UNIVERSITY FOR DEVELOPMENT STUDIES, TAMALE

SMALLHOLDER RICE FARMERS' STRATEGIES FOR SUSTAINABLE ADAPTATION TO CLIMATE CHANGE IN THE KASENA- NANKANA EAST MUNICIPALITY

BY

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DECLARATION

I hereby declare that this thesis is the result of my own original work and that no part of it has been presented for another degree in this University or elsewhere:

Candidate's Signature …… Date: ……

WOMPAKEAH RAYMOND

Supervisors' Declaration

I hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University for Development Studies.

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ABSTRACT

The study assessed the effectiveness of rice farmer's strategies in building climate resilience for sustainable adaptation in the Kasena-Nankana East Municipality in the Upper East Region of Ghana. The study adopted the mixed method approach which uses both quantitative and qualitative methods. Both questionnaires and interview guide were used in the collection of primary and secondary data with a sample size of 96 rice farmers and 8 key informants. The study revealed that; rice farmers indicated that the threat of climatic change is more on agricultural production. The results of the study revealed that climate change has an impact on paddy production. Also, variations in climate have caused an increase in incidences of floods during the raining season. The results further showed that shifts in rainfall seasonality have caused crop failures and low yield. Also, rice farmers do not use water-harvesting techniques as a strategy to climatic change. Thus, it is recommended that smallholder rice farmers need to be educated more on the issues of climatic change and its effects on their rice farming. The weather and metrological service should make it a point to provide timely and accurate information on the rain patterns for the farmers. The government should post more agricultural extension Offices to the district to support in advising and dissemination of appropriate and right information to the farmers.

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DEDICATION

This piece of work is dedicated to my father, John Peter Wompakeah, and my mother, Olivia Aweyise.

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CHAPTER ONE

INTRODUCTION

1.1 Background Information

Climate change has already begun to remodel life on earth. Across the globe, seasons are shifting, temperatures are rising, and ocean levels are climbing up. In line with the Food and Agriculture Organization (FAO, 2011), world temperature change has already had noticeable effects on the surroundings. The increase in world temperature by 4^0C estimate to occur towards the year 2100 is probably going to occur if mitigation efforts do not figure out (FAO, 2011).

In the last 40 years, problems associated with global climate change have shifted from being the priority of a small number of environmental activists and specialized scientists to be the emphasis of a wide scientific, political and community concern and activity (Lefroy et al., 2010). This is much as a result of climate change is anticipated to affect crop and livestock production, hydrologic balances, food systems, input provides and different parts of agricultural systems. Nevertheless, the character of those biophysical effects and the human reactions to them are complicated and unsure.

For instance, as reported by Adams et al., (2008), crop and livestock yields are directly influenced by changes in climatic factors say temperature and precipitation and the frequency and intensity of extreme cases like droughts, floods, and windstorms. Additionally, carbon dioxide is vital for plant production; rising concentrations have the potency to increase the productivity of agro-ecosystems. Climate change may additionally change the categories, frequencies, and intensities of

various crop and livestock pests; the availability and timing of irrigation water supplies; and the severity of soil erosion (Silayo et al., 2008).

The entire nations and ecosystems in the globe will confront the effect of the changing climate.

Scientific findings direct to the very fact that climate change is happening with serious impacts on the poor—both in rural and in urban societies (Cobbinah and Anane 2016; Inter-governmental Panel on Climate Change [IPCC] 2013).

Future forecasting of climate change impacts shows a substantial threat to human and natural systems, as well as biodiversity, human health, food manufacturing and water systems (IPCC 2007, 2013). The underprivileged and vulnerable individuals living in developing countries will linger to stay the most affected due to the highly unintentional nature of their human habitats, in particular cities, and high dependence on climate-reliant resources, like agriculture, electricity power, and forestry. Though climate change is a universal phenomenon, its unfriendly impacts are already having a toll on African countries, and more expected to be lot of torturing within the predictable future (Cobbinah and Anane 2016; Kurukulasuriya and Mendelsohn 2006). This can be as a result of the African setting is essentially determined by climatic conditions with the livelihoods of its people basically dependent on the exploitation and use of natural resources. In Ghana, development thoughts and plans to realize a high-middle income country by 2020 are under duress from climate change. Ghana's contribution to global climate change like many countries in sub-Saharan Africa, is quite insignificant (in terms of emissions compared to the developed countries); nevertheless, the impacts of climate change on the country's economy and its individuals stay substantial. There is proof in recent times that several of Ghana's economic assets—the coastal zone, agriculture, and water

resources— are affected by climate change, that is more touching the social material in terms of financial condition reduction effort, health and women's livelihoods (Ministry of Environment Science, Technology and Innovation [MESTI] 2011). The combined impact is an obstruction to achieving viable development.

On the flip of the twenty-first century, Ghana had already felt some destructive impacts of climate change across its human habituations. As an example, the 2007 floods in Northern Ghana affected almost 317,000 people, ruined 1000 km length of roads, devastated 210 schools and 45 health facilities, and 630 drinking water facilities (MESTI 2011). Recently, the 3 June 2015 flood event in Accra—the national capital—which claimed almost 150 lives spotlighted a bleak picture of climate change impacts on Ghanaian communities (Cobbinah and Darkwah 2017). Lamentably, many residents have not totally recovered from these disasters. Though rural communities are already adapting to climate change effects, there still exist gaps in determining the degree to which the prevailing expertise, cognition, and capacity are capable to meet the necessities of eminent climate change variations.

Experience has demonstrated that agriculture is already well custom-made to the dimension of weather extremes that are ordinarily determined at intervals of living memory however it is ill-adapted to an escalation of these extremes beneath climate change (FAO, 2011). Subsistence crops such as maize and rice, which supply a third of the national daily calorific consumption and are produced by half of the farmers, could be especially affected by climate change. NAPA (URT, 2007) pointed out that with a rise in temperature and change in rainfall patterns, the mean yield would decrease countrywide by 33%.

Evidence available shows that some extent of climate change cannot be avoided (UNFCCC, 2010). Temperatures are rising and seasons continue to change unpredictably and at a faster rate visiting disturbing impacts on humankind (IPCC, 2013). The count of hot days and intensity of warmth waves is rising (IPCC, 2013). We now have more unpredictable weather patterns than in the past (Tompkins &Adger, 2003; IPCC, 2013). Accessible temperature data shows a heating climate in Republic Ghana with the drier Northern part warming more rapidly than southern Ghana. Temperature has amplified by 1℃ for the past thirty (30) years, and it is projected to ascend by 1.7℃ to 2.04℃ by the year 2030. Rainfall has decreased by 20-30% within the same period. Ghana expects more extreme weather events (EPA, 2011; USAID, 2011). In an attempt to find solutions to the challenges associated with climate change, international efforts have given prominence to the role of adaptation (UNFCCC, 2006; Antwi Agyei et al., 2013). Article 10 of the Kyoto protocol and Article 4.1b of the UNFCCC for instance, consign parties to these treaties to scale up adaptation to minimise the negative influences of climate change. Adaptation is well-defined as any action that seeks to scale back the negative effects or to capitalize on the positive consequences of climate change. Adaptation involves initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects (IPCC 2001; UNDP, 2005).

Rural households who feel the effects of climate change particularly droughts and floods have devised their own mechanisms such as livelihood diversification, crop variation, farming of multiple crops within the same season, migration, irrigation, the application of agrochemicals, hunting, charcoal production, small scale mining (Mabe, 2012; Armah et al, 2013). In other to mitigate the impacts of such hazards on their livelihood so as they can achieve certain livelihood objectives for example food

security, increased income, increased well-being and minimise susceptibility to climate change effects (DFID, 1999).

It has however been reasoned that even though adaptation is essential to minimising vulnerability and establishing resilience to climatic impacts, not every adaptation approach to climate change is a good one. Some adaptation measures are 'maladaptive' and unproductive in minimising the impacts of hazards (Barnett and O'Neil, 2010; Below et al., 2010; Eriksen & Lind, 2009; Carr, 2008). Adaptation strategies that work for one group or from a viewpoint might at a time undermine the livelihoods or resource access of another group (Eriksen & O'Brien, 2007). Adaptation should enhance the adaptive capability of the poor and reduce the danger to give livelihood sources (Brown, 2011; Ulstrud et al., 2008; Eriksen & O'Brien, 2007). Effective strategies reduce the impacts of climatic hazards, reduce future risk to livelihood activities and also are able to satisfy the objectives of the adaptors (Jones, 2001).

This work assesses the efficacy of agricultural household's methods for proper adaptation to global climate change in the Kasena- Nankana East Municipality, Upper East Region of Ghana. The intention is to contribute to the policy debate as to how to make adaptation effective in northern Ghana.

1.2 Problem Statement

The numerous debates by scholars about what constitutes effective and sustainable adaptation mean that adaptation strategies to climate change ought to be closely scrutinized within their local and global context taken into consideration their consequences on livelihoods and the environment (Adger et al., 2005; Brown, 2011). The recognition of changes in the local climate of northern Ghana has invoked

autonomous responses across space and time among farming populations (Derbile, 2010). This has been popularly referred to as adaptation. Most of these responses have been based on the local information and perception of climate change and other environmental stresses (Gyampoh et al., 2008). Adaptation is therefore not a new phenomenon.

Extensive research work has been done in northern Ghana in the area of farmer adaptation strategies to environmental amendment as well as climate change. Studies by Dietz et al (1999), Ofori-Sarpong, 2001, Gyampoh et al., (2008) and Derbile (2010), have documented the impacts, coping strategies as well as barriers/constraints to successful adjustment to climate change in Northern Ghana. These studies identified significant influences of climate change in the agricultural sector where erratic down pour of rain, perennial droughts, and floods, pest and diseases, soil infertility due to land degradation have rendered farming unproductive resulting in poverty, malnutrition and food insecurity. They further observed that locals adopt desperate measures such as hunting for wild fruit, selling livestock, exchange of labour for food, giving female children in marriage to rich men, and migration among others, in their efforts to deal and adjust to the impacts. Similar studies by other researchers revealed differentiated strategies that are used by farmers to reduce the susceptibility of their livelihoods to global climate change and build their resilience. These strategies comprise crop diversification, livelihood diversification, water harvesting, the use of fertilizers, irrigation, land rotation, raising mounds and ridges, mixed farming, out-migration, backyard gardening among others (Gyasi, 2006; Laube et al., 2012; Yaro, 2013; Armah et al., 2013).

Other factors influencing the adaptation of climate change are the things the farmers have gone through and their reach to improved climate forecast. Also, forecasts of

climate will be able to improve the wellbeing of households while unsatisfactory information about forecast can be dangerous to deprived farmers (Agarwal, 2008b; Agarwal & Perrin, 2008). The flexibility to react to climate forecasts and the advantages gained from their usage are determined by the policy and institutional settings in addition to the socio-economic standings of the farmers' household (Ziervogel et al., 2005; Vogel & O'Brien, 2006).

In Ghana, farmers are facing the extreme weather events like droughts, low soil fertility and, floods which are the cause of the minimal rate of rice production. The abovementioned challenges necessitate adaptation to climate change or variability to take care of an optimum degree of production (Arimi&Jenyo-Oni, 2014). However, there is plenty of data on the type of adaptation methods employed by farmers within the Kasena-Nankana East Municipal. But information on specific crop adaptation to climate change is lacking. Moreover, the determinants of applicable climate-change adaptation methods employed by smallholder rice farmers within the Kasena-Nankana East Municipality have not been totally investigated. Other studies on adaptation of climate change expended by farmers are targeted on fisheries, cocoa, and cassava production with restricted emphasis on rice production (Oyekale et al., 2009; Oyekale& Oladele, 2012; Obatolu et al., 2003; Arimi, 2014). This study, therefore, identifies determinants of applicable climate-change adaptation methods employed by rice farmers within the Kasena-Nankana East Municipality.

1.3 Main Research Question

How effective are smallholder rice farmer's strategies in building climate resilience for sustainable adaptation in the Upper East Region of Ghana, Kasena-Nankana East Municipality?

1.3.1 Specific Research Questions

To achieve the specific objectives, the research was steered by the following specific questions.

i. What are the impacts of climate change on rice farmers in Kasena-Nankana East Municipality?

ii. What adaptation strategies do rice farmers put in place in other to build their resilience and reduce their vulnerability to climate change impacts in Kasena-Nankana East Municipality?

iii. What are the major factors which account for the success or failure of the rice farmer's adaptation?

1.4 The Overall Research Goal

The study sort to assess the effectiveness of smallholder rice farmer's strategies in strengthening climate resilience for sustainable adaptation in the Kasena-Nankana East Municipality in the Upper East Region of Ghana.

1.4.1 Specific Research Objectives

The following objectives which are specific to the study were set before the beginning of the research:

i. Assess the main impacts of climate change on rice farmers in Kasena-Nankana East Municipality.

ii. Identify the adaptation strategies of rice farmers to climate change in Kasena-Nankana East Municipality.

iii. Examine the factors accounting for the success or failure of rice farmers' adaptation.

1.5 Significance of the Study

This study will contribute immensely to the search for effective adaptation methods that will enhance the ability of rice farmers to withstand climate change impacts. It will also contribute to policy decisions which are responsive to the challenges of climate change in Northern Ghana. This work would iron out the determinants of effective adaptation in the area based on the assessment of the individual strategies that are employed by the indigenous people. In particular, this research will discover groups with low adaptive capacities and higher vulnerability to climate change and will come up with ways of addressing some of the weaknesses of some adaptation strategies with the aim of facilitating sustainable adaptation for target groups based on individual and community-level factors. Finally, it will augment the existing body of information within the area of climate change adaptation in Northern Ghana.

1.6 Scope of the Study

The study looks at the effectiveness of smallholder farmer's household adaptation methods for sustainable adaptation to climate variations in the Municipality of Kasena-Nankana East of Upper East. The study identifies the adaptation strategies of families in the Kasena-Nankana East Municipality and tries to look at the goals of farmers in adopting such strategies and how effective these strategies are in conforming to the goals and aspirations of households. It will then eventually uncover the various ways and means that effective adaptation can be reached in the Kasena-Nankana East Municipality. The Kasena-Nankana East is chosen because the municipality is in one of the poorest regions of Ghana and most of the people live in poverty and rely on natural resources especially agriculture (SEDA, 2014).

1.7 Organization of the Study

This research is arranged into five (5) Chapters. Chapter one (1) is the introduction chapter which gives the background of the study, the problem of the study, the specific objectives and questions, the significance of the study and its limitations. Chapter two (2) comprises of the relevant literature reviewed. Chapter three (3) deliberates the methods and materials used in research. The results that were obtained from the study are staged and talk about in Chapter four (4). Chapter five (5) looked at the sum-up, conclusion, recommendations and proposed areas for time to come research and policy conceptualisations.

1.8 Definitions of Terms

Climate change: Food and Agriculture Organization, FAO, (2008) defines it as the continuing changes within the global climatic system ensuing chiefly from anthropogenic global warming as a consequence of the amplified and continuing emissions of greenhouse gases, and the loss of vegetation cover and different carbon sinks is referred to as climatic change.

Climate variability: Climate variability is a summary of the long-term weather conditions taking into consideration short term fluctuations happening from year to year like severe storms. Additionally, it is a role of the rate, character, and magnitude of climate change and discrepancy to which a system is left bare; its sensitivity and its adaptive capability (Bhrusal, 2009).

Adaptation: IPCC (2001) outlined adaptation to climate change as a modification in natural or human systems in answering the actual or predictable climatic stimuli or their consequence, that moderates damage to take advantage of opportunities. Adaptation could be autonomous or planned.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

A review of literature is an integral component of any investigation and does not solely provide a concept on the works of the past and assists in the delineation of problem areas and also provide a basis of interpretation and discussion of findings. The review covers theoretical and empirical literature concerning the effectiveness of rice farmer's strategies in building climate resilience for sustainable adaptation. It also highlights the research gaps and the critique of the theoretical and empirical literature.

2.2 Definitions and Concepts

2.2.1 The Climate System

The climate has continually been fluctuating through the fluctuations in temperature and patterns of downpour of rains. In establishing fluctuations of the climate, the first thing is to discriminate between weather and climate that are reciprocally exclusive. "Weather" is the regular state of the atmosphere daily in terms of humidity content, movements of air, and temperature; it is derived from the disorderly nature of the atmosphere and is unstable because it is striked by minor perturbations (Kropp &Scholze, 2009).

The term "climate", on the opposite hand, is a scientific idea. It is comprised with statistics, like the averages of all-weather procedures, over a long duration of time (usually, 30 years). Although the weather can be instantly perceived by individuals, the climate cannot. As a popular phrase puts it: 'climate is what you expect; the weather is what you get' (Kropp &Scholze, 2009). So, the weather is the state of the

atmosphere at any appointed time whiles climate is what the figures tell us would occur at any determined time of the year. Thus, for example, climate change might include one parameter like temperature or rainfall and weather changes may lead in a shift to colder, windier, hotter, wetter and cloudier conditions.

The fundamental physics of the climate system is acknowledged and extensively understood. The earth's climate is set by several factors, procedures, and interactions on a global scale. Vital elements include theocean, biosphere, clouds, sea ice, and the ways by which they interrelate. Climate change is allied to the presence of greenhouse gases (GHGs) in the atmosphere (Yamin&Depledge, 2009). The climate arrangement is highly complex and under the influence of radiations from the sun, earth's climate is determined by the climate system (WMO, 1992; FAO, 2008) and comprises of:

- the atmosphere: gaseous matter above the earth's surface
- the hydrosphere: liquid water on or below the earth's surface;
- the cryosphere: snow and ice on or below the earth's surface
- the lithosphere: earth's land surface (e.g., rock, soil and sediment)
- the biosphere: earth's plants and animal life, including humans.

The earth's middle and upper atmosphere is powerfully determined by solar changeability. Changes within the solar spectral irradiance similarly as within the solar wind (a stream of protons that moves radially from the sun) can lead to significant perturbations (Baumgartner et al., 2010). Though climate truly relates solely to the changing states of the earth's atmosphere, the opposite components of the climate systems even have vital roles in making the climate, through their interactions with the atmosphere.

2.2.2 What Is Climate Change?

Climate change, well-defined as any change within the average daily weather pattern over an extended amount of time (typically decades or longer) whether partly due to natural changeability or as a result of human actions (Easterling et al. 2007, IPCC 2007a). Currently, climate change is occurring, and is already touching several natural systems round the world (IPCC 2007a).

The Inter-governmental Panel on Climate Change (IPCC) announced in its Fourth Assessment Report (AR4) that climate change is unambiguous (IPCC 2007a), showed by detected changes in many international and regional climatic pointers. The Food and Agriculture Organization (FAO) expects that substantial efforts would be essential to prepare developing countries to handle with climate-related impacts, particularly in agriculture (FAO 2007). However, the IPCC additionally notes that recent researches show high assurance that there are feasible adaptation choices that may be enforced at low cost and/or with high benefit-cost ratios (IPCC 2007a).

2.2.3 What Causes Climate Change?

Naturally occurring greenhouse gases (GHG) like methane (CH_4), carbon dioxide (CO_2), ozone (O_3) and nitrous oxide (N_2O) are existing within the atmosphere and are answerable for keeping the temperature on Earth at optimum levels to support life.

In search of satisfying contemporary development and dynamic lifestyles, humans contribute immensely to the accelerated accumulation of GHG within the atmosphere: CO_2 is discharged when forests are cleared and burned to yield to commercial and subsistence farming and when fossil fuels are burned to produce energy and power to make provision for industries; methane and nitrous oxides are emitted from various agricultural activities and variations in land use; artificial chemicals called

halocarbons (HFC, PFC & CFC) and different long-lived gases are discharged by industrial processes; ozone in the atmosphere is generated by automobile exhaust fumes and different sources (UNEP & UNFCC, 2002).

The accumulation of GHG within the atmosphere is accountable for the greenhouse effect: the retention of heat energy within the Earth's atmosphere, trapping heat within the atmosphere rather than of freeing it back into space. A higher concentration of GHG ends up in a higher percentage of unfree heat. This phenomenon causes the increase in global temperature, also known as global warming, which in turn causes undefined variation and changes in temperature and rainfall and extreme climate events, better known as climate change.

The climate itself is subject to natural inconsistency and is additionally influenced by both natural and human-induced factors (Yamin&Depledge, 2009). The utmost important challenge is to determine how the dimensions of these compares with the natural variations of the climate. Natural factors that influence the worldwide climate comprise variation in the sun's output of energy, ocean currents, and volcanic eruptions. There is an extensive variety of ways in which human beings' activities will influence the climate through the discharge of chlorofluorocarbon (CFC) into the atmosphere. These activities take in stratospheric ozone depletion (Ozone-hole), aerosols, greenhouse gas emission, dust, and other tiny airborne particles from fossil and burning of biomass (Yamin&Depledge, 2009). Once CFCs encounter the sun's ultraviolet rays within the ozone layer, they start to break down into element of atoms, which include chlorine. These disassociated chlorine atoms can then vastly destroy ozone before they diffuse down into the lesser atmosphere (Datto & Schiff, 1978; Garfield, 1988).

