing in volume [ ] (c) shortening in the duration [ ] (d) increase in the duration [ ] (e) change in the timing of rainfall [ ]
6. Is there any major change in temperature (a) Yes [ ] (b) No [ ]
7. How do you see the change with respect to temperature? (a) Increasing [ ] (b) Reducing [ ]
8. Do you think your farming activity is vulnerable to the change in climate? (a) Yes [ ] (b) No [ ]
9. How would you rate your level of vulnerability to the following changes in the climate?

RANK: 1 = very vulnerable, 2 = not vulnerable

S/N	***Climate incidence***	***Rank your level of vulnerability***
A	Decreasing rainfall pattern	
B	Flood	
C	Increasing temperature	
D	Drought (especially during cropping season)	

SECTION C

FARMERS EXPERIENCES ON CLIMATE VARIABILITY

1. Which of these events have you observed over the past three decades?

RANK; *1 = very severe 2 = not severe*

S/N	***Variation in climatic element***	***Select factor (√)***	***Rank in order of severity***
A	Early onset of rainfall		
B	Late onset of rainfall		
C	Early truncation of rainfall		
D	Late truncation of rainfall		
E	Increase in rainfall intensity		
F	Decrease in rainfall intensity		
G	Increased flood events		
H	Decreased in flood events		
I	Increase in length of drought		
J	Decrease in length of drought		
K	Rainfall with storm		
L	Normal rainfall without storm		
M	High day and night temperatures		
N	Normal day and night temperatures		
O	Lower day and night temperatures		

2. What effects have changes in the weather on your farm?

Rank: in order of severity where: *1 = very severe 2 = mild*

S/N	***Negative consequence***	***Tick (√)***	***Rank in order of severity***
A	Wilting (dehydration) and dying of crops		
B	Low crop yield and crop failure		
C	Decreased (length) cropping season		
D	Extinction of some crop varieties		
E	Rising cost of farming		
F	invasion of pest (army worm) and insects		
G	Poverty and food shortage		
H	Destruction of farm roads		
I	Post-harvest losses		
J	Smaller size of crop/fruit		

3. Have you experienced flood in your farming activities? (a) Yes [ ] (b) No [ ]
4. What is the extent of damage caused by flood to your farm? (a) delays harvesting of crops [ ] (b) reduces in crop yields [ ] (c) rotting of seeds/crops [ ] (d) all the above [ ]
5. Has your farm been affected by drought? (a) Yes [ ] (b) No [ ]
6. What is the extent of damage caused by drought to your farm? (a) failure of crops to germinate [ ] (b) loss of soil moisture [ ] (c) crops wither [ ] (d) all the above [ ]

SECTION D

FORMS OF ADAPTATION STRATEGIES OF FARMERS

1. Have you made some changes in your farming practices due to changes in the weather?

   (a) Yes [ ] (b) No [ ]

2. If "Yes" what changes have you made in response to changes in the weather? Kindly tick (√) in the appropriate box.

S/N	*Form (option) of adaptation*	*Tick (√)*
A	Use of drought tolerant crop varieties	
B	Crop-livestock diversification (mixed farming)	
C	Changing planting dates	
D	Fertilizer application	
E	Use of more weedicides for weed control	
F	Alley cropping (planting trees among crops)	
G	Irrigation	
H	Mulching	
I	Minimum tillage (ploughing)	

3. Have the changes you made in your farming been beneficial to you? (a) Yes [ ] (b) No [ ]

SECTION E

DETERMINANTS OF FARMERS' CHOICE OF ADAPTATION

1. Do you make changes on your farm because of your age? Yes [ ] (b) No [ ]
2. Has your gender been a factor in making changes to your farm? Yes [ ] (b) No [ ]
3. Do you consider your educational background before making changes? Yes [ ] (b) No [ ]
4. Do you make changes based on the size of your family? Yes [ ] (b) No [ ]
5. Has access to agricultural extension service influence your decision to make changes in your farming? (a) Yes [ ] (b) No [ ]
6. Do you consider the amount of money (capital) available before making changes in your farming? Yes [ ] (b) No [ ]

THANK YOU.

KEY INFORMANT INTERVIEW GUIDE FOR MOFA DIRECTOR

1. Gender ……
2. Age …….
3. Level of education ……..
4. Role of responsibility in the district
5. How long have you worked in this district?
6. How would you describe the climate situation in this district?
7. In brief, how is agriculture doing in this district?
8. What role does your organization play with respect to agriculture in the district?
9. In your view is climate change a challenge to farmers in the district?
10. If "Yes" how, and if "No", why?
11. What assistance has your outfit offered so far to farmers in the district?
12. Is there anything extra your NGO is doing to further strengthen the adaptive capacity of farmers?

THANK YOU.

KEY INFORMANT INTERVIEW GUIDE FOR EXTENSION AGENTS

1. Gender ……
2. Age …….
3. Level of education ……..
4. Name of community
5. Role of responsibility in the community
6. How long have you worked in this community?
7. What is your relationship with farmers in this community?
8. How often do you visit farmers' farms in this community?
9. What activities do you carry out during your visit to their farms?
10. Can you tell me something on the progress of agriculture in this community?
11. How would you assess the climate situation in this community?
12. How vulnerable is agriculture in this community to variation in the climate?
13. Are farmers in this community making adjustments in response to changes in the climate?
14. What are some of these common adjustments?
15. How has these adjustments been helpful to farmers in this community?
16. What specific interventions has the Extension Service rolled out to help farmers in this community overcome the shocks associated with changes in the climate?
17. Is there any other thing you would want to do to help farmers?

THANK YOU.

FOCUS GROUP GUIDE FOR FARMERS

Name of community ……

Number in the group ……

Location ……..

Date ……

1. How do some farmers in this community describe the climate situation?
2. What changes have farmers in this community observed in the climate?
3. Do farmers in this community see their livelihoods as being vulnerable to changes in the climate?
4. How does a change in the climate affect farmers in this community?
5. What adjustments have farmers in this community made to their farms in order to reduce the shocks associated with a change in the climate?
6. How has the changes made by farmers in this community helped them to reduce the shocks associated with a change in the climate?
7. Why are some farmers in this community able to make adjustments in their farms to deal with changes in the climate while others are not?
8. Is there any farmer based NGO in this community?
9. How are they (NGO) assisting farmers in this community to withstand changes in the climate?
10. How have all these interventions been beneficial to farmers in this community?
11. What other interventions would farmers in this community need to make them more risk-averse?