

UNIVERSITY OF GHANA

DEPARTMENT OF GEOGRAPHY AND RESOURCE DEVELOPMENT

**ASSESSING THE EFFECTIVENESS OF AGRICULTURAL HOUSEHOLDS'
STRATEGIES FOR SUSTAINABLE ADAPTATION TO CLIMATE CHANGE
IN THE SISSALA EAST DISTRICT**



**THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN
PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF
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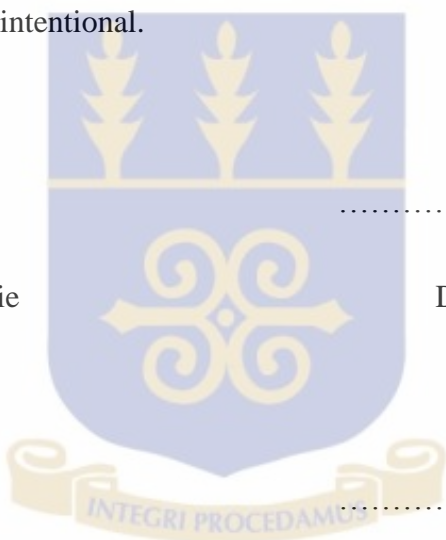
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DECLARATION

I, Buduan Yakubu Dimmie, declare that except for references to works which have been duly cited and acknowledged, this thesis is the result of my own original research carried out under the guidance of my supervisors, Professor Joseph Awetori Yaro and Doctor Joseph Teye of the Department of Geography and Resource Development, University of Ghana, Legon. I also certify that this thesis has not been submitted in part or whole for the award of any degree elsewhere.

The names of individuals cited in this thesis are fictional. Any resemblance thereof to any existing name is unintentional.

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Dr. Joseph Teye (Co-Supervisor) Date

.....

DEDICATION

To Sister Dora Baidoo of the Department of Geography and Resource Development, my wife, Salifu Nafisatu Priscilla, my daughter, Dimmie .B. Noreen and all my teachers.



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I would like to offer my heartfelt thanks and appreciation to the following people who gave their help and time to make this study possible. I am very grateful to my supervisors, Professor Joseph Awetori Yaro and Doctor Joseph Teye for their invaluable advice and encouragement throughout this study and for their patience in correcting and commenting on the various drafts.

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I cannot forget the very important contributions that Gervase Kuuwaabong, a PhD Student in the Department of Geography and Resource Development made to this work.

I extend my gratitude to all my lecturers, the farmers, MOFA officials, my colleague MPhil students of the above mentioned department, and other important people I spent the period with and without whom many things of relevance to this study may never have been revealed.

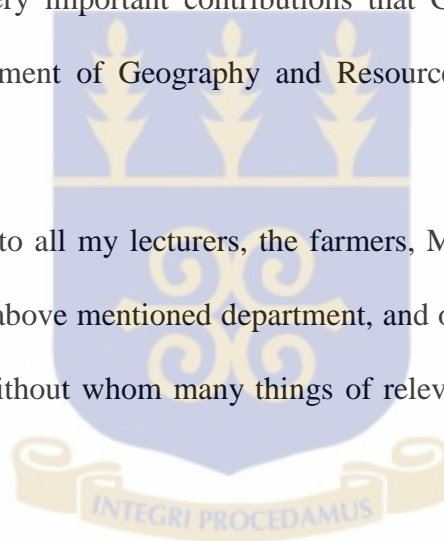


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ABSTRACT

Effective adaptation to climate change provides the means through which agricultural households reduce the vulnerability of their livelihood to the impacts of climatic hazards. Effective strategies reduce the adverse impacts of fluctuations and changes in climatic variables on households' livelihood leading to the achievement of their livelihood targets while maintaining the quality of the environment. Agricultural households in Sissala area have devised their own mechanisms for effectively adapting their livelihood activities to climate change which have been outlined by various studies in the area. However, there have been debates about whether some of these mechanisms are effective in reducing the impacts of climatic hazards especially drought and floods and meeting the food security and increased crop and income targets of households. This study sets out to assess the effectiveness of households' strategies in reducing impacts and meeting their targets using multi-methods. Focus group discussions, individual interviews and questionnaires were used in this study. SPSS version 16.0 and STATA Software for Binary regression analysis were used for analysis.