The United Nations Conference on Environment and Development (United Nations, 1992) concluded that, the felling down of trees is the destabilisation of previously moist forest soil, that is, the soil is exposed to the sun, gets scorched, and the non-existence of canopy leaves to forestall the moisture from rapidly evaporating into the atmosphere (Selby, 2010). The United Nations (1992), study shows that the foremost recent survey on deforestation and emission greenhouse gas, reports that deforestation might account for as much as 10% of present greenhouse gas emissions. In most sub-humid and semi-arid areas, a lot of the ley is burnt annually throughout the dry season to get rid of the old and coarse vegetation. This encourages the growth of young and more nourishing grasses (FAO, 2001). Burning causes the loss of soil organic matter and thus inhibits the sustainability of agricultural production. Additionally, it exposes the soil to the erosive forces of the wind throughout the dry season and of the rain at the end of the dry season. Desertification is the destruction of trees and vegetation mostly within the drier areas. It is an integral part of land degradation (FAO, 2001).

Land degradation is induced by human activities. It results from the direct and indirect activities of human. Land degradation causes have therefore been grouped under the indirect and direct classes (FAO, 2001). The direct causes are primarily; overgrazing, shifting cultivation, deforestation, over-cutting, and mishandling of soil and water resources by agriculture for example improper crop rotation, non-adoption of soil and water conservation practices, insufficient and excessive use of fertilizers and use of marginal land. Mainly, the indirect causes of land degradation are short-term or insecure tenure of land, population increases land shortage, economic pressure and financial condition (FAO, 2001).

All over history, agriculture has had a major impact on the landscapes across the world. Agricultural production has instigated superior environmental change to the

biosphere than any other land use (Gliessman, 1998). Ecologic Institute together with SERI (2010) also reports that agriculture physically, biologically and chemically affects soils especially through the intensification and industrialization of practices, and through unsustainable management practices including land levelling, excessive irrigation and overgrazing.

Until the industrial revolution of the early 1900s, farming practices were comparatively environmentally welcoming. Traditional farms were small scale, used biological controls of pests and diseases, used crop rotation to take care of soil nutrients and required very little or no significant heavy machinery (Gliessman, 1998). The modernization of farming practices within the 1950s caused in thrilling increases in productivity typically at the disadvantage of environmental quality. Modern, or standard agricultural practices use rigorous tillage, irrigation, the use of inorganic fertilizers, chemical pest control, and plant genome alteration to maximize profit and production (Gliessman, 1998). These practices significantly improved crop yields, and agricultural production rose steadily after World War II. Nevertheless, these practices have varied long-term ecological impacts like species composition impacts, habitat alteration, water quality impacts, soil degradation, deforestation desertification and adverse effects of irrigation.

In Ghana, agriculture is assessed to be the second largest contributor to greenhouse gas (GHG) emissions subsequently the energy sector (De Pinto et al., 2012). Vital sources of increse in emissions especially of nitrous oxide (NO2) and methane (CH4) are fertilizers, livestock, biomass burning, and chemical rice farming (Brown and Crawford, 2008; De Pinto et al., 2012). Farmers residing the North of Ghana engage in activities such as cutting down of trees, bush burning, wood charring, excessive use of chemical fertilizer, high exploitation of farmlands and discharged into the

atmosphere gases using diesel tractors. Agricultural practices by farmers (such as tillage and crop harvesting) result in soil translocation and this causes disturbance to the soil.

2.2.4 What is the proof that Climate is Changing?

The 2007 IPCC AR4 gives captivating proof that Earth's climate is certainly changing as a result of human influence. A few of its main findings are conferred below.

- Since the start of the industrial revolution in 1750, there is real high confidence that the world's average net effect of activities of the human beings on the atmosphere has caused in global warming.
- Currently, global warming is occurring, demonstrated by the fluctuations in climate such as decrease in snow cover, increases in surface temperature (both air and ocean), and melting of ice, inflicting the increase of world's average water level.
- The activities of humans are very expected to be the cause of most of the detected increases in global average temperatures in the last 100 years, given a faster rate of upsurge observed from the 1950s onwards.
- The observed mean retreat of mountain glaciers and snow cover in both hemispheres (excluding the Greenland and Antarctic ice sheets) has paid for the global rise of sea level.
- From 1961 to 2003, the worldwide average water level of the sea rose at a proportion of 1.8 mm annually, showing a quicker rate of increase between 1993 and 2003 (about 3.1 mm per year). It has not been established whether or not the quiker rate of increase from 1993 to 2003 is due to short-term variability or long-term change, however there is high confidence that there

was a rise within the rate of determined sea level rise from the 19th to the 20th century (UNEP & UNFCC, 2002).

2.2.5 Climate Change and Agriculture

Agricultural production serves as a supply of food to mankind. Agriculture is very important for food security in two instances: it produces the food humans eat; and importantly, it provides the primary supply of individuals for 36% of the global total workforce. Within the heavily inhabited countries of Asia and the Pacific, this share ranges from 40% to 50% and in sub-Saharan Africa, two-thirds of the salaried population still earn their living from agriculture (ILO, 2007; FAO, 2008). Production of agriculture has become industrialized and dependent on technology and this has gone a long way to improve productivity, but problems associated with the climate are making it difficult to reach maximum productivity.

Economists have spent almost two decades quantifying the impacts of climate change on agriculture (Seo& Mendelsohn, 2008). FAO (2008), reports that, if agricultural production in the low-income developing countries of Asia and Africa is adversely affected by climate change, the livelihoods of large numbers of the rural poor will be at risk and their vulnerability to food insecurity will increase. Meanwhile, Mariara (2008), indicated that climate variability is most pronounced in the arid to semi-arid lands that encompass about two-thirds of the African continent.

In Ghana, the agricultural sector comprises approximately 30% of the country's GDP and employs approximately 50% of the population (Kolavalli et al., 2012; De Pinto et al., 2012). The agricultural sector is believed to have the potential to grow at rates as high as 6% (Breisinger, 2008; De Pinto et al., 2012), but climate change could potentially inhibit such progress, in the long run, the agricultural sector is particularly

vulnerable to this ongoing phenomenon – climate change. Ghana is already experiencing an increase in mean annual temperature of 1°C per decade since 1960. Monthly rainfall decreased about 2.4% per decade during the same period, though in the 1960s, the rainfall over Ghana was particularly high (GoG, 2011; De Pinto et al., 2012).

2.2.6 Climate Change and Food Security

About 200 years ago, climate was not depended on for performance of food system, than it does today globally; the likely effects of climate change on food security have inclined to be viewed with most concern in areas where rain-fed agriculture is still the key source of food and income (FAO, 2008). Food security is the result of food system processes alongside the food chain. Food system involves the actions related to production, processing, distribution, preparation, and utilization of food (FAO, 2008), although the food chain is linear, containing an arrangement activity of that need to happen for individuals to acquire food (FAO, 2008). A family's sustenance framework contains all the food chains it partakes in to meet its consumption necessities and dietary inclinations. However, the climate is principally an important cause of food system performance at the most distant end of the food chain, influencing the amounts and kinds of food cultivated and the competence of production-related income. Extreme weather cases can annihilate transport and distribution infrastructure and disturb other non-agricultural components of the food system unpleasantly (FAO, 2008).

FAO (1996a) indicates that food security occurs when individuals consistently have physical or monetary access to adequate safe and nutritious food to meet their dietary needs and food preferences for a functioning and solid life. FAO (2008), reports that, there are four categories of food security: food availability, food utilization, food

accessibility, and food systems stability. It was stated again that climate change can affect all these dimensions; as temperature and rainfall vary, agriculture-based livelihood systems which are by now vulnerable to food insecurity face impending danger of increased crop disappointment, new forms of pests and diseases, absence of proper seeds and planting material, and loss of farm animals. This means that individuals who are as of now helpless and food insecure are probably to be significantly influenced.

Nelson &Agbey (2005), reported that over 60% of the Ghanaian populace is found in the rural areas and are directly dependent on locally grown crops of food that are harvested from the nearby location for consumption and as well for the urban populace. The nation's agricultural productivity adds about 20% to Gross Domestic Product. Maize, millet, yam, cowpea, cocoyam, plantain, and cassava are the major food crops produced in the country. However, production of these crops is based heavily on climate and is therefore affected by weather patterns. Notably, it has been seen that during the drought periods, crop production and livestock herd declined. Nelson &Agbey (2005), also indicated that in the 1980s predominantly in 1983, the extreme dry season and bush fires witnessed across the nation influenced food security leading to starvation in some parts of the country. This demonstrates the vulnerability of the country's agriculture to dominating climatic condition and the consequences that an alteration of the climate would cause to food security if no proper measures are taken.

2.2.7 Consequences of Climate Change

The microclimate has continuously been fluctuating. On each timescale, since the earth was first fashioned, its surface conditions have vacillated. Past changes are carved on the scene which has shaped the evolution of all life forms and is a subtext

of our financial and social history. Present climate changes are the portion of the discussion about the penalties of human activities on the worldwide situation, while the future course of the weather may well apply in credible requirements on economic advancement particularly in developing nations (Burroughs, 2001).

The changing climate has a greater impact on agricultural productivity especially food production. Harsh evaluations recommend that throughout the following 50 years, climate alteration may probably have a dangerous threat to meeting the world's food needs than other imperatives on agricultural frameworks (IPCC, 2007; BNRCC, 2008; Apata et al., 2010). Precisely, population, income, and economic development could all influence the seriousness of climate change impacts as far as food security, hunger, and nutritional adequacy are concerned. Whenever climate change unpleasantly disturbs agriculture, human impacts are likely to be more extreme in a less fortunate world (Apata et al., 2010). Rising request for food throughout the following century due to number of people and genuine income advance, will lead to the extending of food shortage, and a deteriorating of hunger and malnutrition glitches mostly in developing countries (Wolfe et al., 2005; Stige, 2006; Orindi et al., 2006; Apata et al., 2010).

It is anticipated that harvest yield in Africa may fall by 10% to 20% by 2050 or even up to half because to climate change (Enete&Amusa, 2010; Jones & Thornton, 2002), mainly because African farming is largely rain-fed and hence primarily reliant on the weather. Enete&Amusa (2010) stated that the negative impacts on agricultural yields will be exacerbated by additional recurrent weather events. Bhrusal (2009) had indicated that, increasing of the concentration of atmospheric CO_2, higher temperatures, fluctuates in annual or periodic precipitation outlines and changes in the recurrence of outrageous events will affect the quality, quantity, stability of food

production, volume, and the natural habitats in which agriculture occurs (Enete&Amusa, 2010).

Khanal (2009), indicated that the dynamics of climate change has both positive and negative effects. For instance, increases in temperature assists to grow crops in high elevation zones. However, crops regularly reacts negatively with an abrupt drop in net growth and yield when temperatures surpass the ideal level for biological procedures. Khanal (2009), added that heat stress because of amplified temperatures might influence the entire physiological advancement, maturation and lastly decreases the yield of the cultivated crop (Enete&Amusa, 2010).

The consequences change in climate may likewise be as drought or floods. Droughts and floods are a risk to stability of food and could fetch both chronic and short-lived food insecurity. Both drought and floods are predicted to get more frequent, more forceful and less foreseeable as a result of climate change (FAO, 2008).

Climate change in Ghana might have a considerable effect on the country in the future (McSweeney et al., 2012). The general pattern for temperature change is anticipated to expand more in the NR than in the rest of the country. The annual mean temperature is expected to go up by 1°C to 3°C in 2060 and by 1.5°C to 5.2°C in 2090 with changes expected to be progressively articulated or severe in the northern parts of Ghana (De Pinto et al., 2012). The anticipated warming with temperature increment from about 1°C to over 3°C will effectively affect the well-being of humans and their activities, food security, and water availability (Euronet Consortium, 2012).

Yearly mean precipitation is likely prone to diminish somewhere in the range 1.1% and 3.1% across all the six agro-ecological areas by 2020, with the noteworthy

decrease happening in the rainforest and the coastal savannah zones. The adjustments in yearly mean rainfall by 2080 is relied upon to be between 13% and 21% decrease of the observed baseline values (Euronet Consortium, 2012). The overall trend in rainfall over 2006-2050 visibly demonstrates a downward trajectory without adaptation to climate change. This will meaningfully influence agricultural production and lead to substantial variation in the actual growth of gross domestic product (GDP). Agricultural GDP is projected to decline by 3% to 8% likened to the standard projection for the 2050s (Euronet Consortium, 2012).

It is also estimated that 35% of Ghana's land is prone to desertification and that; the desert is increasing by 20,000 hectares a year (Enriquez, 2011). This is because of the relatively unrestricted exploitation of some natural resources to cope with authentic socio-economic requirements and this extensively damages productive lands and the environment. It is anticipated that climate change in conjunction with these damaging land use practices could quicken desertification in northern Ghana as rainfall drops and temperatures rises. With these changes, existing liabilities (to soil erosion, loss of fertility, destruction of biodiversity, recurring drought, deforestation, frequent bush fires, and overgrazing) will be worsened (Euronet Consortium, 2012).

2.2.8 Vulnerability to Climate Change

Susceptibility to climate change result when ambiguity and danger are not managed. Jeopardy occurs when there is doubt about the future consequences of ongoing processes or about the occurrence of future events. The more certain a result is, the less jeopardy because inevitability allows knowledgeable decisions and readiness to deal with the effects of hazardous procedures or occasions (FAO, 2008). The vulnerability of individuals in a given region to the impacts of climate change relies on two key factors; the helplessness of the encompassing natural landscape unit to

meteorological conditions extremes and climatic changes, and the versatile limit of the local populace (Nelson &Agbey, 2005). Worldwide climate change projections have a strong scientific foundation, and there is growing certainty that outrageous weather proceedings are going to rise in recurrence and intensity. This makes it almost certain that asset losses credited to weather-related disasters will rise. Regardless of whether these losses include productive resources, individual belongings or even departure from the living, the livelihoods and food security state of many people in calamity inclined regions will be unfavourably affected (FAO, 2008). Seasonal disparities in the food supply, together with vulnerabilities to flooding and fire, can cause livelihoods more vulnerable at specific times of the year. Even though these effects might seem indirect, they are significant on the grounds that numerous marginal livelihood groups are near to the destitution edge, and food is a vital component of their existence (FAO, 2008).

In Ghana, the vulnerability of the agriculture sector to climate change is to a great extend due to its reliance on precipitation (Yaro, 2010), chiefly in the nation's semi-arid north. Ghana's agriculture is not just powerless to climate change; it additionally adds to the issue. The Northern part of Ghana comprises of three administrative areas: Upper East, Upper West, and NR. Together, they encompass the poorest region of the nation, with destitution rates extending from 69 to 88% across the province (Shepherd et al., 2005; Nyantakyi-Frimpong, 2013) and thus have a lower intrinsic resiliency to any livelihood surprise (Euronet Consortium, 2012). As opposed to the more urbanized southern parts of the country, most of the individuals in Northern Ghana resides in rural territories and depends on agrarian actions for their bread and butter. Social vulnerability is therefore likely to be severe in these three regions (Euronet Consortium, 2012).

In Northern Ghana, the agricultural scheme is predominantly rain-fed for the cultivation of crops for example groundnut, sorghum, millet, maize, rice, and vegetables (Dietz et al., 2004; Nyantakyi-Frimpong, 2013; Shepherd et al., 2005). This part of the country is characterized by a unimodal rainfall pattern (beginning in April/May and winding-up in September/October) followed by a dry season that goes on for the rest of the year. For the past 40 years, drought has become a typical event and yearly precipitation levels are progressively variable; corresponding to changes in food availability. This has led farmers to develop intricate strategies to adapt.

2.2.9 Adaptation

In response to actual or expected climatic stimuli and their effects or impacts, adaptation is defined as an adjustment in ecological, social or economic systems. It pertains to alterations in climate change-related processes, practices and structures to moderate potential damage (or opportunities) (Ramsey et al., 2008). It is possible to distinguish various kinds of adaptation, including anticipatory, independent and scheduled adaptation. Examples of adaptation measures include vegetation slopes that are threatened by flood erosion and the preservation of natural ecosystem biodiversity to decrease their vulnerability. The forestry and agriculture industries are significant components in adapting to climate change, primarily by keeping features such as biodiversity and crop diversity and water cycles that assist determine the ability of an ecosystem.

IPCC (2001), identified climate change adaptation as an adjustment in natural or human systems in reaction to real or anticipated climate stimuli or their impacts, which moderates damage in order to exploit possibilities. It may be autonomous or planned to adapt. Most adaptation measures take place impulsively in independent adaptation, based on the individual requirements and capabilities of an industry of

culture. On the other side, planned adaptation results from choices taken based on the understanding that circumstances have changed or are about to alter. Adaptation may also be assertive if adaptation steps are taken before climate change effects are observed or if adaptation steps are placed in order after climate change effects have been noted (UNFCCC, 2006). Nelson et al (2007) described adaptation as a intentional change process in anticipation or response to external stimuli and tension. The environmental changes presently observed pose a danger to many communities and livelihoods, making it essential to adapt to changing circumstances and transform fundamental social organization, use of resources and settlements (Nelson et al 2007).

According to Carr (2008), adaptation is not a shake up in a single behaviour, but a change in a array of risk-related doctrines that take shape under particular locally unclear conditions. In an environment where people face continuous difficulties to their well-being due to open-ended modifications in financial and environmental circumstances, these convictions and procedures become an essential part of day-to-day decision-making about their lives and livelihood, making adaptation and living indivisible. This interpretation of adaptation combines adjustment and livelihood in such a way that adaptation implies adaptation to the evolving socio-economic and environmental circumstances within the individuals concerned cultural landscape and local circumstances (Carr, 2008).

Mabe et al. (2012) described climate change adaptation in agricultural production as the adjustment of farming activities or methods in line with changing climatic conditions to minimize potential adverse effects on food production. For them, if they are able to adapt efficiently to climate change, farmers can attain the goals of food security, high revenue, and safe living (Mabe et al, 2012).

2.2.10 The Concept of Sustainable Adaptation

Sustainable adaptation has taken center stage in both developed and developing countries ' climate change discourse. Brown (2011), asserted that sustainable adaptation shares certain similarities with sustainable development, so policy reactions and adaptation strategies must tackle climate-related problems while addressing problems of poverty and overall growth. The notion of sustainable adaptation emerged as a subset of a larger discussion aimed at drawing the connection between adaptation to climate change and sustainable development. Feasible adaptation methods should be aimed at decreasing vulnerability and strengthening the resilience of impacted communities through risk decrease and poverty alleviation operations. (Citing Ulstrud et al., Katrina Brown, 2011, 2008).

Sustainable adaptation does not suggest that a specific technology or practice can be identified that will always be viable in all places or . Instead, practices need to change as the context changes, forming part of the new and dynamic development paths required to reduce both vulnerability and greenhouse gas emissions (Eriksen et al., 2010). The chance that feedback and connections over both space and time can affect social justice and environmental integrity raises concerns about the sustainability of many reactions to adaptation. Therefore, adaptation focuses on the need for answers to acknowledge the relationships between local and international procedures that can generate both beneficial and negative feedback (Eriksen et al., 2010).

Eriksen & O'Brien (2007) views viable adaptation in a comparable vein as the junction between approaches aimed at alleviating poverty on the one side and strategies aimed at decreasing the vulnerability of individuals impacted by climate change on the other. They asserted that three basic problems need to be resolved in order for adaptation to be viable, namely: improving the adaptive capacity of poor

people, addressing the factors that placed the poor at risk and decreasing the risk of living. Every mechanism for sustainable adaptation must address at least one of the above-mentioned basic problems without influencing another. The opinions above indicate that sustainable adaptation must go beyond the ordinary processes of adaptation, i.e. considering poverty alleviation, vulnerability reduction and at the same moment laying the basis for longer-term adaptation (Eriksen & O'Brien, 2007). Feasible adaptation is once again seen by other academics as a unit of a broad spectrum of processes integrating climate change adaptation and poverty alleviation goals. There are links between notions of bad climate change adaptation, societal adaptation and climate change adaptation that help to alleviate poverty (Tanner & Mitchell, 2008; Ensor & Berger, 2009; Adger et al., 2003).

Eriksen & Brown (2011), asserted that while adaptation is a needed condition for reacting to climate change problems, little is known about the long-term consequences of adaptation itself. We are currently not sure whether our adaptation approaches are viable in terms of their environmental and social effects and in terms of enhancing our well-being and poverty reduction.

Barnett & O'Neill (2010), observed that many climate change reactions are not in line with the fundamental values of sustainable growth. Some hi-tech alternatives and climate change adaptation policies tend to serve some groups ' interest while disadvantaging other groups that create social inequities (Barnett & O'Neill, 2010). The type of interventions that we use, the policy frameworks and all local household policies have an impact on sustainable adaptation.

McCray et al. (2007) argued that there have been several trial strategies on adaptation around the world since the emergence of the concept of adaptation. Some of these

approaches concentrated on attaining overall development goals, especially poverty reduction, while others concentrated on building people's ability to address climate risk and effects on climate change. These methods were presented as a ' continuum ' from focusing on vulnerability to focusing on climate impacts. A review of present adaptation approaches shows that, as described previously in this job, only a few of these approaches are in the tendon with sustainable adaptation. Indeed, some of these approaches indicate that many reactions to climate change deviate from sustainable development and have adverse effects on the environment and the poor (McCray et al., 2007 ; Ensor & Berger, 2009 ; Brown, 2011) Carr (2008), revealed that Ghana's sex roles are strengthened and strengthened by adaptation. Men usually grow crops for sale whereas women tend to grow crops for consumption in households. Such a strategy circulates dangers between two different manufacturing modes, where subsistence production can preserve life and well-being in times of market adversity, and market production can provide income for buying necessities in times of environmental shocks shortage. He once more observed that households ' adaptation approaches were strongly related to the masculine household head's revenue (Carr, 2008).

Adaptation has been said to have the opportunity to strengthen or consolidate current power systems and inequalities and deteriorate disputes in Kenya in another job by Eriksen & Lind (2009) (Eriksen & Lind, 2009).

Some adaptation strategies may also destroy biological diversity and cause loss of ecological capital. Livelihood diversification which is the commonest autonomous adaptation strategy among small-scale farmers as a result of complex marketing, Africa introduces new risks. In addition, it has the potential of destroying the ecosystem thereby threatening the sustainability of the environment. Diversifying into

charcoal production and small-scale mining destroy the environment and causes inter-household and intra-household inequalities (Turner et al., 2010; Below et al., 2010).

Barnett & O'Neill (2010), described requirements that could be used to examine adaptation choices for possible negative effects. They documented that actions are ill-adaptive if they I increase greenhouse gas emissions (ii) disproportionately burden the most vulnerable (iii) have high cost of opportunity (iv) reduce adjustment incentives or (v) create dependence on the path. They again stated that the time difference with both climate change and institutional change is a significant issue facing adaptation.

Adger et al. (2005), reported that climate change adaptation includes stakeholder decision-making. These actors include civil society, governments, and international bodies, firms, and individuals at various levels. The decisions that are made influence the outcome of any adaptation mechanisms. Some decisions basically involve making policies and regulations aimed at developing people's adaptive capacity and others aimed at implementing policies and regulations. However, the implementation of the policies and regulatory frameworks for adaptation are normally constrained by institutional setups within societies (Adger et al., 2005). Building people's adaptive capability depends on better communication of information on climate change, raising awareness of the prospective effects of climate change, maintaining well-being, protecting land or property, enhancing economic growth, and creating new economic opportunity boundaries (Adger et al., 2005). We should strive to decrease the cumulative impacts of climate change when implementing adaptation choices, guarantee that adaptive measures adopted by one organisation do not adversely affect others, prevent the expected adverse impact of climate change, and guarantee that adaptation distribution is minimized (Adger et al., 2005).

2.2.11 Concept of Successful/Effective Adaptation

For Africa to be effective, adaptation actions must focus on building resilience to climate change at the level of individual, community, local and central government (IPCC, 2007). In order to determine the efficacy of individual and community approaches in constructing resilience for sustainable adaptation, this study work focuses on individual and community levels. Some adaptation strategies do not take climate change-related dynamic risks into account, while others include specific climate information in decisions (Reilly &Schimmelpfennig, 2000).

Adger et al. (2005), argued for the following criteria: adaptation efficiency, adaptation efficiency, adjustment equity and legitimacy, and success assessment. They described efficacy to mean an adaptation strategy's capacity to attain its planned goals. It can be measured either in terms of reducing impacts and their exposure, or in terms of reducing risk, avoiding danger, and promoting security (Jones, 2001). An adaptation approach, however, may fulfil its planned goals but may adversely impact other regions or organizations or may have negative long-term effects. Thus, robustness to uncertainty and flexibility or the capacity to change in reaction to changed circumstances are two main indicators of the efficacy of an adaptation policy (Adger et al., 2005). Adaptation efficiency is stated to imply that climate change adaptation involves both expenses and advantages. These may be personal or public expenses and advantages. The allocation of such expenses and advantages and the timing of adaptation actions have consequences for adaptation achievement. Equity and legitimacy are measured by who wins and who loses from adaptation decisions as well as by who decides to adapt. It looks at the current energy structures and institutional adjustment decision-making arrangements. Successful adaptation balances efficiency, effectiveness and equity through structures of decision-making

(Adger et al., 2005). The effectiveness of climate change adaptation strategies depends on the social acceptability of such strategies, institutional adaptation constraints, and the place of adaptation in the process of socio-economic development. Adaptation efficiency also depends on globalization and other trends (O'Brien &Leichenko, 2000).

Yaro (2013), noted that effective adaptation hinges on the synergy between farmer knowledge of climate change and technical scientific knowledge systems. Farmers have knowledge of the various climatic elements and how they affect their productivity and other livelihoods. Commercial farmers understand climate change science better than small-scale farmers who rely solely on local climate change explanations. Compared to small-scale farmers, commercial farmers also face a greater manufacturing threat as they make more investment in agriculture than small-scale farmers. Local knowledge of climate change is therefore important for effective adaptation among the small-scale farmers (Yaro, 2013). Gyampoh et al. (2007) noted in a similar vein that traditional knowledge is key to effectively adapting to climate change, but this is often side-lined in national policymaking. Financial obstacles, institutional obstacles and absence of climate change data limit efficient adaptation to climate change adaptation in southeastern Ghana (Antwi-Agyei et al., 2013).

2.2.12 Small farmers ' adaptation strategies

Deressa (2008) recorded prevalent climate change adaptation approaches among farmers in Ethiopia's Nile Basin to include: crop diversification, irrigation, changing planting dates, the use of drought-tolerant crop varieties, early ripening crop varieties, soil conservation, tree planting, early and late planting.

Mabe et al. (2012) reported in a comparable research that rice farmers ' adaptive capacity influences their choice of climate change adaptation policies, which in turn impacts farm production. The following adaptation methods are used by rice farmers in the northern area: use of chemical / organic fertilizers, mulching, cultivation on fallowed soil, formal irrigation, cultivation close water bodies, early rice varieties, drought-tolerant rice varieties, blended cultivation, mono-cropping, development of fire belts, altering planting dates, use of dugouts, construction of embankments, tree integration and crop rotation in rice farms (Mabe et al., 2012). The following four indigenous adaptation strategies for handling agrobiodiversity in northern Ghana are also categorized by Armah et al. (2013): soil and crop management practices (Raising mountains and ridges, mulching, fallowing of soil, use of crop residues and application of manure, avoidance of bushfires, blended plant or farming, crop rotation, crop diversification, planting timing, periodic weeding or pest control), farm animals-related activities, off-farm income generation (charcoal production, pito brewing, petty trading, shea butter processing and dawadawa processing), production and marketing strategies.

Gyampoh et al. (2008), found that although local individuals may not comprehend the notion of climate change, they feel its impacts: decreasing precipitation, rising air temperature, increasing sunshine intensity and changing rainfall patterns in the season. Local coping strategies and challenges include water rationing, rainwater harvesting, raising awareness with water bodies about the effects of deforestation, sensitizing communities to prevent bush fires, community-based forest management, fining, traditional taboos / forbidden days. However, the use of penalties and taboos is questioned by modernization and community infiltration by settler farmers and various individuals who have no complete loyalty to traditional officials (Gyampoh et

al., 2008). Indigenous knowledge of agriculture and water management acquired over many years of practice is based on such activities as growing drought-tolerant crops such as cassava, growing vegetables in moist river plains (not sustainable), planting trees on farms for shade (not attractive to farmers because of timber operators ' activities) (Gyampoh et al., 2008).

2.2.13 Acclimatization, Adaptation and Mitigation Strategies

Acclimatization is fundamentally a spontaneous adaptation that takes place through self-directed attempts. Acclimatization is an effective and powerful strategy for adaptation. Simply put, it means becoming accustomed to climate change and learning to live with it in comfort (FAO, 2008). Adaptation to climate change refers to deliberate adjustments in natural or human systems and behaviours involving set of actions, strategies, processes and policies that respond to actual or expected climate stimulus (effects) to reduce risks to people's lives and livelihoods (FAO, 2008 ; Shalizi&Lecocq, 2009 ; Cap-Net, 2010 ; De Pinto et al., 2012). Climate change mitigation relates to short-term actions or procedures aimed at decreasing the possibly damaging impacts of global warming by decreasing GHG emissions or atmospheric concentrations of GHG, as well as sequestering or storing carbon, and long-term design decisions leading to low emissions (FAO, 2008 ; Shalizi&Lecocq, 2009 ; Cap-Net, 2010 ; De Pinto et al., 2012).

FAO (2008) suggests certain adaptation practices that will help to reduce the SSA's climate change impact. They include protecting local food supplies, assets and livelihoods from the effects of increasing weather variability and increasing the frequency and intensity of extreme events, however: general risk management; researching and disseminating crop varieties and breeds adapted to changing climatic

conditions and introducing tree crops to supply food, fodder and energy and boost cash income.

Kropp &Scholze (2009), also indicates that local mitigation policies, such as solar panel installation, could also have a huge impact on adaptation. For example, individuals have more time for education rather than gathering wood for fuel-a main precondition for adaptation and improving livelihoods.

2.2.14 Building resilience

Strengthening resilience includes adopting procedures that allow vulnerable individuals to safeguard current livelihood systems, diversify their revenue sources, and alter their livelihood policies. Livelihoods can be described as a set of resources, skills, and activities that allow a individual or family to survive (FAO, 2003; FAO, 2008). These resources include physical assets such as infrastructure and household products, economic assets such as money stocks, natural assets such as natural resources, social assets based on people and societies ' cohesiveness, and human assets dependent on individual status (this includes schooling and skills). Key determinants of sustainability and resilience are the quantities of these resources that a family or community possesses or can readily access (FAO, 2008). Marginal organizations include those with few funds and little access to authority that may restrict the ability of individuals to adapt to climate change that could have an adverse effect on them. The variability of rainfall in Ghana, particularly in the northern region, is a threat to the livelihood of smallholder farmers who are mainly engaged in rain-fed farming. Due to occurrences of late planting rainfall, variability in patterns and concentrations of rainfall and intermittent droughts and floods in Nor, crop failure has become a prevalent occurrence in recent years. Smallholder farmers have become vulnerable to variability in climate. Climate variability therefore includes hazards in

Ghana, particularly in northern Ghana's dryer (Amikuzuno&Donkoh, 2012). Smallholder farmers therefore need to enhance their resilience by adopting practices that will protect their livelihood systems.

2.3 Theoretical Framework

The study of climate change and its effects on food production draws different theories that act as frameworks for the subject's understanding. The connection between climate change and sociology raises several associated issues: does climate change challenge human societies ' dominant perspective as distinct from the environment? If so, we can continue to assume the central human status as the main player in the global sociological scheme?

Using the structuring theory, the research investigated the impacts of climate change on crop manufacturing. For many sociologists, the structure is seen as a lasting framework rather than as a matter of Girders within a concrete building that constrains people's behaviour, is beyond their control and is out of place in relation to the study.

Giddens, however, perceives constructions as enablers and restrictors. Giddens structures are not external to people as they are in functionalism and structuralism, for instance. The theory of structuring aims at avoiding extremes of structuralism or theories of agencies. Agency and structure balance are referred to as structure duality. Giddens-based structures make action possible while at the same moment creating the very structures, in this case climate change. Social structure is the medium of social action as well as the outcome. In this case, human activities such as industrialization, deforestation, and urbanization lead to a structure-forming climate change.

The word reflectivity is used to describe an agent's capacity to deliberately change his or her position in the social structure, so it could be said that the advent of post-traditional culture enables higher social reflectivity. Climate change and its adverse effects can be said to form a framework in this research. In this context, agency refers to individuals' ability to act independently and therefore make their own free choices; they can find strategies to address the impacts of climate change on crop production.

One of the fundamental assumptions of structuring is that the deterioration of individual agency acts reproduces structure, in this case, human activities such as urbanization, veldt fires, deforestation, and industrialization reproduce the climate change structure. For Giddens, it is not necessary to conceptualize constructions as putting restrictions on human agency, but as allowing. In this case, climate change in Guruve allows people to innovate and adapt so that, despite its devastating effects, they can achieve high yields. For him, there is inextricably linked human agency and structure. Structures are reproduced by and according to him through regular interaction with knowledgeable agents; buildings assist the human agency solve issues. In regard to the research, the human agency has developed climate change through its operations and has limiting effects on its operations such as crop production.

However, people have the agency to adopt. Linked to Giddens' notion of agency is the Actor-oriented approach which has also been adopted in this study. The characterization of social action as implying both social significance and social exercise as emphasized by Long (2002) is at the heart of the Actor-Oriented Approach. Giddens (1989) purported that the processes of social experience should be attributed to the individual actor as they cope with life in diverse ways. Long (1992), proposed that this theory put in place individual actors at the middle and allows the

visualization and imaginations of interventions as an ongoing transformational process in which different actors' interests are located, instead of viewing it as a simple plan of action. Actors, in reality, are agents who can handle and manipulate the conditions they encounter to make space for manoeuvre to some extent (Long, 1992).

This refers to this research of social action in which small-scale crop producers are considered to be agents that are vehemently able to mobilize and transform their world of life to escape the adverse effects of climate change. Long (1992) emphasized that only through peoples ' own agency can poverty be eradicated. Thus, in order to reduce the adverse impacts of climate change on their crop productivity, small-scale crop producers need to be highly innovative and adopt certain strategies to get rid of the impacts of climate change.

Agency is the centerpiece of the Actor-Oriented approach. Long (2002), observed that the concept of agency means some knowledgeability, whereby experiences and wishes are given meaning reflexively and purpose agency also includes the capacity to see the appropriate abilities to solve an issue. As a consequence, small-scale farmers are regarded to be knowledgeable people capable of adapting to climate change. The study also used the Sustainable Livelihoods Framework to analyse the effects of climate change on crop manufacturing. Serrat (2008) in Asian Development Bank (2008), noted that the Sustainable Living Framework enhances the knowledge of bad people's livelihoods. It organizes factors that restrict or enhance opportunities for living and shows how they relate to each other. The Sustainable Livelihood Framework, according to Serrat (2008), promotes the identification of practical objectives for actions that are based on those concerned opinions and concerns but are not a panacea. In this situation, practical priorities for actions based on their opinions and interests were recognized by Guruve small-scale farmers. Sustainable living also

depends on changing thinking about how bad people live their life. Sustainable livelihood in the case of Guruve is based on changing thinking about how the vulnerable who the small-scale farmers are are living their life. Serrat (2008) also observed that the Sustainable Living Framework helps to formulate human-centered, sustainable development practices that are carried out in collaboration with the government and private industries and responsive and participatory.

The Framework for Sustainable Livelihoods also draws attention to the inherent potential of individuals in terms of their skills, social networks, and access to physical and financial resources. Small-scale crop producers ' strategies are considered sustainable because they can deal with and recover from the stresses and shocks induced by climate change, which changes rainfall patterns and increases temperature. These approaches do not, at the same moment, undermine the natural resource base, but rather maximize the beneficial results that result in enhanced efficiency.

Serrat (2008), however, noted that the Framework for Sustainable Livelihoods does not pay enough attention to power inequalities. About the study, it does not pay attention to the power imbalances among the small-scale farmers between men and women, the rich and the poor. It also underlines the fact that improving one group's livelihoods can undermine the others. This research considers the agency of all actors in society, including males and females and other vulnerable groups.

2.4 Conceptual Framework

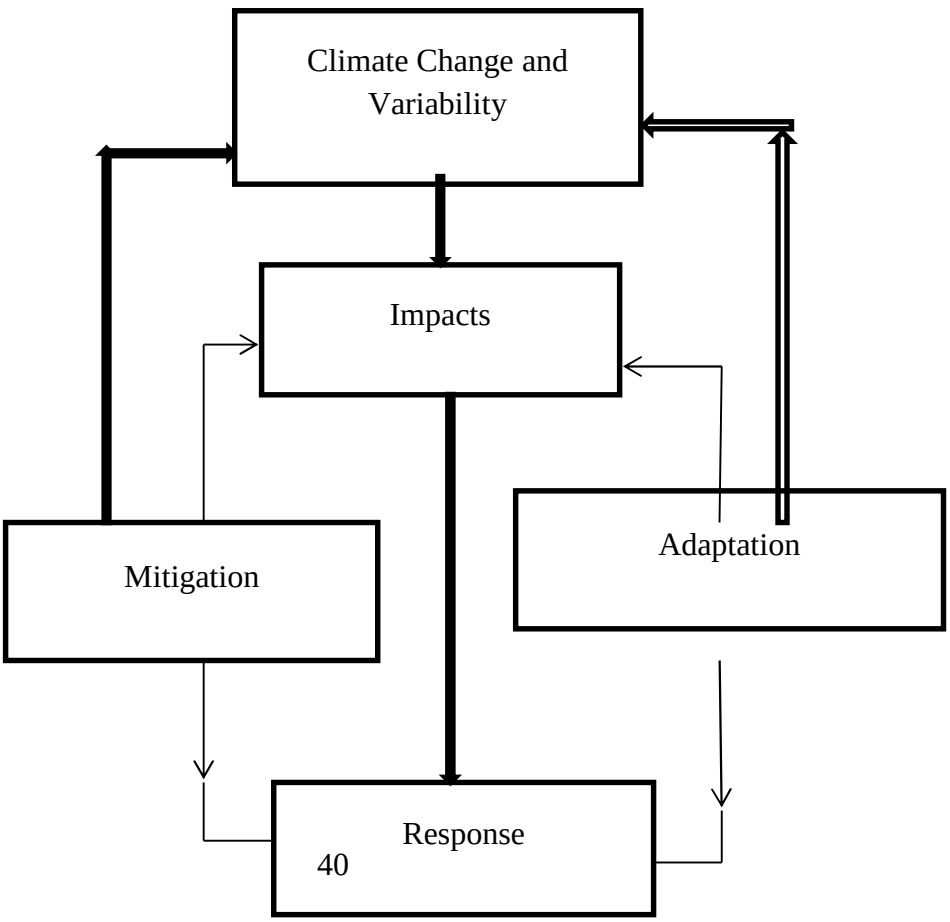
2.4.1 Climate change response – mitigation and adaptation

Reactions to climate change can be divided into two categories, mitigation and adaptation, according to the Intergovernmental Panel on Climate Change (IPCC) of the United Nations (1994). Mitigation encompasses reactions that address the cause of

climate change rather than the effect on a specified region of climate change (Carter et al., 1994). For example, raising taxes on kerosene is a response to mitigation, as it is perceived as a method of reducing flight traffic and emissions that contribute to the greenhouse gas content in the atmosphere and cause anthropogenic climate change.

Responses categorized as adaptations address the effect rather than the cause of climate change (Carter et al., 1994). For example, growing drought-resistant crops in areas experiencing decreasing rainfall can be classified as adaptation, as it is a response to an impact on climate change rather than its cause. This does not imply that the impact on climate change is excluded by an adaptation reaction, but the impact will only be secondary rather than main. This is shown in Figure 1, where black arrows symbolize direct effects or feedback, whereas grey arrows show secondary/indirect effects.

Figure 1: The Relation of Mitigation and Adaption to Climate Change and its Impact.



Source: Smith (1993) referred to in Carter et al. (1994, p. 32).

2.4.2 Adaptation to Climate Change

Adaptation to climate change is described as modifications in ecological, social, or economic structures in reaction to real or anticipated climate stimuli and their effects or impacts in the IPCC's Third Assessment Report from 2001. It refers to changes in processes, practices and structures to mitigate potential damage or to take advantage of climate change opportunities (Smit &Pilifosova, 2001).

A stimulus is defined here as a change in climate-related meteorological variables. It is essential to improve the difference between these factors and weather occurrences and refer to altered values of statistical parameters such as average intensity, frequency or variance of temperature and precipitation patterns, for instance (Eisenack&Stecker, 2012). This involves both long-term global climate change and present climate variability, but the climate stimuli with the most severe effect are variability and extremes rather than average circumstances in agricultural structures (IPCC, 2001; Smithers & Smit, 1997). Climate stimulus is important only if it affects an exposure unit that relates to all performers and structures that are subjected to a stimulus because they are dependent on climatic circumstances (Eisenack&Stecker, 2012).

In Smit &Pilifosova's (2001) definition, adaptation refers to ecological, social and economic adjustments made to and the impact of climate stimulus. I use the word adaptation in this thesis to include only human changes and always in the context of climate change. I know human adaptation as ' a process, action or outcome in a

scheme (household, community, group, region, nation) to better handle or adapt the system to altering conditions, stress, dangers, risks or opportunities ' (Smit &Wandel, 2006). It also involves cultural adaptation, which relates to the process of developing or adopting new and enhanced techniques and techniques in their cultural repertoire to deal with the setting (Smit &Wandel, 2006; Tompkins & Eakin, 2012). The study therefore understood human adaptation as adaptations to changing conditions, stresses, hazards, risks, and opportunities triggered by climate change stimuli through the development or adoption of new and improved methods, skills, and technologies when projected to climate change. Adaptation is crucial as it can be used to assess a system's effect and vulnerability and to create and evaluate alternatives for reaction. There have been different types of adaptations with different classifications (Eisenack&Stecker, 2012; IPCC, 2001; Smithers & Smit, 1997). Adaptations are classified according to their purposefulness, timing, and temporal scope and spatial range in the Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report (IPCC, 2001). The IPCC group adaptations as either independent or scheduled, depending on their purposefulness.

Autonomous adaptation is described as a reaction that is caused by modifications in the economy or welfare and as an unconscious reaction to climate stimulation (IPCC, 2007a). In addition, autonomous adaptation refers to responses that are initiated by private actors rather than governments and tends to respond to multiple stimuli rather than just a climate stimulus. These other stimuli are triggered primarily by economic, social, technological, institutional and political changes (IPCC, 2001). Planned adaptation is the outcome of a deliberate policy choice based on knowledge of climate change and requires action to return to, maintain, or attain the required state (IPCC, 2007a). Accordingly, autonomous and planned adaptation is broadly interpreted as

private and public adaptation, where private decision-makers include individuals, households, businesses, and corporations, whereas governmental decision-making at all levels always takes place. In addition, consciousness is used as a parameter that distinguishes between independent and scheduled adaptations. The IPCC definition means that the farmer does not behave at the moment of the choice as a result of a deliberate reaction to climate change, but rather as a result of market and welfare change stimulating his reaction (IPCC 2001). For example, if a farmer changes his crop type because the crop is better suited to the new climatic conditions, the response can be defined as autonomous adaptation, as the response is initiated by the farmer himself (private actor) and triggered by what the farmer incrementally perceives as climate variability or changes in the growing season, and does not necessarily imply the farmers understanding of climate change on a global scale (Jamieson, 2005). The government could produce and distribute seeds of drought-resistant varieties to the farmer, which is categorized as a public act, caused by a deliberate consciousness of climate change.

Autonomous adaptations can mean both conscious and unconscious changes to climate change, according to Smithers & Smit (1997). Smithers & Smit (1997) defines deliberate adaptations as modifications in which the performer reacts by knowing the climate stimulus and with the objective of reducing the adverse effect or benefiting from the effect of the climate stimulus. On the contrary, they describe unconscious adaptations as incidental adaptations produced after the effect of a climate stimulus without knowing the cause and thus a passive intervention (Smithers & Smit, 1997). This thesis focuses on adaptations carried out by farmers rather than governments and thus on independent adaptation rather than scheduled adaptations. In addition, I focus on adaptations that are applied consciously since it is

methodologically difficult to achieve the analysis of unconsciously applied adaptations.

Another distinction between adaptation types is to be reactive and anticipatory, depending on their timing. Before climate change impacts are observed, anticipatory or also called proactive adaptation takes place, whereas reactive adaptation refers to the responses after an impact on climate change. Adaptation in anticipation requires a well-founded understanding of climate change and knowledge of possible strategies for adaptation. Therefore, autonomous adaptations are primarily reactive, while scheduled adaptations can be either reactive or predictive. Additionally, adaptations can be divided into short and long-term, localized and extensive adaptations (IPCC, 2001). An interesting alternative grouping is based on an adaptation's motive. An adaptation can be classified as a facilitating adaptation if the operator acts to change something for other operators or a biophysical system, while adaptations made to change something for her are classified as a reflexive adaptation (Eisenack&Stecker, 2012). However, it is not always easy to identify a precise difference between whether an adaptation is applied to the person or to others. Analysing which factors are important for an individual or system to adapt to climate change is more important than categorizing the type of adaptation.

2.4.3 Successful Adaptation Factors

Adaptation with the right technology and funding is often assumed to be possible and desired, but there are limits and barriers to individuals and communities ' ability to adapt (Alston, 2013). Successful adaptation needs, according to Frankhauser& Tol (1997),

i. Recognition of the need for adaptation
ii. Fitness to adapt

2.4.3.1 Recognition of the need for adaptation

Although the IPCC (2001) states that adaptations can be carried out unconsciously, it is important to be aware of the need to adapt to climate change in a timely and successful manner (Frankhauser& Tol, 1997). According to Maddison (2007), farmers who are unaware of climate change are less probable than farmers who are conscious of climate change to apply agricultural policies that are efficient in adjusting to climate change. Therefore, Maddison (2007) says that effective adaptation to climate change includes a two-stage process in which it is first essential to recognize that climate change has taken place before choosing whether an adaptive measure should be applied. I see it as becoming conscious of something straight through any of the senses when using the word perceiving. Climate change perception is an important prerequisite for awareness of climate change, particularly in areas where climate change information is limited. Perceiving climate change, however, does not necessarily mean recognizing the need for adaptation (Maddison, 2007).

Similarly, Eisenack&Stecker (2012) notes that if there is no operator to execute the adaptation, adaptations to climate change will not be implemented. Eisenack&Stecker(2012), defines an operator as an individual or collective actor (i.e. an individual, a personal household, a group, a government) performing the response and forming part of a social entity. If none of the prospective carriers are conscious of climate change or acknowledge the issue and therefore the need to adapt, an operator will be lacking. Climate change unconsciousness or its effect can happen when social habits and normative norms forbid the knowledge of climate stimulus.

In addition, the scenario of a missing operator will happen if the effect of the climate stimulus on the exposure unit is ignored by prospective carriers. The problem may be

ignored if other issues are prioritized by potential operators (Eisenack&Stecker, 2012).

2.4.3.2 Fitness to adapt – Adaptive Capacity

The second requirement to adapt successfully is the ability to adapt, also known as adaptive capacity. Adaptive capacity can be described as an individual's or a social system's potential or ability to deal with a broad spectrum of environmental circumstances by creating genetic or behavioral properties (Fullan & Loubser, 1972; Smit &Pilifosova, 2003).

In evolutionary biology, the notion of adaptive capacity has its origin, and in an anthropological context, cultural practices can replace the word genetic features. Similarly, the adaptive capacity of a community or culture determines its survival to evolutionary biology. Cultures or societies that can react rapidly and easily and adapt to change are regarded to have a high adaptive capacity (Smit &Wandel, 2006).

Adaptive capacity was also referred to as' coping capacity," coping capacity' or' response capacity' (Gallopín, 2006), but I choose to use the term adaptive capacity as the term adaptive refers to adjustment while capacity refers to a capacity measure. Therefore, the two terms combined generate a feature that provides a measure of climate change adjustment capacity.

Often a system's adaptive capacity is confused with the word resilience. Resilience is distinct in that it refers to the capacity of structures to absorb change and disruption while undergoing change in order to maintain essentially the same role, structure and identity (Gallopín, 2006). Thus, a system's adaptive capability can be a element of resilience as adaptations can be made to keep a present state, but adaptive capability

can also determine adaptations to attain a fresh function, structure, and identity (Gallopín, 2006).

Marshall et al. (2013) define adaptive capacity as the human potential to transform existing resources into successful strategies for adaptation. Among other things, these resources or variables that determine one's adaptive ability are: natural and man-made resources, data, social networks, technology, infrastructure, human capital, institutions, governance and equal access (Adger& Tompkins, 2004; IPCC, 2007b; Smit &Pilifosova, 2001).

The accessibility and access to means in particular will improve the adaptive capacity of an individual, but the absence of these can also cause obstacles to his / her spectrum of coping. According to Eisenack&Stecker (2012), means can consist of three concepts: accessible, used and needed. Available means relates to means that the operator can dispose of, used means refer to the portion that is used for a adaptation, and needed means are those needed to create efficient execution. If the necessary means are not available, there will be a barrier to implying adaptations. In addition, group (ibid) means in:

1. Resources
2. Knowledge/Information
3. Power

Resources are described here as natural or man-made resources, and while knowledge and energy are sometimes classified as resources as well, it only relates to material values when talking about resources in this sense (Eisenack&Stecker, 2012). Both natural and man-made resources are often crucial to apply a measure of adaptation

and thus their absence of adaptive capacity is greatly decreased. Likewise, the wider the access of an individual to different resources, the greater will be his / her adaptive capacity (IPCC, 2007b).

In order to adapt effectively to climate change, knowledge / information on useful adaptation policies is required (Frankhauser& Tol, 1997). The term refers primarily to knowledge / information on agricultural adaptation strategies when used in the context of farmers.

Power as a mean here relates to the energy to decide also called decision-making authority. In order to invent an adaptation concept and lastly be able to apply the approach, decision-making power may already be essential from the outset. For instance, if a motivated operator does not have the legal authority to behave, an adaptation can be limited. In another situation, owing to cultural norms that oppress the operator, an operator may have the legal authority to behave but does not use the authority. This can happen in societies where, because of cultural norms, women are taught to oppress their ideas and opinions. Although the legislative framework gives them the legal power to act, due to cultural constraints they may not feel empowered or know about their power.

There is a need to alter all three variables in order to adapt effectively to climate, namely access to natural and man-made resources, access to data, and the authority to decide and take action (Eisenack&Stecker, 2012). For instance, if the farmer was subjected to heavier rains and thus an increase in soil erosion, he would need to know what he could do to avoid the fresh adverse effect on his property. However, there is a need not only to know that construction terraces can decrease soil erosion, but also to know how to build the terrace. In addition, the farmer needs resources in the form of

basic digging tools or building materials to build the terraces. These resources are rather easy in this instance, but in other instances the resources needed may not be available either because they are too costly, not present, or because social structures and roles make them inaccessible to certain organizations or gender. Finally, in order to purchase the building materials, the farmer requires authority to decide that financial resources are being spent and the legal authority to enforce the adaptation measure.

In addition to access to resources, expertise, and decision-making power, an individual's adaptive capacity is further related to social and economic development, with financial, technological, institutional, and political variables affecting the ability to adapt to climate change, but culture, community, and conduct can also have a major impact on adaptive capacity. Lastly, individual adaptive capacity is further determined by human capital identified as individual features (IPCC, 2007b).

2.4.3.3 Human Capital

According to Verhoglyadova (2006), human capital is described as "the incarnated fund of human capacity, expertise, skills and motivations to foster human productivity." Fullan & Loubser (1972) stated that individual adaptive ability is highly influenced by mental strength-related personality factors (such as self-esteem, self-competence) and abilities influenced by an individual's abilities.

The ability of an individual to create fresh thoughts and alternative solutions to issues is the capacity of variation. The retentive capability relates to an individual's ability to assess and can therefore pick and apply fresh thoughts to fix the issue. Variation and selective retention are complementary processes, and only after a number of ideas have been generated can selective retention occur. Furthermore, the two tasks may vary in their spectrum and therefore the capacity to create different feasible

alternatives does not mean the capacity to order and pick the most efficient one from the concepts produced (Fullan & Loubser, 1972).

An individual's capacity for variation, hence the ability to generate new ideas and solutions to problems, is based on intuitive thinking and is formed according to Guilford (1963) by three critical functions (cited in (Fullan & Loubser, 1972):

1. The ability to retrieve or retrieve memory storage of information.
2. Flexibility
3. Opportunities for fresh experiences

To generate ideas and alternative solutions, the ability to retrieve or recall information from memory storage is essential. Theoretically, with an individual's moment and age, the magnitude of memories rises. Similarly, there would be a wider variety of knowledge and data accessible for retrieval the more trained a individual is (Fullan & Loubser, 1972). The capacity to remember these memories and collect data from them, however, differs between people and may rely on age and other individual variables. It can be asserted that the capacity of the individual to recover memories improves to a certain era, after which it naturally declines.

Flexibility is the second feature that contributes to the variation capacity, which relates to the ability to continuously alter or redefine data to view it in fresh circumstances. In other words, the capacity to reflectively move from imagining one scenario to another is flexible thinking.

Fullan & Loubser (1972), through schooling, indicate that flexible thinking can be educated and enhanced. The third critical role for the variable ability of an individual

is openness to fresh experiences. Fullan & Loubser (1972) states that it is the faith in one's own judgement and the perception that the environment can be manipulated and controlled that underlies this quality characteristic. Therefore, a person open to new experiences will be more likely to question traditional practices and develop new or alternative ways rather than accepting traditional ones passively.

Retention capacity includes the ability to organize distinct experiences and thoughts, systematically connect them on the basis of logical reasoning, and pick them to fix an issue. It is based on analytical thinking and depends on the ability of the individual to analyse, abstract, and combine new elements with their logical relationships (Fullan & Loubser, 1972).

In order to obtain a strong individual adaptive capacity, variation and retention capability are equally essential. A high capacity of variation will not create a high capacity of adaptation if the individual has a low capacity of retention and is therefore unable to sort his ideas generated for the optimum solution. Similarly, if the individual cannot produce a variety of thoughts to solve the issue, having the ability to analytically sort out the best alternative will not lead in a strong adaptive capacity therefore, a strong individual adaptive capacity needs a strong capability for variation and retention, where the person can create many alternative alternatives to an issue and can order and range them according to their efficacy.

2.4.4 Levels of Adaptive Capacity

The adaptive capacity is context-specific and differs between nations, societies, social groups and people over time, according to Barry Smit &Wandel (2006Adaptive capacity scales are interdependent and hence a household's ability to deal with climate stress relies to some extent on the community's adaptive capacity, which may be

further shaped by the region's adaptive capability (Smit &Pilifosova, 2003). Likewise, Fullan & Loubser (1972) indicated that people and social systems ' adaptive capability is interdependent and shows a reciprocal connection in which people with elevated adaptive ability will affect the personality and adaptive functioning of a social system and vice versa. Fullan & Loubser (1972), further states that education and adaptive capability are interwoven on an individual level as well as on a social level.

2.4.5 Coping Range

Most people and societies can deal with circumstances that deviate from the average, but only to some extent and within a certain range. An individual or system's adaptive capacity determines its coping variety where the limits of this range are of a gradual nature and referred to as "the limit for coping or adaptation" (Smit &Pilifosova, 2003). A person or family becomes susceptible to circumstances beyond the limit of coping and thus beyond the scope of coping. An increased likelihood of occurrences close to the coping threshold or a major disaster beyond a coping range threshold may reduce the threshold beyond which the scheme cannot adapt (Smit &Wandel, 2006). For instance, in a year of drought, by drawing on stored funds, a farmer can adapt to this stress. However, if he continues to use stored funds as an adaptation to climate stress, thereby reducing his adaptive capacity, his spectrum of coping will be small. If he is equally impacted by drought in the following years, therefore close to the limit of his coping range, he will not be able to construct up his storage and the coping range will be too small to survive at some time.

A system's coping range is not static, and over time it reacts to changes in financial, social, political, and institutional circumstances. For instance, population pressure and depletion of resources may gradually decrease the adaptive capacity of an individual and thus narrow his / her variety of coping. Increasing infrastructure and technology

could also improve an individual's adaptive capacity and individual and consequently its variety of coping (Smit &Wandel, 2006).

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This part of the study describes the research methods and materials that was used in this study. Thus, the section starts with study area, research design, research questions, population and sampling strategy, research instrument, data collection techniques, and data analysis.

3.2 Study Area

The Kassena-Nankana East Municipality was updated by LI 2106 from the Kassena Nankana District which was built in 1988 by LI 1855. It is one of the thirteen (13) districts in the Upper East Region of Ghana. The Municipality has Navrongo as its political and administrative capital. The Municipality lies roughly between latitude 11°10' and 10°3' North and longitude 10°1' West.

The municipality parts borders to the north with Kassena-Nankana-West Municipality and Burkina Faso. Toward the east, it parts a frontier with Kassena-Nankana West District and Bolgatanga Municipal, to the west with Builsa District and to the south with the West Mamprusi District in the Northern Region.

The climatic situations of the Kassena Nankana Municipality are categorized by the dry and wet seasons, which are impacted predominantly by two (2) air masses – the North-East Trade winds and the South-Westerly's (Tropical Maritime). The harmattan air mass (North-East Trade Winds) is frequently dry and dusty as it stems from the Sahara Desert. During such periods, precipitation is basically missing because of low relative humidity, which seldom surpasses 20% and low vapour pressure less than 10mb. Day temperatures are high as 42° Celsius particularly between February and March) and night temperatures could be as low as 18° Celsius. The Municipality go through the tropical maritime air mass between May and October. The yearly rainfall is 950mm. The Municipality is commonly low-lying. The landscape is generally undulating with isolated hills rising to about 300 metres above sea level in the western parts of the municipality. Particularly among these hills include Fie (280 metres), Busono (350 metres) and Zambao (360 metres) above sea level.

The drainage system of the municipality is formed primarily around the tributaries of the Sissili River – Asibelika, Afumbeli, Bukpegi, and Beeyi. A tributary of the

Asibelika River (Tono River) has been dammed to give irrigation amenities. The Kassena-Nankana Municipality is found within the Guinea Savannah woodlands. The Municipality is enclosed mostly by the Sahel and Sudan-Savannah types of vegetation containing largely of the savannah grassland with short trees and thumps. Prevailing trees found are Dawadawa, Baobab, Sheanut, and Mango.

The Kassena Nankana Municipal Assembly is the most astounding managerial and political authority in the municipality and is appointed with the obligation of devising and executing development plans, programs, and projects.

The Municipal General Assembly includes 49 members, 35 elected and 14 appointed in addition to the Municipal Chief Executive (MCE) and a Member of Parliament (MP). The Municipal Chief Executive and the Member of Parliament, yet, have no voting rights.

The Executive Committee works through sub-committees that are statutory or established by the assembly itself. There are 9 of such committees in the assembly including; the social services; justice and security; finance and administrative; women and children; works; economic and development planning; climate, environment, and agriculture; medium and small-scale enterprise and public compliant committees.

There are six (6) areas councils in the municipality which comprise Kologo, Pungu, Pindaa, Naaga, Gia area councils and the Navrongo Urban Council.

There likewise exist decentralized departments that assist the Municipal Assembly to accomplish the complete development in the Municipality. These decentralized departments include: the central administration, works department, physical planning department, department of trade and industry, agriculture department, social welfare and community development, finance department, department of education youth and

sports, department of forestry game and wildlife, disaster prevention and management, feeder roads department, department of registry of births and deaths and information services department.

Trading and commercial activities in the municipality revolve mainly around foodstuffs, semi-processed food, and crafts. These commodities are sold in the local markets and outside the municipality. Commodities traded in ranges from foodstuffs and livestock to manufactured goods. The Kassena-Nankana Municipality has not much large-scale manufacturing industries. It is mostly characterized by small scale food processing, craft and manufacturing industries, examples of which include smock weaving, pottery, and blacksmithing.

Processing of foodstuffs, cash crops, and different products are common features of the local economy. The main small-scale industrial activities comprise shea butter extraction, pito brewing, milling or grinding of millet for local use, dawadawa processing, weaving and dressmaking, pottery, rice milling, and soap making. Majority of these small-scale enterprises are one-man industries and barely hire people. The section is prevailed by females and wishes to be arranged into groups and their abilities constructed to enhance their enterprises. Additionally, there are diverse business types in the municipality which must be advanced in order to improve the local economy.

There are non-banking organizations in the municipality which collaborate with the financial institutions to offer credit to groups and individuals except for the Naara Bank Provincial Limited of Paga. Such organizations comprise Non-Governmental Organizations, Community Based Rural Development Project and National Board for

Small Scale Industries. Moreover, non-formal credit arrangements such as "Susu" are available for traders and small-scale producers.

The municipality is gifted with both human and natural resources. The spotting of one of the campuses of the University for Development Studies in the municipality has as well heightened the easy access to tertiary education to the youth thus raising human capital in the municipality. Sand and clay are the major natural minerals mined in the municipality for construction intentions. The distinct weather condition has made it feasible for the generation of electricity for national use through a solar plant in Pungu, a suburb of Navrongo. The Tono irrigation facility has also made it possible for all-year-round cultivation of crops particularly vegetables such as tomato, pepper, cabbage, and onion.

The municipality flourishes in tourism potentials with various sites, cultural practices and other features of tourists' interests. The main ones among them are the Unique Catholic Cathedral Edifices and the TONO Irrigation Dam, both in Navrongo. The festivals and funerals of the people are sources of tourist attraction. Supporting the tourism industry in the municipality is the hospitality industry, offering recreation and avenues for socialization. They include Mayaga Hotel, Tono Guest and Club Houses, Catholic Social Centres and many new guest houses in the various communities GSS (2010).

3.3 Research Design

Quantitative and qualitative and methods were the research employed. The choice of the research methodology determined the nature of the study. There was a strong requirement in the research to comprehend the needs, problems, interests, perceptions and adaptation strategies of the small-scale rice farmers to an adaptation of

sustainable climate change. Qualitative study addresses the understanding people' perceptions of the world from his or her edge of reference. Bogdan & Biklen (1997), note that qualitative research pursues not truth and standards but the comprehension of the social world. Therefore, to accomplish this it concentrates on those things that move the behaviour of human beings, for example, internal thoughts, emotions, and intensions. It, therefore, seek out understanding and is troubled with processes rather than outcomes. The researcher, therefore, spent two weeks in the field observing the small-scale rice farmers working in their farmlands and preparing their fields, to fully satisfy the requirements of understanding processes that transpire in their farming activities.

In addition to that qualitative methodology was appropriate for the research since in reality, as sensed by the participants, is multiple and idiosyncratic. The inquiry therefore focused on how participants interpreted and made meaning out of their involvements with climate change and crop production. The qualitative methodology was employed because it is essentially context specific. Even though it has a few hindrances in terms of generalizability, it was selected in the light of the fact that it helps yield in-depth information on the phenomenon under research.

From in-depth interviews, case studies were built. Yin (1984), noted that the case study is a pragmatic research that explores contemporary phenomenon in their real-life situation and in which numerous sources of proofs are triangulated and utilized. Abramson (1992) cited in (Wilson 2001), was of the view that the major appeal of case studies is that they have what he terms "face value credibility" that is they can be realised to give illustrations that can be easily identifiable. Therefore, the case study research design was employed. Nevertheless, Hamel (1992), noted that the case study

method raises the problem of generalisability. Some researchers in the likes of Hamersley (1992) argued that generalisability is not always the main purpose of social science research. For this study understanding small scale crop producers' strategies becomes indispensable in understanding their attempt to acclimatise to change of climate impacts on crop production.

The researcher also employed quantitative research methodology. The investigator used questionnaires to assemble quantitative data relating to attitudes towards climate change and adaptation strategies.

3.4 Study Population

The people under study were all farmers involved in small-scale rice production in the selected locations. They were selected because individuals were in different agro-ecological areas and practice diverse production systems and were unfavourably affected by changes in climate in the crop production in their respective farms.

3.5 Sample Size and Sampling Procedure

The researcher chose snowball, purposive and random sampling for the various categories of respondents. Snowball is a type of sampling which is an analogy of a snowball which rolls down a slope and becomes larger as it collects more snow. Similarly, the researcher identified respondents who could be classified as small-scale rice farmers. The respondents referred the researcher to others; the researcher repeated the process until there was an adequate picture of the phenomenon under study.

Women were deliberately included in the administering of the questionnaire. Gender was anyway not a thought during the interviews of vital informant. The organizations that were visited were known through snowball sampling. Fifty respondents were targeted for each community, but, Gia =50 and Bonia=46 totaling 96 for

questionnaire, eight (8) stakeholders were interviewed, and two (2) session one for male and one for female-focused group discussion were held. Hence, the sample for the study was ninety-six (96) respondents.

Snowball sampling contains the attributes of purposive and convenience sampling because in either case, the researcher will be looking for information-rich sites (Patton 2007). According to Patton (1999), purposive sampling pursues information-rich cases that evident the phenomena strongly and can be studied. This enabled the researcher to pick on cases that met some criterion which the small-scale rice producers is.

Purposive sampling was used in choosing various participants and key informants by the researcher. As indicated by Oliver (2001), purposive sampling is a type of non-likelihood sampling in which choices concerning the people to be incorporated into the sample are taken by the investigator, in light of an assortment of criteria which may include expert knowledge of the study issue or limit and readiness to participate in the study.

3.6 Data Collection Techniques and Tools

A total of eight (8) interviews were conducted. The researcher interviewed the two rice farmers Association in Navrongo, the two officers in charge of crops and livestock at the Ministry of Food and Agriculture (MOFA) in the Kassena East Municipality and 4 other experienced farmers which were recommended to the researcher by some community members. These farmers were believed to have enormous experience in farming and could, therefore, speak to the issues without difficulty. This was done using an interview guide.

Questions bordered on the experiences of agriculturalists on the impacts of climate change on their livelihoods, their adaptation strategies, and other livelihood sources, their livelihood objectives, how social change affected their livelihood sources, institutional support, land management practices. This gave the researcher the opportunity of digging into the reasons why farmers see some adaptation strategies to be more effective than others. The interviews helped the researcher to listen to both the minority and majority views on the efficacy of individual adaptation approaches to climate change. The data collected from interviews was used to explain emerging patterns from the questionnaire survey. These empowered the research to address the research questions provided in the work above. The interviews were done using an interview guide which helped the researcher to control conversations between him and interviewees. It also made it easy for him to compare responses from different respondent's whiles ensuring that respondents respond to all questions and provide a strong basis in organizing and analyzing data (Kitchin& Tate, 2000; Creswell, 1998).

Direct observation was also employed to look at farmers' land-use practices, harvesting techniques for crops and rainwater and furthermore a portion of the off-farm activities of the individuals in the area. Farmers were seen thrashing their rice with combined harvesters which are carried by tractors. Very big clay pots and plastic containers which are used to harvest and store rainwater in the raining season were also spotted in various homes. Again, the youth were seen daily loading rice onto long vehicles owned by companies and individuals. It helped the investigator to respond the research question on the adaptation approaches that are accepted by farmers in the area. This is because these activities can be observed empirically. Observation also enabled the researcher to verify data collected from interviews and questionnaires.

The difference flanked by observation and interview is that interviews are self-reports of experiences, sentiments and feelings whereas observation depends on the eyewitness' ability to interpret what is happening and why (Kitchin& Tate, 2000). The importance of observation is its openness. Rather than asking people about their perspectives and emotional states, you watch what they do and listen to what they say (Frankfort-Nachmias&Nachmias, 1996). The directness makes the research findings valid as it focuses on people actions or activities rather than what they say.

3.7 Data Types and Sources

Primary data were attained by means of a structured questionnaire and holding a focus group discussion by means of key informants. Primary data comprised farmers' recognition on climate change consequences, adaptation choices, input and output prices.

The main sources of secondary data encompassed different reports from publications including journal articles and reports were retrieved. This is since supplementary information from diverse perceptions was desired to augment the research. These secondary data involved the number of farmers by means of the outline, investment cost, potential zones for irrigation, downscaled climate data and trends for the last 30 years documented by various meteorological stations.

3.8 Data Analysis

Primary data were sorted out, coded, processed and analysed by means of quantitative and qualitative methods. Microsoft (MS) Excel 2016 version, Statistical Package for Social Sciences (SPSS) version 12 was used to analyse data. Descriptive statistics such as means, frequencies and percentages were derived using SPSS. The analysis was carried out to accomplish the research objectives as depicted underneath.

Descriptive statistics including frequencies, means, percentage, and standard deviation were used to analyse farm data (yield) and economic and socio-demographic profile of respondents. Likert scale was employed to assess and present results of respondents' perceptions on the climate change effects in diverse rice production systems. For each perception measuring statement, respondents were asked to state whether they agree, strongly agree, disagree, strongly disagree or were neutral (Undecided). In analysing the responses, agree and strongly agree responses were combined into one category to indicate strongly agree while disagreeing and strongly disagree were combined to show strongly disagree and neutral were treated as do not know (undecided).

3.9 Ethical Considerations

It is basic that an enquiry study is steered in agreement with principled ethics in research. Gall, Borg, and Gall (1996), clarified that ethics in research include contemplations such as honesty, fairness, respect for honesty and nobility of people and confidentiality of confident information just as questioning. In such manner, the investigator was guided by the Commonwealth Association of Social Anthropologists' codes of ethics. The researcher sought permission from the District Administrator to gain entry then informed consent forms her respondents by disclosing to them the purpose and objective of the research. Respondents were educated that the research was for academic intentions only. The investigator went further to translate consent forms into vernacular for the village heads. Another critical issue in research ethics is confidentiality and privacy. The investigator furnished the subjects the confidence that only pseudonyms will be used in the study exploitations, hence guaranteeing their anonymity. Where the researcher saw that

small scale, farmers were busy and not ready to attend to her she did not coerce them into talking to her.

The researcher also faced some difficulties as the area was over-researched and the subjects were complaining about other researchers who came and promised them that they were going to solicit for help from the government on their behalf but failed to deliver. The researcher told them that this was for academic purpose.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

The study assesses the effectiveness of rice farmer's approaches in establishing climate resistance for sustainable acclimatization in the Kasena-Nankana East Municipality. The chapter introduces the results of the research in four segments. Part

one shows the respondent's features for example age, educational standing and sex. Part two assesses the main effects of the change of climate on paddy farmers. Section three identifies the adaptation approaches of paddy growers to climate change. Section four outlines the factors responsible for the achievements and disappointments of rice farmer's adaptation.

4.2 Socio-Demographic Characteristics of Respondents

This segment introduces the demographic features of respondents who took part in the study, their age and other pertinent socio-cultural information relevant to the research were observed. This data is very vital for the clarification of the findings stemming from the analysis finished in obedience of the effectiveness of rice farmer's approaches in raising climate resilience for sustainable acclimatization in the Kasena-Nankana East Municipality in the Upper East Region of Ghana.

4.2.1 Sex Distribution of Respondents

The study revealed that 45.8 % of the interviewees of rice farmers, were females, whereas 54.2 % of the rice farmers were males. On the stakeholders, 62.5 % were males whilst 37.5 % of the respondents were females. This means most of the rice farmers are males residing in males residing in the district. This implies rice farmers are dominated by males and this could be accredited to the point that in the municipality property is mostly owned by men and can either to be rented out to others who don't own land. This implies that women rice farmers depend on men for land to farm.

4.2.2 Age Distribution of Respondents

As of the research, information on age allocation for rice farmers unveiled that 13.5 % of the interviewees were flanked by the ages 18-25 years, another 13.5 % of the

interviewees were amongst the ages of 26-30 years, 29.2 % of the interviewees were among the ages of 31-40 years, 19.8 % of the respondents were sandwiched between the age 41-50 years, and 24.0 % of the interviewees were 51 and more in age. As well, for the age allocation of the stakeholders' shows that 12.5 % of the interviewees were sandwiched between the ages of 26-30 , 37.5 % of the interviewees were between the ages of 31-40, 25.0 percent each were between the ages 41-50 years and 51+ years respectively. The mean age of the rice growers is 36 years, which means that young people are engaged in rice farming and it thus implies that there is future for rice farming in the district since most of the rice growers are still youthful and engaged in energetic farming for the next 25-30 years.

4.2.3 Level of Respondents' Education

For the rice farmers, the research revealed that, those with informal education comprised of 19.8 % of the interviewees, Certificate and below covered 57.3 %, HND/Diploma comprised 16.7 % of the rice farmers, 3.1 % of the rice farmers had First Degree, whereas masters constituted another 3.1 percent of the rice farmers. With the stakeholders, all of them had formal education, and HND/Diploma's constitute 50.0 % of the stakeholders; 37.5 % of the stakeholders have had first degree, whereas 12.5 percent of the stakeholders hold master's degree. This means that most of the rice farmers have formal education. This indicates most of them are able to write and read the language English, the main medium of instruction in Ghana. It, therefore, means that the farmers and the extension offices will not have challenges when it comes to advise as to the best and new methods to adopt in their rice farming.

4.2.4 Marital Status of Respondents

On marriage aspect, the studies revealed that for rice farmers, 61.5 percent were married, 15.6 % of the rice farmers were single, 16.7 % of the rice farmers were

widows, while 6.3 percent of the rice farmers were widowers. For stakeholders, the study revealed that as high as 62.5 % of them were married, while 37.5% of the stakeholders were single. This means that most of the rice farmers are married, which indicates that the paddy growers have some responsibilities of taken care of their families. This could be credited to the truth that the municipality is more of rural area, and in the rural area, more people marry early as compared to the urban areas in Ghana.

4.2.5 Major Income Source of Respondents

On the major income source of respondents, the study revealed that for rice farmers 69.8 % of the interviewees had their chief income from rice farming, 3.1 percent had their major income source from animal farming, 14.6 % had their major income sources from trading, 9.4 % had their main source of income from civil service, whiles 3.1 % of the respondents had their main income from other sources not mentioned. For stakeholders, the study revealed that 62.5 percent had their major income source from rice farming, whereas 37.5 % of them had their major income source from the civil service as shown in Table 4.1. This means that rice growing is the chief profession of the respondents and that implies that their survival depends on rice farming because they derived their income from the farming of rice. This could also be attributed to the fact the area is more of a rural area and there is no other available job for them to opt for.

Table 4. 1: Socio-demographic characteristics of Respondents

Sex	**Rice Farmers**	**Percent (%)**	**Stakeholders**	**Percent (%)**
Male	52	54.2	5	62.5
Female	44	45.8	3	37.5
Total	**96**	**100.0**	**8**	**100**
Age				

18-25 years	13	13.5	0	0.0
26 – 30 years	13	13.5	1	12.5
31 – 40 years	28	29.2	3	37.5
41 - 50 years	19	19.8	2	25.0
51+ years	23	24.0	2	25.0
Total	**96**	**100.0**	**8**	**100.0**
Education				
No formal education	19	19.8	0	0.0
Certificate and below	55	57.3	0	0.0
HND/Diploma	16	16.7	4	50.0
First Degree	3	3.1	3	37.5
Masters	3	3.1	1	12.5
Total	**96**	**100**	**8**	**100**
Marital Status				
Married	59	61.5	5	62.5
Single	15	15.6	3	37.5
Widow	16	16.7	0	0.0
Divorce	6	6.3	0	0.0
Total	**96**	**100**	**8**	**100**
Main Source of Income				
Rice Farming	67	69.8	5	62.5
Livestock Farming	3	3.1	0	0.0
Trading	14	14.6	0	0.0
Civil servant	9	9.4	3	37.5
Others	3	3.1	0	
Total	**96**	**100.0**	**8**	**100.0**

Source: Field Survey, 2017

4.3 Climate Change Impacts on Smallholder Rice Growers

The study observed climatic change impacts on smallholder paddy farmers, and on the question “Do you have access to extension services or technical advice in your Area?” Results from the research disclosed that 66.0 % of the interviewees suggested that No, they have had reach to extension facilities or procedural advice in their area during the farming season, while 34.0 percent of the respondents indicated that Yes,

they have access to extension service or technical advice in their area during the last farming season. This means that rice farmers in the municipality are having challenges about having access to the services of extension offices. This implies that farmers output will be affected because they may not apply the right quantity of farm inputs and will not farm at the right time because they need the advice from extension office to be able to do all the above-mentioned service. It also implies that rice farmers may lack the right knowledge in terms of effective adaptation strategies to climatic change because of lack of access to extension service. This result is in accordance with the argument of Yaro (2013), who noted that effective adaptation hinges on the synergy between farmer knowledge of climate change and technical scientific knowledge systems. Farmers have knowledge of the various climatic elements and how they affect their productivity and other livelihoods.

On the question of farmers having access to finance to run their farming works, the research brought out that as high 79.2 percent of the respondent said No, they do not have access to finance to run their agricultural works, whereas 20.8 % of the interviewees shown that Yes, they have way to money to run their agricultural activities. This means that rice farmers in the municipality are having challenges with regards to funds to support their rice farming activities. This implies that rice farmers' production will be reduced, or rice farmers may not be able to farm at the right time or apply the necessary fertilizer or chemicals needed to increase the yield of their rice. This may well be attributed to the rural nature of the municipality where financial institutions are not all that available as expected for farmers to access or high cost of lending from the few financial institutions in the municipality.

On the question of "What is your average annual household income" they research unveiled that 40.6 % of the interviewees indicated that their average annual household

income is less than GHC 500, 32.3 % of the interviewees indicated that their yearly household income is between GHC 600-1000, 11.5 % of the interviewees added that their yearly domestic income is between GHC 2100-3000, 9.4 % of the respondent had their annual domestic income is GHC 4100+, 4.2 % of the interviewees had their annual household income stand between GHC 3100-4000, and 2.1 percent of the respondents have their annual household income between GHC 1100-2000 as shown in Table 5.1. This means that most of the rice growers' average annual income is less than GHC 500. This indicates that rice growers s in the municipality are suffering in terms of meeting the needs of their families as most of the expenditure is far higher than GHC 500 (Table 4.2).

Table 4.2 Annual Household Income of Respondents

Income (GHC)	Frequency	Valid Percent
Less Than 500	39	40.6
Between 600-1000	31	32.3
Between 1100-2000	2	2.1
Between 2100-3000	11	11.5
Between 3100-4000	4	4.2
More than 4100+	9	9.4

Total	96	100.0

Source: Field Survey, 2017

In addition, the research observed the respondents owning a house as asset, data from the study revealed that over 50% of the respondents which is 64.0 % shown they own not a house whereas 36.0% of the respondents specified they own a house. This means that most of the rice farmers do not own their own houses, and that could best be explained by the average income of most of the rice farmers been below GHC 500. This could also be attributed to the culture of the municipality where extended family system dominates, and several households live in a unit within a family house and share the same common pot with other family members.

The study also looked at respondents owning land as an asset, information from the study revealed that as high as 53.1 percent stated they own not a land whereas 46.9 % of the respondents emphatically responded they are owners of lands. This means that most of the paddy growers do not own the land they are farming on. It thus implies that rice production will be affected because rice farmers may need more money to rent land for their rice farming.

On the question of respondents being aware of Climate Change taking place, the research unveiled 83.0 % of the respondents which is high stated that they are knowledgeable of climatic change taken place, while as low as 17.0 percent of the respondents indicated that they are not aware of climatic change taken place. This means that most of the rice farmers are up to date of climatic change taken place. This implies that since rice growers are versed of climatic change, they have taken steps to adopt the best practice of farming to minimise the outcomes of climatic change on

their rice farming activities. The reason for sure might have been the status of higher learning of the rice farmers since most of the rice farmers have formal education.

The research made known that 59.4 % of the interviewees shown that the threat of climatic change is more on agricultural cultivation, 34.4 % of the respondents were of the notion that the threat of climatic change is more on both health and agricultural production, and 6.2 % of the respondents shown that the threat of climatic change is more on biodiversity quantity sustainability as shown in Table 4.3. This means that the majority of the rice farmers attributed climatic change threat to be more on agricultural production. This could be attributed to the views of the rice farmers since all the respondents are engaged in rice farming which forms part of agricultural production. This means that crop products such as rice, maize, etc. are more affected by climatic change. This implies more farmers are affected in the KasenaNakana Municipality since many of the growers are engaged in paddy and maize cultivation. This finding is supported by the ILO, (2007); and FAO, 2008) where they argue that farming is significant for food security in two ways: it brings forth the food people eat; and even more importantly, it gives rise to the primary source of livelihood for 36% of the globe's total labour force. In sub-Saharan Africa, 2/3 of the employed populace still get their living from agriculture.

Table 4.3 The menace of Climate Change is more on rice farmers

	Frequency	Percent
Agriculture Production	57	59.4
Both Health and Agric Production	33	34.4
Biodiversity Quantity Sustainability	6	6.2
Total	96	100.0

Sources: Field Survey, 2017

4.4 Impact Change of Climate on Small Holder Paddy Growers

The results of the study showed a mean value of 1.37 meaning respondents strongly agreed that climate change has a very huge effect on paddy production. The result is buttressed by Apata, et al., (2010) where they contended that the income and economic growth could be affected with climatic change effects in relations to food security, hunger, and nutritional appropriateness. If climate change affects agriculture adversely, human effects in a poorer world are likely to be more severe (Apata et al., 2010). Also, with an average value of 2.12 indicating that the respondent agreed that climate variation caused a rise in flood incidences during the rainy season. This implies that during the raining season, variation in climate change creates an increase in floods. This implies that when there are floods during raining season human movement are affected, thus the erosion of farm products. This finding is comparable to the FAO's (2008) argument that the effects of climate change can also be in the form of drought or flooding. Droughts and floods pose a threat to food stability and could lead to food insecurity both chronic and short-lived. As a consequence of climate change, both drought and floods are expected to become more frequent, more intense and less predictable (FAO, 2008). Furthermore, the findings showed a mean value of 1.29 meaning participants highly agreed that changes in seasonality of rainfall caused crop failures and low yield. This means that changes in rainfall patterns have caused crop failure and low yield. This implies that farmer’s crops are affected in terms of the high cost of production and subsequently lead to low income of farmers. Dietz et al. (2004) ; Shepherd et al. (2005) ; and Nyantakyi-Frimpong (2013) support this finding where this part of the country is indicated, it is characterized by an unimodal rainfall pattern (starting in April / May and ending in

September / October) followed by a dry season which lasts for the rest of the year. Drought has become a prevalent event over the past 40 years and annual concentrations of rainfall are progressively variable, corresponding to changes in the supply of food.

The findings also showed a mean value of 1.89 equal to 2 meaning participants agreed that owing to persistent droughts in the region, some crop varieties were no longer productive. In addition, the findings indicate an average value of 1.82, equal to 2 meaning participants agreed that climate change has led to plant infestation and drought-related illnesses, also with an average value of 1.72, equal to 2 meaning participants agreed that climate change has led to rural-urban migration. Furthermore, the research disclosed a mean value of 1.60 stating that participants agreed that excessive rainfall would contribute to houses and infrastructure destruction. In addition, with an average value of 4.5 indicating that respondents strongly disagreed that flooding does not contribute to soil erosion. In addition, with an average value of 3.01, participants are not sure that water becomes scarce and dry owing to droughts and low rainfall, with an average value of 2.20 meaning participants agreed that dry crop spell is the consequence of drought. This implies that rice farmers are now battling a disease because of climate change that contributes to farmers ' rural-urban migration in the municipality of Kasena-Nakana. This will affect the production of rice in the area which will subsequently lead to a food shortage in the country. This is supported by the argument that changing climate has a greater impact on agricultural productivity especially food production. Rough estimates indicate that over the next 50 years, climate change is probable to pose a severe threat to worldwide food requirements compared to other agricultural system limitations (BNRCC, 2008; Apata

et al., 2010). Population, income, and economic growth could all affect the severity of the impact of climate change on food security, hunger, and nutritional adequacy.

The research also showed an average value of 1.59 meaning participants agreed that climate variability has an effect on rain-fed production as well as a decline in rainfall reduction water stored in bands has an average value of 2.31 indicating that participants agreed that decreasing rainfall decreases water stored in band. It also disclosed an average value of 2.68 showing that the respondent is not sure that climate change has led to deforestation, and finally with an average value of 2.28 indicating that participants agreed that food costs are rising due to climate change (Table 4.4). This finding is backed by the 2080 annual mean precipitation forecast, which is anticipated to decrease the observed baseline values between 13% and 21% (Euronet Consortium, 2012). In the absence of adaptation to climate change, the overall trend of precipitation over 2006-2050 clearly indicates a downward trajectory. This will have a significant impact on agricultural production and will result in significant variability in actual gross national product (GDP) development. It is estimated that agricultural GDP will decline from the baseline projection for the 2050s by 3% to 8% (Euronet Consortium, 2012).

Table 4.4 Climate change impacts on small-scale rice farmers

	Mean	Std Deviation
Climate change has a major effect on the manufacturing of paddy	1.37	0.791
Climate variations have led to an increase in flood incidences	2.12	0.954

during the rainy season		
Seasonal changes in rainfall have resulted in crop failures and low yield	1.29	0.774
Some crop varieties have ceased to be productive because of persistent droughts in the area	1.89	1.856
Due to droughts, climate change has resulted in crop infestation and diseases	1.82	0.691
The change in climate has led to rural-urban migration	1.72	0.518
Excessive rainfall helps buildings and infrastructure to be destroyed	1.60	1.026
Flood does not cause soil erosion	4.50	0.997
Due to droughts and low rainfall, water becomes scarce and dry	3.01	1.298
The result of drought is the dry spell of plants	2.20	0.802
Climate variability affects the manufacturing of rain-fed	1.59	0.755
The drop-in rainfall reduces the amount of water stored in bands	2.31	1.042
The shift in climate has resulted to deforestation	2.68	1.044
Due to climate change, the price of food plants is growing.	2.28	1.036

Source: Field Survey, 2017

4.5 Small-scale farmers ' adaptation strategies to climate change

With the multiple results of participants in Kasena-Nakana Municipality in the Upper East region of Ghana, this chapter examined the adaptation policies of smallholder rice farmers to climate change. Study data disclosed that 75.3% of participants said No indicating that they did not use irrigation intensification as a climate change approach, while 24.7% said yes suggesting that they use irrigation intensification as a climate change approach. Off those respondents who did not use intensification of irrigation as a strategy to climatic change gave the following reasons for not using it; 63.0 percent of them said they lack the finance to implement irrigation projects, while

37.0 percent of them said they lack the knowledge of managing irrigation projects. This means that the rice farmers cannot afford to irrigate their farms due to their inability to finance the project and knowledge to undertake such a project. It means that smallholder rice farmers in the municipality of Kasena-Nakana are impacted by climate change because of their failure to adapt irrigation as a strategy to boost their rice farms ' yields. This finding is consistent with Yaro's (2013) finding, which noted that effective adaptation depends on the synergy between farmers ' knowledge of climate change and systems of technical science. Farmers have knowledge of the various climatic elements and how they affect their productivity and other livelihoods.

The research also disclosed that 83.4 percent of participants said no indicating that they did not shift from crop to livestock as a climate change approach, while 16.6 percent of participants said yes indicating that they are changing from crop to livestock as a climate change approach. Off those respondents who did not change from crop to livestock as a strategy to climatic change give the following reasons for not using it; 43.0 percent of them said they lack finance to change from crop to livestock, 26.0 percent of them said they lack the knowledge to change from crop to livestock, and 31.0 percent of them said they did not believe in strategy by changing from crop to livestock. This means that rice farmers never considered changing to livestock farming; this implies that they are stacked to their old strategy of rice farming despite the change in climate in the area. This they attribute to lack of finance, knowledge and not believe in the approach. This finding is comparable to the argument that economic obstacles, institutional obstacles, and absence of climate change data limit efficient adaptation to climate change adaptation in north western Ghana (Antwi-Agyei et al., 2013).

The research further disclosed that 77.6 percent of participants said No stating that they did not use water collecting methods as a climate change strategy, whereas 22.4 percent said yes showing that they used water collecting methods as a climate change approach. The following reasons were given by those participants who did not use water harvesting strategies as a climate change approach; 74.0 percent of them said they lack the knowledge to use water-harvesting techniques, and 26.0 percent of them said they did not believe in strategy by the use water-harvesting techniques. This means that respondents lack information with regards to the use of water-harvesting techniques as a strategy to climatic change. This finding is consistent with the efficacy of climate change adaptation policies depending on the societal acceptance of such policies, institutional adaptation limitations, and the position of assimilation in the process of socio-economic growth. Adaptation effectiveness also depends on globalization, effective fellow information and other trends (O'Brien &Leichenko, 2000).

Additionally, the study also revealed that 53.6 percent of the respondents said No indicating that they did not plant different crops as a strategy to climatic change, while 46.4 percent of the respondents said yes indicating that they plant different crops as a strategy to climatic change. The following reasons for not using it were given by those respondents who did not plant different crops as a climate change strategy; 32.0 percent of them said they lack finance to plant different crops, 24.0 percent of them said they lack knowledge to plant different crops, 18.0 percent of them said they did not believe in strategy to plant different crops, and 26.0 percent of them said they did not have a permanent land to plant different crops. This means that smallholder ice farmers still do not believe in the strategy of adding any additional crop to their rice farming. Besides they lack the finance to plant different crops and

also did not believe in the strategy as well as not having permanent land to cultivate different crops in addition to rice. This finding is comparable to Deressa's (2008) argument that documented prevalent climate change adaptation approaches among farmers in Ethiopia's Nile Basin to include: crop diversification, irrigation, altering planting dates, the use of drought-tolerant crop varieties, early maturing crop varieties, soil conservation, tree planting, early and late planting.

The research also disclosed that 67.0 percent of participants said No indicating that they did not modify the planting date as a climate change strategy, while 33.0 percent said yes indicating that they change the planting date as a climate change strategy. Off those respondents who did not change planting date as a strategy to climatic change gave the following reasons for not changing it; 82.0 percent of them said they lack the finance to change planting date, and 18.0 percent of them said they change planting date. However, 73.0 percent of the respondents said they adapt chemical fertilizer application as a strategy to climatic change which helps to reduce the impacts of hazards, while 27.0 percent of those surveyed noted that they did not adapt the application of chemical fertilizers. This means that rice farmers in the municipality still maintain their old ways of planting their rice and not changing their planting dates to counter the change in climate as a way of improving their farm yield. This finding is the opposite of Gyampoh et al's (2008) findings when they found that although local people may not understand the concept of climate change, they feel its effects: decreasing rainfall, increasing air temperature, increasing sunshine intensity, and seasonal changes in rainfall patterns. Local coping mechanisms and difficulties include water rationing, rainwater harvesting, awareness-raising of the impacts of deforestation along with water bodies, awareness-raising groups to prevent bush fires, community-based forest fines management, traditional taboos/ forbidden days.

The research also disclosed that 57.0 percent of participants said No indicating that they did not apply compost / manure as a climate change approach, while 43.0 percent said yes indicating that they used compost / manure as a climate change approach. Off those participants who did not apply mulch / manure as a mulch / manure approach provide the following reasons for not implementing mulch / manure; 39.0 percent of them said they lack finance to applied compost/manure, 45.0 percent of them said they lack knowledge to applied compost/manure, and 16.0 percent of them said they did not believe in strategy to applied compost/manure.

The study also revealed that 66.0 percent of those surveyed said no to indicate that they did not adapt tillage practices as a climate change strategy, while 34.0 percent said yes to indicate that they adapt tillage practices as a climate change strategy. Off those respondents who did not adapt tillage practices as a strategy to climatic change give the following reasons for not changing it; 63.0 percent of them said they lack the Knowledge to adapt tillage practices, and 37.0 percent of them said they did not believe in strategy. The research also disclosed that 55.0 percent of participants said No indicating that they did not adapt cover cropping / mulching as a climate change approach, while 45.0 percent said yes indicating that they adapt cover cropping / mulching as a climate change strategy. Off those respondents who did not adapt cover cropping/mulching as a strategy give the following reasons for not applying it; 34.0 percent of them said they lack finance to adapt cover /mulching, 46.0 percent of them said they lack the knowledge to adapt cover cropping/mulching, and 20.0 percent of them said they did not believe in strategy to adopt cover cropping/mulching. This result is not consistent with Armah et al. (2013), where he classified indigenous agrobiodiversity management approaches in northern Ghana: Land and crop management practices (Raising mountains and ridges, mulching, land fallowing, crop

residue use and application of manure, bushfire prevention, mixed crop or farming, crop rotation, crop diversification, planting schedule, regular weeding or pest control), livestock-related activities, off-farm income generation activities (charcoal production, pito brewing, small trade, shea butter processing and dawadawa processing), strategies of production and marketing.

The research also confirmed that 83.0 percent of those surveyed said no suggesting that they had not adapted land rotation as a climate change strategy, while 17.0 percent of respondents said yes showing that they were adapting land rotation as a climate change approach. Off those respondents who did not adapt land rotation as a strategy gave the following reasons for not adopting it; 33.0 percent of them said they lack finance to adopt land rotation, 24.0 percent of them said they lack the knowledge to adopt land rotation, and 43.0 percent of them said they did not have a permanent land to adapt to land rotation as a strategy. These smallholder rice farmers use the same land for every farming season without changing to a different land to allow the old land rest for a period as a result of lack of knowledge and not having permanent land. The above finding is not similar to the findings of Gyampoh et al. (2008) where they revealed that although locals may not grasp the concept of global warming, they feel its impacts and the use of crop residues and application of compost, preventive measures of bush fires, mixed crop or agriculture, crop rotation, crop diversification, planting timing, regular weeding or control of pests, etc.

Furthermore, the research disclosed that 100.0 percent of participants said No indicating that they did not adapt purchasing insurance as a climate change approach, while none of participants supported purchasing insurance as a climate change approach. Off those respondents who did not support the buying insurance as a strategy to climatic change gave the following reasons for not buying it; 51.0 percent

of them said they lack finance to buy insurance, 33.0 percent of respondents said that they lacked knowledge of the use of insurance purchases, and 16.0 percent of them said they did not believe in strategy to buy insurance. This means that smallholder rice farmers in the Kasena-Nakana Municipality do not ensure their rice farms as they lack finance and knowledge to do so. This implies that rice farms are left to the mercy of rain and God delivery.

Rainfall variability is a threat to the living conditions of smallholder farmers who are mainly engaged in rain-fed farming. Over the previous few years, crop failure associated with rainfall has become a prevalent occurrence owing to occurrences of late planting rain, variability in patterns and rainfall concentrations, and intermittent droughts and floods affecting the smallholder rice farmer.

The research also disclosed that 56.0 percent of participants said No indicating they had not adapted seasonal migration to other rural fields as a climate change approach, and 44.0 percent of participants said yes suggesting they had adapted seasonal migration to other rural fields as a climate change approach. Off those respondents who did not adapt seasonal migration to other rural areas as a strategy gave the following reasons for not adopting it; 35.0 percent of them said they lack finance to adopt seasonal migration to other rural areas, 23.0 percent of them said they lack the knowledge to adopt seasonal migration to other rural areas, and 42.0 percent of them said they did not believe in the strategy. This means that smallholder rice farmers do not travel to other regions or places during the dry season to seek for greener pastures. The above finding is not consistent with Adger et al (2005) finding documented that climate change adaptation involves migrating to other regions where the condition is favourable during most of the dry season farmers.

The research also disclosed that 54.0 percent of participants said No indicating that some household members did not adapt permanent migration as a climate change approach, while 46.0 percent said yes indicating that some household members adapt permanent migration as a climate change approach. Off those respondents who did not adapt permanent migration by some household members as a strategy to climatic change gave the following reasons for not adopting it; 37.0 percent of them said they lack finance to adopt permanent migration by some household members, 25.0 percent of participants said they lacked the expertise to embrace continuous migration as a strategy for some family members, and 38.0 percent did not believe in the approach.

Furthermore, information from the research disclosed that 54.6% of participants said No indicating that they did not adapt crafts making and selling as a climate change approach, while 45.4% of participants said yes indicating that they adapt crafts making and selling as a climate change approach. Off those respondents who did not adapt making and selling of handicrafts as a strategy to climatic change gave the following reasons for not adopting it; 42.0 percent of them said they lack finance to adapt selling and making of handicrafts, 33.0 percent of participants said they lacked the expertise to tailor sales and craftsmanship as a strategy, and 25.0 percent did not think in the approach. This finding is not consistent with Armah et al (2013) identifying the following four native peoples agrobiodiversity management strategies in northern Ghana: Land and crop management practices (Raising mountains and ridges, mulching, land fallowing, crop residue use and application of manure, bushfire prevention, blended crop or farming, crop rotation, crop diversification, planting schedule, periodic weeding or pest control), livestock-related operations, off-farm revenue generation activities (charcoal production, pito brewing, pett brewing, small

trading, processing of shea butter and dawadawa), strategies of production and marketing.

In addition, the research also reported that 64.2 percent of those surveyed said no stating that they did not acclimate charcoal production as a climate change approach, while 35.8 percent said yes showing that they make adjustments to charcoal production as a climate change strategy. Off those respondents who did not adapt charcoal production as a strategy, gave the following reasons for not adopting it; 56.0 percent of them said they lack the knowledge to adapt charcoal production as a strategy to climatic change, and 44.0 percent of them said they did not believe in the strategy to adapt Charcoal manufacture. Furthermore, the research disclosed that 74.0 percent of participants said No indicating that they did not embrace small-scale mining as a climate change approach, while 26.0 percent said yes indicating that they adapt small-scale mining as a climate change approach. Off those survey participants who did not endorse small-scale mining as a climate change technique, the following justifications were given for not embracing it ; 66.0% said they lacked funding to integrate small-scale mining, 16.0% said they lacked the knowledge to adapt small-scale mining as a strategy, and 18.0% did not believe in the strategy (Table 4.5).

Table 4.5 Adapting smallholder rice farmers ' strategies to climate change

	Response		Did strategy help to reduce the impacts of hazards	Give reasons why the strategy was not adopted (%)
Adaptation Strategy	**Yes (%)**	**No (%)**		
Intensification of irrigation	24.7	75.3		1.lack of finance (63.0) 2.lack of knowledge (37.0)

Change from crop to livestock	16.6	83.4		1.lack of finance (43.0) 2.lack of knowledge (26.0) 3.Did not believe in strategy(31.0)
Usewater-harvesting techniques				1.lack of knowledge (74.0) 2.Did not believe in strategy(26.0)
Plant different crops	46.4	53.6		1. Lack of finance (32.0) 2. lack of knowledge (24.0) 3.Did not believe in strategy (18) 4.Did not have a permanent land(26.0)
Change planting date	33.0	67.0		1.Lack of knowledge (82.0) 2. Did not believe in strategy (18.0)
Adapt chemical fertilizer application	73.0	27.0	Yes (67.0) No(33.0)	
Application of compost/manure	43.0	57.0		1.Lack of finance (39.0) 2.lack of knowledge (45.0) 3 Did not believe in strategy (16.0)
tillage practices	34.0	66.00		1.Lack of knowledge (63.0) 2.Did not believe in the strategy (37.0)
:ropping /mulching	45.0	55.0		1.lack of finance (34.0) 2.lack of knowledge (46) Did not believe in strategy (20.0)
otation	17.0	83.0		1.lack of finance (33.0) 2.lack of knowledge (24) 3.Did not have a permanent land (43.0)
surance	0.0	100.0		1.lack of finance (51.0) 2.lack of knowledge (33.0) 3.Did not have to believe instrategy (16.0)
ıal migration to other reas	44.0	56.0		1.lack lack finance (35.0) 2.lack of knowledge (23.0) 3.Did not believe in strategy (42.0)
nent migration by ıousehold members	46.0	54.0		1.Lack of finance (37.0) 2.lack of knowledge (25.0) 3.Did not believein strategy(38.0)
rafts	45.4	54.6		1.Lack of finance (42.0) 2.lack of knowledge (33.0) 3.Did not believe in strategy (25.0)
ɔal production	35.8	64.2		2.Lack of knowledge (56.0) 3.Did not believe in strategy (44.0)
Small scalemining	26.0	74.0		1.lack of finance (66.0) 2.lack of knowledge (16.0) 3.Did not believe in strategy (18.0)

Source: Field Survey, 2017

On the issue of why participants adapt strategies and plan to accomplish this approach, the research found that 45.8% of participants stated that they had adapted strategies in order to attain food safety, 41.7% of participants stated that they had adapted strategies due to increased family revenue, 6.3% of participants stated that they had adjusted the policies with the aim of increasing crop production, while 6.3%

stated that they had adjusted the strategies for other purposes not listed but known to them as shown in Table 6.2. This implies that, due to food safety and an increase in family revenue, most participants embraced their approaches. This implies that the adaptation of the rice farmer depends on feeding their family. This finding is endorsed by the FAO (1996a), which stated that food safety exists when all individuals always have physical or financial access to adequate secure and nutritious food to satisfy their nutritional requirements and food preferences for an active and healthy life. FAO (2008) also added that there are four aspects of food safety: food availability, food accessibility, food use and stability of food systems, and that climate change will impact all of these aspects; as temperatures and rainfall differ, farming-based livelihood systems that are already susceptible to food insecurity face instant risks of enhanced crop failure, fresh trends of pests and illnesses, absence of suitable plants and planting material, and animal loss as shown in Table 4.6.

Table 4.6 Why Adapted the Above Strategies and the Intend to Achieve

	Frequency	Percent
Food Security	44	45.8
Increased Family Income	40	41.7
Increased Crop Output	6	6.3
Others	6	6.3
Total	96	100.0

Source: Field Survey, 2017

Furthermore, on the issue of farm inputs accessible to farmers, information from the research revealed that up to 77.0 percent of participants stated that they had yes farm inputs accessible to apply to their rice, and 23.0 percent of participants stated that no, farm inputs were not accessible to apply to their rice. This implies that rice farmers had farm inputs to purchase and apply to their rice paddy farms.

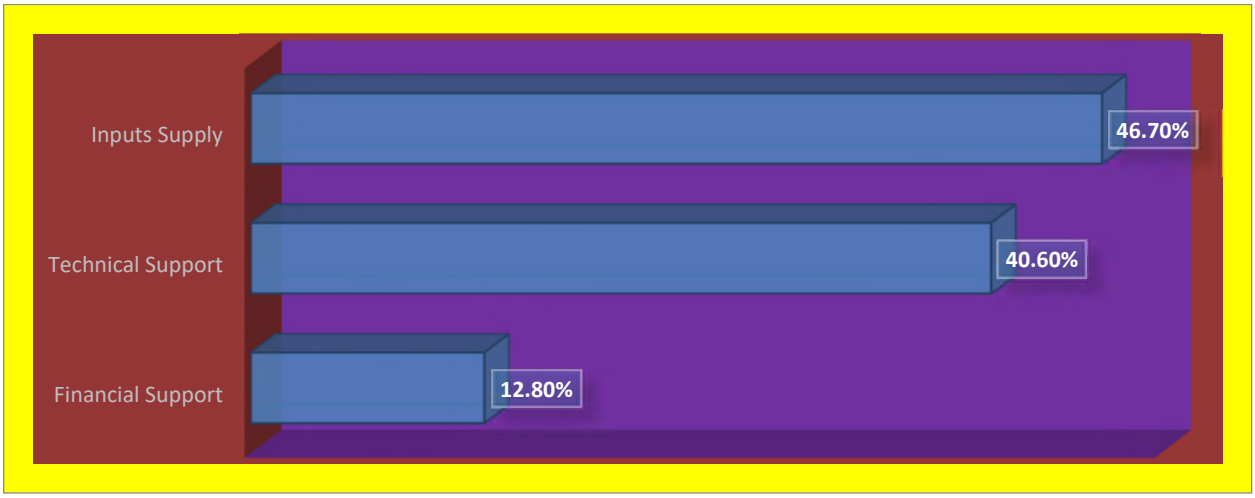
The research disclosed that 66.0% of participants stated that they received their farm inputs from their society, while 34.0% of participants stated that they received their farm inputs from the municipal community centre. This implies that farm inputs in their municipality are sold or circulated. This means that rice farmers will not travel to other districts or communities to purchase their farm inputs, reducing the cost of transporting inputs to their different farms.

The research disclosed to those farmers who were willing to get their farm inputs that 70.0 percent of those farmers said yes, they were willing to pay for the price of farm inputs while 30% of those farmers said no they could pay for the price farm inputs. This means that most rice farmers could afford the cost of buying inputs from the farm. It therefore also implies that rice farmers were able to adapt as a strategy for climate change to the application of farm inputs.

On institutional assistance for farmers, 58.6% of participants said yes, they have Farmer Based and Community Organization, while 41.4% of participants said no, they have no Farmer Based and Community Organization as shown in figure 4 below. This means rice farmers have some support in their rice farming from a farmer-based and community-based organization.

The research reported on membership of the farmer and community-based organization that 52.2 percent of participants are landowners and community-based organization members, and 47.8 percent of participants are not landowners and community-based organization members. This implies that most rice farmers belong within the municipality to the farmer and community-based organization. This could be attributed to the reason that rice farmers have farmers and community-based organization support in getting farm inputs to apply to their rice farms.

On the question of "What kind of support do you get from this / this organization," the study revealed that 46.7 percent of the respondents indicated that they were supported by the farmer and community organization to obtain supply of inputs, 40.6 percent of the respondents indicated that they were supported by the farmer and community organization to obtain technical support, and 12.8 percent of the respondents indicated that they were supported by the farmers and community organization in order to obtain technical assistance, 12.8% of participants stated that they had the assistance of the farmer and the community organisation to obtain economic assistance as shown in Figure 1 below. This implies rice farmers are provided with feedback from the farmer and community-based organization to be used in rice farming. Figure 1 Kind of Support Farmers Get from the farmer and Community Organization.



Sources: Field Survey, 2017

4.6 Factors Accounting for Rice Farmer's Success and Failure

Adaptation activities concentrate on building person, community, local and central public resilience to climate change if they are to be efficient. Individual and community levels determine the efficiency of individual and community approaches in creating sustained adaptation resilience. Some adaptation approaches do not take climate change-related dynamic hazards into account.

The research findings showed an average value of 2.14 meaning participants agreed that weather and meteorological data (e.g. early warnings) account for the success and failure of lower rice farmer adaptation. This implies that the rice farmers are not notified about the weather and weather information about the quantity of rain and how coherent the rain will be the smallholder rice farmers were therefore notified. This finding is backed by the argument that precipitation variability is a threat to the livelihood of predominantly rain-fed farmers. Rainfall-related crop failure has become a prevalent occurrence in Northern Ghana owing to occurrences of late planting rain, pattern variability and rainfall levels, and intermittent droughts and floods. Smallholder farmers have become susceptible to climate change and need weather and metrological service information (Amikuzuno&Donkoh, 2012).

Also, with an average value of 1.80 indicating that the respondent strongly agreed that Knowledge of soils and how to improve their fertility accounts for the success and failure of adaptation of smaller rice farmers. Furthermore, the findings showed an average value of 2,06 mean participants agreed that climate change projections account for the success and failure of the lower holder paddy growing adaptation. This implies that in regard to climate change, smallholder rice farmers do not have the correct understanding of soil and prediction. This implies that the production of rice farmers is affected by the lack of knowledge in relation to climate change prediction. This result is endorsed by the FAO (2008) proposal that some adaptation methods that will assist decrease the effect of climate change include expertise on the impacts of growing weather variability and enhanced frequency and intensity of extreme occurrences, study and dissemination of crop varieties and races adapted to altering climatic circumstances and introduction of tree plants for food supply, fodder, power and money income enhancement.

The findings also showed an average value of 2.38 for agricultural methods, expertise and data, meaning participants agreed that better management of agricultural property for sustainable production is a success of adaptation of smallholder rice farmers. In addition, the results show an average value of 2.04 meaning respondents agreed that the proper use of agricultural inputs is a success of adaptation of smallholder rice farmers, also with an average value of 2.63 meaning respondents are not sure that climate change and sustainable farming systems are a success of adaptation of smallholder rice farmers. Furthermore, the research disclosed a mean value of 1.72 showing that participants agreed that crop varieties tolerant to severe climatic circumstances are successful in adapting smallholder rice farmers. Also, with an average value of 2.85 which is equivalent to 3 indicating that those respondents are not sure that agricultural intensification is a success of adaptation by smallholder rice farmers. In addition, with an average value of 1.89 equal to 2 meaning participants agreed that adaptation knowledge and techniques for farmers are a success of adaptation for smallholder rice farmers.

For financial / commercial data on variables that account for the success and failure of smallholder rice farmers, the research indicates an average value of 2.33 meaning participants agreed that plants that command excellent rates on the market as a achievement of adaptation of smallholder rice farmers also reflect economic possibilities resulting from climate change have an average value of 2.57 suggesting that participants are not sure of the economic possibilities of climate change. It also disclosed a mean value of 2.35 suggesting that the respondent agreed that the accessibility and access of credits is not a consequence of climate change, and the end outcome was an average value of 2.67 equivalent to 3 suggesting that the participants are not sure that the accessibility and access of rewards, e.g. inputs, is an incentive.

With an average value of 2.11 showing that participants agreed that social data about climate change adaptation leads to failure of farmers, also with an average value of 2.33 meaning participants agreed that local and traditional adaptation knowledge and techniques are a success of adaptation of smallholder rice farmers. It also disclosed a mean value of 1.19 meaning participants highly agreed that culture and sustainable adaptation is a success of adaptation of smallholder rice farmers, also with a mean value of 2.34 indicating that participants agreed that mixing science and local expertise to promote adaptation is a success of adaptation of smallholder rice farmers.

For legal information on variables that account for the success and failure of adaptation of smallholder rice farmers, the findings showed an average value of 2.97 meaning participants are not sure that land tenure problems are factors that account for the failure of adaptation of smallholder rice farmers. Furthermore, the findings indicate an average value of 2.77 which is equal to 3 meaning participants are not sure that land rights are factors that account for the failure of smallholder rice farmer adaptation, also with an average value of 3.00 meaning participants are not sure that contract problems are factors that account for the failure of smallholder rice farmer adaptation.

For strategic and policy information on factors that account for the success and failure of adaptation of smallholder rice farmers, the study revealed an average value of 2.59, equivalent to 3 indicating that respondents are not sure that government efforts to address climate change and variability challenges are a success or failure of adaptation of smallholder rice farmers. With an average value of 2.63 equivalent to 3 meaning respondents are not sure that alternative livelihood options to reduce the severity of climate change impacts on smallholder rice farmers adaptation, also with an average value of 3.42 meaning respondents are not sure that crop insurance is part

of smaller rice farmers adapting to climate change, and finally, with an average value of 2.51 in the Kasena-Nankana East Municipality in the Upper East region of Ghana, which is equal to 3 participants, it is not certain that sustainable climate change adaptation policies and strategies are being adopted by smaller farmers as shown in Table 4.7.

Table 4.7 Factors Accounting for the Success and Failure of Small Holder Rice Farmer Adaptation

	Mean	Std Devia
Scientific information on climate change causes		
Meteorological and weather information (e.g. early warnings)	2.14	1.069
Knowledge of soils and how fertility can be improved	1.80	0.501
Predictions of climate change	2.06	1.030

Practices in agriculture, knowledge and data		
Better agricultural land management for sustainable production	2.38	0.820
Use of agricultural inputs appropriately	2.04	0.820
Climate change and sustainable agricultural systems	2.63	0.976
Varieties of crops tolerant of severe weather	1.72	0.993
Agricultural intensification	2.85	1.215
Adaptation of farmers ' knowledge and technologies	1.89	0.885
Economic / commercial information		1.155
Crops that command good market prices	2.33	1.299
Climate change financial possibilities	2.57	1.039
Accessibility and accessibility of credit	2.35	1.271
Accessibility and access to incentives, such as inputs	2.67	0.880
Social Information about	2.11	0.864
Knowledge and techniques of local and traditional adaptation	2.33	0.686
Culture and sustainable adaptation	1.19	0.763
Blending scientific and local knowledge to support adaptation	2.34	0.456
Legal Information about		
Land tenure issues	2.97	0.949
Land rights	2.77	0.957
Contracts issues	3.00	0.978
Information on strategic and policy		
Government efforts to tackle climate change and variability problems	2.59	1.024
Alternative livelihoods to reduce the impacts of climate change	2.63	0.942
Crop insurance	3.42	0.771
Sustainable policies and strategies for climate change	2.51	0.916

Sources: Field Survey, 2017

The findings of the research showed the mean value of 4.81 meaning participants disagreed that abandoning agriculture at the cost of other financial operations as a consequence of climate change, on what can be done in the future to be able to adapt to the changes if they continue. Also, with an average value of 3.85, the respondents disagreed that they abandon the existing farms and move to wetter areas like the banks of the river, climate change will diminish. Furthermore, the findings showed an average value of 3.81 mean participants disagreed that immigrating from your village

to other regions with better circumstances will improve future climate change adaptation. The findings also showed an average value of 1.71, equal to 2 meaning participants agreed that continuing to change farming methods in line with changes in local climate will improve the adaptation of smaller rice farmers to climate change. Furthermore, the findings show an average value of 3.43 which equals 3 meaning respondents are not sure that requesting food aid will reduce climate change, also with an average value of 1.42 meaning respondents strongly agreed to request government support such as introducing new and modern climate change adaptation choices.

Furthermore, the research disclosed a mean value of 1.78 suggesting that participants agreed to seek more data, understanding, and education on climate change adaptation. Also with an average value of 1.78 equal to 2 showing that participants agreed to encourage irrigation using subterranean water to decrease climate change. In addition, with an average value of 1.85 equivalent to 2 meaning respondents agreed to further promote conservation practices, with an average value of 1.66 equivalent to 2 meaning respondents agreed to improve their capacity through education and training. The research also demonstrates a mean value of 1.84 which is equal to 2 meaning participants agreed that enhancing organizational ability and effectiveness will decrease climate change, also in line is that enhancing access to credits has a mean value of 1.94 which is equal to 2 suggesting that participants agreed that improving access to credits by lower landowners will help decrease climate change. It also disclosed an average value of 1.75 which is equal to 2 showing that the respondent agreed that increasing knowledge and data for lower rice farmers would decrease climate change, with an average value of 1.75 which is equal to 2 suggesting that more study and dissemination of study outcomes to farmers and other stakeholders would decrease climatic change.

The findings also showed an average value of 1.92, equal to 2 meaning participants agreed that respecting and disseminating local experience and expertise will improve the adaptation of lower rice farmers to climate change. Furthermore, the findings indicate an average value of 1.53 which is equal to 2 meaning participants agreed that the development and introduction of fresh crop varieties to improve the tolerance and suitability of crops to temperature, humidity and other appropriate environmental circumstances, also with an average value of 2.48 which is equal to 3 meaning participants are not certain that the introduction of crop insurance will improve smallholder paddy grower's adaptation to climatic change. The research further disclosed an average value of 1.51, equal to 2 indicating that participants agreed that supporting the adoption of enhanced crop varieties, contemporary irrigation and better techniques linked to agriculture will improve the adaptation of smallholder farmers to climate change. Also, with an average value of 1.40 indicating that those surveyed highly agreed to provide the necessary infrastructure in rural regions, post-harvest support and support for agro-industries will improve the adaptation of smallholder farmers to climate change.

In addition, with an average value of 1.33, respondents strongly agreed to develop and/or reinforce early warning systems that provide daily weather forecasts and seasonal forecasts to help smallholder rice farmers adapt to climate change. In addition, with an average value of 1.43, participants highly agreed that the timely dissemination of weather forecast data should be strengthened timely dissemination of information to farmers on weather forecasting. The study also indicates an average value of 1.65 which is equal to 2 meaning participants agreed that encouraging private sector involvement in investment in agriculture will improve the adaptation of smallholder rice farmers to climate change, as well as conducting studies to quantify

the magnitude of climate change for each agro-ecological area and recommend that the average value is 1.74 which is equivalent to 2 indicating that respondents agreed to undertake research to quantify and advise on the magnitude of climate change for each agro-ecological zone will improve adaptation to climate change for smallholder rice farmers.

It also disclosed a mean value of 1.75 which is equal to 2 suggesting that the respondent agreed that developing and enhancing innovations in water management to tackle the danger of moisture deficiencies and growing droughts will improve smallholder adaptation to climate change with a mean value of 1.69 Which is equivalent to 2 indicating that respondents agreed that with the introduction and/or improvement of subsidies and incentives provisions to support farmers in adapting to climate change, and finally with a mean value of 1.72 which is equivalent to 2 indicating that respondents agreed that policies and programs to influence the use and management of agricultural land and water resources should be developed and implemented farm-level land and water resource policies and programs and management procedures will improve climate change adaptation for smallholder rice farmers (Table 4.8).

Table 4.8 Future adaptation to changes in Climate

	Mean	Std Dev
Failure to farm at the cost of other financial operations	4.81	0.647
Leave the existing farms and transfer to wetter regions such as riverbanks	3.85	1.406

Emigrate to other areas with better conditions from your village	3.81	1.313
Continue to change farming methods in line with local climate change	1.71	1.230
Request food assistance	3.43	1.305
Request support from the government such as introducing new and modern adaptation options	1.42	0.496
Seek more information, knowledge and education on climate change adaptation	1.54	0.669
Promote underground water irrigation	1.78	0.657
Further foster conservation practices	1.85	0.706
Improve your capacity through training and education	1.66	0.651
Improve the capacity and efficiency of institutions	1.84	0.631
Improve access to credits	1.94	0.734
Enhance awareness and information provision	1.88	0.557
Further research and dissemination to farmers	1.75	0.761
Respect and disseminate understanding and local experience	1.92	0.679
Develop and introduce new crop varieties to enhance plant tolerance and adaptability to temperature, humidity and other relevant climatic conditions	1.53	0.916
Insurance of crops	2.48	0.913
Support for improved crop varieties, modern irrigation and improved technologies related to agriculture	1.51	0.670
Provide the necessary infrastructure in rural areas, support after harvest and support for agribusiness	1.40	0.554
Develop and/or reinforce early warning systems that provide daily weather and seasonal predictions	1.33	0.538
Reinforce the timely dissemination of data on weather forecasts to farmers	1.43	0.713
Encourage private sector involvement in investment in agriculture;	1.65	0.654
Investigate and advise on the magnitude of climate change for each agro-ecological zone	1.74	0.624
Develop and strengthen innovations in water management to address the risk of deficiencies in humidity and increasing drought frequency	1.75	0.503
Introduce and/or enhance arrangements for subsidies and incentives to promote the adaptation of farmers	1.69	0.466
Develop and execute policies and programs to impact the use and management of agricultural land and water resources	1.72	0.518
Supporting agricultural diversification as an economic activity	1.59	0.494

Sources: Field Survey, 2017

4.7 Narratives of FGDs and interviews

Interview data backed the perception of farmers that over the previous 30 years there have been several modifications in the local climate. Most of the information stated changes in the local climate, though with somewhat distinct explanations for reasons connected with perceived modifications. Changes mostly related to the rainfall status and temperature in the area.

Changes in rainfall qualitative information were consistent with the information gathered in most of what farmers perceived through a questionnaire. During the interviews, the perception that rainfall has been declining for the previous thirty years and that changes are occurring in the start, as well as the distribution of rainfall in seasons. The interviewees verified that changes are occurring in the region regarding rainfall and the quantity is declining relative to the previous 30 years. First, the District Agricultural Officer gave a comprehensive explanation on the state of rainfall in the region and answered the question: ' How do you explain the state of climate in the district? ' The policeman had to say, "The area's climatic circumstances differ with altitude. We have one area in the district in terms of rainfall that receives rain once a season in a year".

As to what the climate state is this time compared to the past 30 years, it was found that the local climate was not static but changed. However, the modifications recognized from the interviews were negative for both farmers as well as all other stakeholders, including professionals. On this one, the District Council representative was very explicit about modifications in the quantity, onset and distribution of rainfall. Moreover, he also made it clear that they are now facing a hard time for growers because the predictability of rainfall is quite difficult and often impossible since, unlike in the olden days, it does not currently have a clear and consistent pattern. Currently, as they used to in the past, farmers are unable to predict rainfall patterns because there are many changes that make it hard for them to do so. The official further clarified in the following quote:

"There has been regular, predictable and normal rainfall in the past. We had some quantity fluctuations, but not much. This was suitable for farmers and for their agricultural activities they rarely experienced water shortage. However, in terms of

quantity and onset, rainfall is unpredictable for these years. In all of these fields, there is a declining trend in rainfall''.

This explanation suggests that there are changes in terms of rainfall. Such changes have created it hard, if not impossible, for farmers to be sure of what will happen in a season due to the unpredictable nature of the rainfall over the past few years. Not only the municipal representative had such opinions on the climate status in the region, but also nearly all those questioned and those involved in the debates. It is worth having other respondent examples and finding out how they perceived and communicated the state of local conditions based on their expertise and experience in the region. For instance, one village elder commented on this issue by emphasizing the unpredictability of the rainfall nature in these years:

"When you're talking about modifications in the local environment, you remind me of those 1950s, 60s-70s, and 80s excellent years. It was very predictable in those years that we harvested in early June, rainfall began and came in October and November. Rainfall wasn't an issue. But that's not the case now. No one can any longer predict the onset of rainfall and how long it will last."

In a comparable note, this had to be said by the chairperson of the group of smallholder rice farmers while explaining the state of the local climate in the region in particular:

"I can tell you that this area's climate has changed so much compared to the past 30years. We don't get good rainfall nowadays as it used to be. In many instances, rainfall occurs very late and it is usually brief, so it does not satisfy the expectations of farmers. Now seasonally flowing rivers that used to flow annually."

The explanations show that while the seasonality of rivers may be affected by many variables, some of which may not necessarily be ascribed to climate change, farmers

use it as an indicator to support their arguments and perception that the local climate has altered because the rivers they used to see flowing annually now flow during rainy seasons and get dry just a short time after that.

In addition to interviews, FGD data also supports the perceptions of farmers about changes in local climate and the main reference to these changes is made on rainfall. This is because rainfall supports smallholder farmers because they primarily rain-fed their output on the farm. Some citations justify what farmers said during group debates. For example, one village elder placed it very obviously referring to the 1960s through the 1970s through the 1990s and what the scenario has been all along:

"Really speaking, this area's climate situation was very conducive. For example, conditions were so good in the 1960s and there were no rainfall issues. There was no food shortage, rice flourished, and because of constant excellent harvests, individuals had cash. But from the early 1970s until now, the situation was slowly evolving negatively. We have been witnessing a shortage of rainfall in latest years and the rivers that have supported farmers to irrigate are now slowly disappearing due to insufficient rainfall. We received very little rainfall this year, for example, and this puts people's future at risk. So this is my knowledge of the situation."

Not all farmers of the year receive tiny quantities of rainfall, however. Through interviews and FGDs, it was found that while the recorded amounts may be optimal for some years, the seasonal distribution becomes a problem on some occasions. In such cases, too much rainfall can concentrate within the seasons in a couple of weeks, leaving many weeks or months without rainfall affecting farmers in their farming activities. In addition to affecting farmers, it has also been noted that such rainfall is destructive of infrastructure and some farms in some locations.

"Rainfall is up to the expected amount in some specific seasons, but it falls dramatically. In a short time like one or two weeks, the regions may receive heavy downpour. These rains become so disastrous as crops, infrastructure and properties are damaged. Then the regions are dry after two or three weeks and they receive no rainfall until the next season. These are frequent instances."

This account showed that the presumed changes in local climate are complex in a manner, particularly for farmers who rely completely on rainfall for their livelihoods. This indicates that in terms of amount as much as in some of the rains of the year can be enough; distribution within the season is not something farmers can take for granted and beyond their control. Therefore, for that matter, they cannot describe their destiny. Apart from not being suitable for farmers, the catastrophic nature of such rainfall affects the area's socio-economic development by destroying bridges and other available infrastructure. This generates other socio-economic issues for both the families and the community while overburdening the government by rebuilding infrastructure.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This part displays the sum-up of main results, conclusions, and recommendations of the research. The research evaluates the main impacts of climate change on rice farmers. The adaptation strategies used by rice growers to counter the change in climate are identified in this chapter. It further determines factors accounting for the success and adaptation failure of Kasena- Nankana East Municipality rice farmer in Ghana.

5.2 Summary

5.2.1 Impacts Climate Change on smallholder Rice Farmers

The study revealed that the effects of change of climate on rice farmers. The research discovered indication by respondents that the threat of climatic change is more on agricultural production respondents strongly agreed that climate change has affected paddy cultivation, respondents agreed that changes in climate have triggered a rise in occurrences of floods during the raining season, respondents strongly agreed that shifts in precipitation seasonality have caused crop failures and low yield, respondents agreed that climate change has led to rice infestation and diseases due to droughts, also respondents agreed that climate change has led to rural-urban migration, respondents agreed that climate variability has an impact on rain-fed production, and respondents agreed that a decrease in rainfall reduce water stored in bands.

It additionally uncovered that 59.4% of the respondents specified that the threat of climatic change is more on agricultural production, respondents strongly agreed that

climate change has an impact on paddy cultivation, respondents agreed that variation in climate has instigated an increase in occurrences of floods during the raining season, respondents strongly agreed that changes in rainfall seasonality have caused crop to fail and low yield. Respondents agreed that climate change has led to rice infestation and diseases due to droughts, respondents agreed that climate change has led to rural-urban relocation, respondents accorded that climate inconsistency has an impact on rain-fed cultivation, respondents agreed that decline in rainfall decrease water stored in bands.

5.2.2 Adaptation Strategies of Rice farmers to Climate Change

The research revealed that adaptation strategies used by rice growers to encounter change of climate. The study disclosed that rice farmers do not use intensification of irrigation as a strategy to climatic change, respondents are not changing from crop to livestock as a strategy to climatic change, respondents are not using water-harvesting techniques as a strategy to climatic change, respondents are not planting different crops as a strategy to climatic change, respondents are not changing planting date as a strategy to climatic change. However, respondents used chemical fertilizer application as a strategy to climatic change which helps to reduce the impacts of hazards, respondents are not applying compost/manure as a strategy to climatic change, respondents are not adapting land rotation as a strategy to climatic change, respondents do not have a permanent land to adapt to land rotation as a strategy, respondents are not adapting to buying insurance as a strategy to climatic change, respondents are not adapting seasonal migration to other rural areas as a strategy to climatic change, respondents are not adapting handicrafts making and selling as a approach to climatic change.

The research revealed that 75.3% of the interviewees do not use intensification of irrigation as a strategy to climatic change. Off those respondents who did not use intensification of irrigation as a strategy to climatic change give the following reasons for not using it; lack finance to implement irrigation projects and lack the knowledge of managing irrigation projects. Moreover, the research unveiled that 83.4% of the interviewees are not changing from crop to livestock as a strategy to climatic change. Off those respondents who did not change from crop to livestock as a strategy to climatic change give the following reasons for not using it; 43.0 percent of them said they lack finance to change from crop to livestock, 26.0 percent of them said they lack the knowledge to change from crop to livestock, and 31.0 percent of them said they did not believe in strategy by changing from crop to livestock.

It also revealed that 77.6% of the interviewees do use water-harvesting techniques not as a approach to climatic alterations. Off those respondents who did not use water-harvesting techniques as a plan of action to climatic modification give the following reasons for not using it; 74.0 percent of them said they lack the knowledge to use water-harvesting techniques, and 26.0 percent of them said they did not believe in strategy by using techniques of water-harvesting.

The research revealed 53.6 % of the interviewees answered No indicating they did not plant different crops as a scheme to climatic variation. Off those respondents who did not plant different crops as a strategy to climatic change gave the following reasons for not using it; 32.0 percent of them said they lack finance to plant different crops, 24.0 percent of them said they lack knowledge to plant different crops, 18.0 percent of them said they did not believe in strategy to plant different crops, and 26.0 percent of them said they did not have a permanent land to plant different crops.

It also revealed that 67.0% of the interviewees uttered No indicating they did not change planting date as a mechanism to climatic alteration. Off those respondents who did not change planting date as a strategy to climatic change gives the following reasons for not changing it; 82.0 percent of them said they lack the finance to change planting date, and 18.0 percent of them said they change planting date. However, 73.0 % of the respondents stated they adapt application of a fertilizer which is chemical as a strategy to climatic change which helps to reduce the impacts of hazards.

The study further revealed that 57.0 % of the interviewees do not apply compost/dung as a mechanism to climatic change. Off those respondents who did not apply compost/manure as a plan of action gave the following reasons for not applying it; 39.0 percent of them said they lack finance to apply compost/manure, 45.0 percent of them said they lack the knowledge to apply compost/manure, and 16.0 percent of them said they did not believe in strategy, 83.0 % of the respondents do not adapt land rotation as a mechanism to climatic change. Off those respondents who did not adapt land rotation as a strategy gave the following reasons for not adopting it; 33.0 percent of them said they lack finance to adapt, Land rotation, 24.0 percent of them said they lack knowledge to adapt, land rotation, 43.0 percent of them do not have a permanent land to adapt to land rotation as a strategy.

The research unearthed that all the respondents do not adapt to buying insurance as a strategy to climatic change. Off those respondents who did not support the buying of insurance as a strategy to climatic change give the following reasons for not do so; 51.0 percent of them said they lack finance to buy insurance, 33.0 % of the respondents stated they lack information with regards to buying of insurance use, and 16.0 percent of them said they did not believe in strategy to buy insurance, 56.0 percent of the respondents do not adapt seasonal migration to other rural areas as a

strategy to climatic change. Off those respondents who did not adapt Seasonal migration to other rural areas as a strategy give the following reasons for not adopting it; 35.0 percent of them said they lack finance to adopt seasonal migration to other rural areas, 23.0 percent of them said they lack knowledge to adapt, Seasonal migration to other rural areas, and 42.0 percent of them said they did not believe in the strategy.

Again, 54.6 percent of the respondents do not adapt to handicrafts making and selling as a strategy to climatic change. Off those respondents who did not adapt making and selling of handicrafts as a strategy to climatic change give the following reasons for not adopting it; 42.0 percent of them said they lack finance to adapt selling and making of handicrafts, 33.0 percent of the interviewees said they lack the information to adapt selling and making of handicrafts as a strategy, and 25.0 % of the respondents did not trust in strategy.

5.2.3 Factors mitigating the Success and Failure of rice Farmers Adaptation

On the factors mitigating for success and failure of rice farmer's adoption, the study revealed that respondents agreed that meteorological knowledge (for example, early warnings) is accounting for the failure of smaller holder rice farmer adaptation, respondents strongly agreed that knowledge around soils and ways to improve its fertility is accounting for the failure of smaller holder rice farmer adaptation, and respondents agreed that predictions pertaining to climate alterations are accounting for the failure of smaller holder rice farmer adaptation. The study further revealed that respondents agreed that climatic conditions is accounting for the failure of smaller holder rice farmer adaptation, respondents strongly agreed that knowledge concerning soils and means to meliorate its fertility is accounting for the failure of smaller holder

rice farmer adaptation, and respondents agreed that predictions in reference to climate change are responsible for the failure of smaller holder rice farmer adaptation.

5.3 Conclusion

Based on the finding of the effects of change of climate on rice farmers the research concluded; threat of climatic change is more on agricultural production; climate change affected rice cultivation; disparities in climate has triggered a rise in occurrences of floods during the raining season; changes in rainfall seasonality have produced crop failures and low yield; modification has led to rice infestation and diseases due to droughts; climate change has resulted in rural-urban relocation; climate fluctuation has affected rain-fed production; and decrease in precipitation decrease water stored in bands.

Concerning adaptation strategies of rice farmers to change of climate the research concluded on that; rice farmers are not using intensification of irrigation as a strategy to climatic change; rice farmers are not changing from crop to livestock as a strategy to climatic change; rice farmers are not using water-harvesting techniques as a strategy to climatic change; rice farmers are not planting different crops as a strategy to climatic change; rice farmers are not changing planting date as a strategy to climatic change; rice farmers are not applying compost/manure as a strategy to climatic change; rice farmers did not adapt land rotation as a strategy to climatic change, rice farmers do not have permanent land to adapt to land rotation as a strategy; rice farmers do not adapt to buying insurance as a strategy to climatic change; rice farmers are not adapting to seasonal migration to other rural areas as a strategy to climatic change; rice farmers are not adapting handicrafts making and selling as a strategy to climatic change; however, rice farmers adapt chemical fertilizer application as a strategy to climatic change which helps to reduce the

impacts of hazards. Based on findings from the factors accounting for success and failure of rice farmers adaptation: meteorological and weather conditions data (for example early cautions) is accounting for the failure of smaller holder rice farmer adaptation; information concerning soils and how to ameliorate its fertility is accounting for the failure of smaller holder rice farmer adaptation; and c) predictions in connection to environmental change is accounting for adaptation failure of smaller holder rice farmers.

5.4 Recommendations

Considering the research findings, to tackle the issues of the smallholder rice farmers in the Kasena-Nakana, the following are recommended for proper actions;

1. The government should post more agricultural extension offices to the district to support in advising and dissemination of appropriate and right information for the farmers, and also the municipal assembly should mobilize resource to support and train both the smallholder rice farmers and the agricultural extension office on the need to adhere to expert advice on climatic change.
2. The financial institution should devise some ways to support the smallholder rice farmers with some form of loans for them to advance on their rice farming by adopting appropriate strategies to help curtailed climatic change in the district.
3. Smallholder rice growers ought to be informed more about the issues of climatic change and its effects on their rice farming. Smallholder rice farmers should incorporate the traditional methods of farming to avoid land degradation which also affect the land management.
4. The weather and metrological service should make it a point to provide timely and accurate information on the rain patterns for the farmers.

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APPENDIX

UNIVERSITY FOR DEVELOPMENT STUDIES, TAMALE

Dear respondents; my name is **Raymond**, graduate student at University for Development Studies. Currently, I am conducting master's thesis entitled: "***Smallholder Rice Farmers Strategies for Sustainable Adaptation to Climate***

Change in the Kasena- Nankana East Municipality". The purpose of the study is to assess the effectiveness of small holder rice farmer's strategies in building climate resilience for sustainable adaptation in the Kasena- Nankana East Municipality in the Upper East Region of Ghana. To this effect, this semi-structured questionnaire is designed to collect pertinent information relating to the topic. The quality of this research is very much dependent up on the data you may provide. Indeed, the researcher would like to assure you that the data collected will be used only for academic purpose and will be kept confidential. Thank You in advance!

Raymond

Instructions:

□□Please put a tick mark corresponding to your choice

□□No need to write your name

Section A: Personal Information

Please provide the following information about your personal information by checking the appropriate box.

1. Respondent 's age in year 18-25 [ ] 26-30 [ ] 31-40 [ ] 41-50 [ ] Above 51 [ ]

2. Sex: Male [ ] Female [ ]

3. Marital status. 1. Married [ ] 2.Single [ ] 3. Widowed 4. Divorced/Separated

4. What is your main source of income?

1. Rice farming [ ] 2. Livestock farming [ ] 3. Hunting [ ] 4. Trading and commerce [ ] 5.

Civil Servant [ ] 6. Others, specify……

5. Educational Level: No formal education [ ] Certificate [ ] HND/Diploma Holder [ ] BA/BSC

holder [ ] Masters [ ]

6. Do you have access to extension services or technical advice in your area?

1= Yes [ ] 2= No [ ]

7. Do you have access to finance to run your farming activities? 1= Yes [ ] 2= No [ ].

8. What is your average annual household income? (Tick the appropriate answer)

A. Less than 500,000 [ ]

B. Between 500,000 and 1,000,000 [ ]

C. Between 1,000,000 and 3,000,000 [ ]

D. Between 3,000,000 and 5,000,000 [ ]

E. Between 5,000,000 and 7,000,000 [ ]

F. More than 7,000,000 [ ]

9. Do you own the following? (Tick the appropriate answer)

House(s) A. Yes [ ] B. No [ ]

Land A. Yes [ ] B. No [ ]

Section B: To assesses the main impacts of climate change on smallholder rice farmers in the Kasena- Nankana East District in the Upper East Region of Ghana

10. Are you aware that climate change is taking place? 1= Yes [ ] 2= No [ ].

11. The threat of climate change is more on 1. Health [ ] 2. Agriculture Production [ ]

3. Both health and agriculture production [ ] 4. Fuel wood availability [ ] 5. Biodiversity quality and sustainability [ ].

12. Kindly use the option below to answer the following questions according to your level of agreement or disagreement.for each of the statements below, please circle

the number that best describes how much you agree or disagree with the statement:

strongly disagree (SDA), = 5 disagree (DA), = 4

Neutral (N), = 3 Agree (A) = 2 and Strongly Agree (SA) = 1

		SA	A	N	DA	SDA
	Climate change has a very big impact on paddy production					
	Variations in climate has caused an increase in incidences of floods during the raining season					
	Shifts in rainfall seasonality have caused crop failures and low yield					
	Some crop varieties have no longer been productive due to persisted droughts in the area					
	Climate change has led to crop infestation and diseases due to droughts					
	Climate change has led to rural-urban migration					
	Excessive rainfall contributes to destruction of buildings and infrastructures					
	Flood does not contribute to soil erosion					
	Water becomes scarce and dried due to droughts and low rainfall					
	Dry spell of crops is the results of drought					
	Climate variability has impact on rainfed production					
	Decrease in rainfall reduce water stored in bands					
	Climate change has led to the deforestation					
	The cost of food crops are increasing because of climate change.					

Section C: To identify the adaptation strategies of smallholder rice farmers to climate change in the Kasena- Nankana East District in the Upper East Region of Ghana

13. Use the table below for this question. Which of the following adaptation strategies did you adopt to cope with climate related hazards? For each strategy adopted, state whether it was able to help reduce hazards or not. If strategy was not adopted, can you explain why?

Give reasons why strategy was not adopted **(Use codes 1. lack of finance; 2. lack of Knowledge; 3. Did not believe in strategy 4. Did not have a permanent land. 5 Other**

Adaptation Strategy	Strategy adopted?		Did strategy help to reduce the impacts of hazards	Give reasons why strategy was not adopted
	Yes	No		
Intensification of irrigation				
Change from crop to livestock				
Change from livestock to crops				
Reduce number of livestock				
Use Water-harvesting techniques				
Plant different crops				
Change planting date				
Adapt chemical fertilizer application				
Application of compost/manure				
Adapt tillage practices				
Cover cropping/mulching				
Agroforestry				
Land rotation				
Buy insurance				
Seasonal migration to urban areas				
Seasonal migration to other rural areas				
Permanent migration by some household members				
Handicrafts				
Find off-farm job				
Reduce expenses by changing consumption (type and number of meals				
Hunting				
Charcoal production				
Small scale mining				

Objectives of Households

14. Why have you adopted the above strategies or what do you intend to achieve?

It is a multiple respond so you can select more than one if you have more than one objective.

1. Food security [ ] 2. Increased family Income [ ] 3. Increased crop output [ ] 4. Others, specify……

15. What has been the state of your family food security over the last 30 years

1. Increasing [ ] 2. Decreasing [ ] 3. Has remained the same [ ].

16. What about the output of your major crops?

1. Increasing [ ] 2. Decreasing [ ] 3. Has remained the same [ ]

17. What would you say about your family income over the last 30 years?

1. Has been Increasing [ ] 2. Has been decreasing [ ] 3. Has remained the same [ ].

18. Do you get inputs for your farm? 1. Yes [ ] 2. No [ ]

19. Where do you get your inputs to buy?

1. In my community [ ] 2. At the district centre[ ] 3. In the regional capital [ ]

20. If you get inputs for your farm, are you able to pay for the cost of the inputs?

1. Yes [ ] 2. No [ ]

Institutional Support

21. Do you have Farmer based organization and community based organization in your community? 1. Yes [ ] 2. No [ ]

22. What is/are the name(s) of this/ these organization(s)...……

23. Are you a member of any of them? 1. Yes [ ] 2. No [ ]

24. What kind of support do you get from this/these organization (s)? It is a multiple response question so you can choose more than one response.

1. Financial support 2. Technical support 3. Inputs supply

Section D: To outline the factors accounting for the success and failure of smallholder rice farmer adaptation in the Kasena- Nankana East District in the Upper East Region of Ghana

25. For each of the statements below, please circle the number that best describes how much you agree or disagree with the statement: strongly disagree (SDA), = 5 disagree (DA), = 4 Neutral (N), = 3 Agree (A) = 2 and Strongly Agree (SA) = 1

		SA	A	N	DA	SDA
	Scientific Information about					
	The causes of climate change					
	Weather and meteorological information (e.g. early warnings)					
	Knowledge about soils and how to improve its fertility					
	Predictions in relation to climate change					
	Agricultural Practices, Knowledge and information					
	Better management of agricultural land for sustainable production					
	Proper use of agricultural inputs					
	Climate change and sustainable farming systems					
	Crop varieties tolerant to harsh climatic conditions					
	Intensification of agriculture					
	Adaptation knowledge and technologies for farmers					
	Economic/Commercial Information about					
	Crops commanding good prices in the market					
	Financial opportunities arising from climate change					
	Credits availability and access					
	Incentives availability and access, e.g. inputs					
	Social Information about					
	Local and traditional adaptation knowledge and technologies					
	Culture and sustainable adaptation					
	Blending scientific and local knowledge to support adaptation					
	Legal Information about					
	Land tenure issues					
	Land rights					
	Contracts issues					
	Strategic and Policy information about					
	Government efforts to address the challenges of climate change and variability					
	Alternative livelihoods options to reduce severity of climate change impacts					
	Crop insurance					
	Sustainable climate change adaptation policies and strategies					

26. What do you think you can do in the future to be able to adapt to the changes if they persist?

for each of the statements below, please circle the number that best describes how much you agree or disagree with the statement: strongly disagree (SDA), = 5 disagree (DA), = 4 Neutral (N), = 3 Agree (A) = 2 and Strongly Agree (SA) = 1

		SA	A	N	DA	SDA
	Abandon agriculture at the expense of other economic activities					
	Abandon the current farms and move to wetter areas like river banks					
	Emigrate from your village to other areas with better conditions					
	Continue changing agricultural practices in line with the changes in the local climate					
	Ask for food aid					
	Ask for government support like introduction of new and modern adaptation options					
	Seek to obtain more information, knowledge and education on adaptation to climate change					
	Promote irrigation using underground water					
	Promote conservation practices further					
	Enhance your capacity through education and training					
	Improve institutional capacity and efficiency					
	Improve access to credits					
	Enhance awareness and information provision					
	More research and dissemination of research results to farmers					
	Respect and disseminate local experience and knowledge					
	Develop and introduce new crop varieties to increase the tolerance and suitability of plants to temperature, moisture and other relevant climatic conditions					
	Introduce crop insurance					
	Support to adopt improved crop varieties, modern irrigation and agricultural related better technologies					
	Provide the needed infrastructure in the rural areas, post-harvest support and support for agro industries					
	Develop and/or strengthen early warning systems that provide daily weather predictions and seasonal forecasts					
	Strengthen timely dissemination of weather forecasting information to farmers					
	Encourage participation of private sector in agriculture investment;					
	Undertake research to quantify the magnitude of climate change for each agro-ecological zone and advise accordingly					
	Develop and strengthen water management innovations to address the risk of moisture deficiencies and increasing frequency of droughts					
	Introduce and/or improve subsidy and incentives provisions to support farmers to adapt					

	Develop and implement policies and programs to influence farm-level land and water resource use and management practices					
	Support diversification of agriculture as an economic activity					

Interview and Focus Group Discussion Guide for Stakeholders

UNIVERSITY FOR DEVELOPMENT STUDIES, TAMALE

Dear Respondent,

My name is Raymond a student of University for Development Studies, pursuing MPhil- in Development Studies. I am conducting a research entitled "**Smallholder Rice Farmers Strategies for Sustainable Adaptation to Climate Change in the Kasena- Nankana East Municipality**" as part of my master degree studies. You have been selected as one of the respondents to this survey questionnaire.

This survey will only take about 10-20 minutes of your valuable time. I wish to assure you that, your response will remain confidential and would only be used for the purposes of this study. Only the final results will be made public through the academic report, counting on your cooperation.

Thank you very much.

Section A: Personal Information

1. How old are you?

2. What is your marital status?

3. What is your highest qualification?

4. What work do you do?

5. Which religion do you belong to?

6. How do you explain the state of climate change in the district?

7. In your opinion what are the effects of climatic change on your rice farm?

8. How do you feel about the effects of the changes in the whether parting on your rice
farm?

9. What are some of the strategies you adopt as a rice farmer to reduce the impact of the climatic change?

10. How do you apply those strategies adopted?

11. What account for the failure/success of the strategies adopted by farmers?