The main climatic impacts and threats identified in the area include: droughts, floods, rainstorm and the incidence of pests and diseases which destroy crops, public infrastructure, private properties and loss of farmlands. Farmers have knowledge of climate change through local experience and awareness creation via radio and mobile phones. The main adaptation strategies of farmers include: crop diversification, the use of weedicides/pesticides and chemical fertilizer, changing consumption, land rotation, tillage practices, changing planting dates, irrigation, harvesting of rain water, and migration to urban areas, the use of compost/manure, and cultivation of cover crops.

Due to the need to pay for social services, farming households' objectives have shifted from achieving food security to enhancing family income. Location factors and characteristics of households influence the adaptive capacities of farmers. Also the success of adaptation strategies adopted depend on wealth of the farmer, gender, experience and the ecological conditions of the community where farms are located. The use of weedicides, tillage practices and chemical fertilizer were found to be more effective for non-poor and rich farmers and experienced farmers than poor and inexperienced farmers and also more effective among farmers in Wellembelle than their counterparts in Sakai. Changing consumption and the cultivation of cover crops was common among poor and older farmers.

It was however revealed that, if care is not taken, the unintended effects of some of these strategies could lead to maladaptation in the long-run. The use and misuse of weedicides has taken a toll on livestock population and exacerbating inequalities between livestock and crop producers. Again, the use of wood for fencing gardens in irrigation areas on annual basis could lead to deforestation in the area. Also, environmentally friendly strategies such as the use of compost/manure are poorly patronized. The effectiveness of land rotation is waning due to social change processes.

CHAPTER ONE: GENERAL INTRODUCTION

1.0 Background of the Study

Global climate change is real. Evidence available shows that some degree of climate change is inevitable (UNFCCC, 2010). Temperatures are rising and seasons continue to change unpredictably and at a faster rate visiting disturbing impacts on humankind (IPCC, 2013). The number of hot days and intensity of heat waves is increasing (IPCC, 2013). We now have more unpredictable weather patterns than in the past (Tompkins & Adger, 2003; IPCC, 2013). Available temperature data indicates a warming climate in Ghana with the drier Northern area warming more rapidly than southern Ghana. Temperature has increased by 1°C over the last 30 years, and it is projected to go up by 1.7°C to 2.04°C by the year 2030. Rainfall has decreased by 20-30% within the same period. Ghana expects more extreme weather events (EPA, 2011; USAID, 2011).

The current and future climate change impact is a concern. Everybody will be affected somehow by climate change impacts, but developing countries will be the worst affected even though, they may have contributed little to the problem (Stern Review, 2007). In developing countries, the risks associated with climate change pose serious challenges to societies which are dependent on rain-fed agriculture for their livelihood.

African countries are among the most vulnerable globally to the effects of climate change because of their dependence on rain-fed agriculture and widespread poverty which makes them unable to withstand climate stress (Stern Review, 2007). Additional constraints such as disease burden, debt burden, political instability, and conflict reduce the adaptive capacity and increase the vulnerability of rural populations. Recurrent drought in many countries has demonstrated the effects of climate change on food resources (USAID, 2011). This consequently affects food security (Molua, 2002; Yaro, 2013; Turnbull et al 2013). Within these countries the poor stand to be burdened more

with the negative impacts of climate change. This is because majority of the poor depend on climate-sensitive resources such as fields, forests, fisheries and other natural resources (World Resources Institute). Climate change impacts weigh heavily on these resources reducing the prospects for many poor communities to escape from poverty (Orlove et al, 2010a). The interaction between climatic hazards and the vulnerable conditions that exist in developing countries will lead to disasters (IPCC SREX, 2013). About 75-250 million people are projected to be exposed to water stress by 2020, yield from rain fed agriculture will be reduced by up to 50% in Africa, arid and semi-arid land area will also increase by between 5% and 8% by 2080 which will require 5% to 10% of the GDP of affected countries to deal with the situation by the end of 21st century (IPCC FAR, 2013).

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). For example article 10 of Kyoto protocol and article 4.1b of the UNFCCC consign parties to these treaties to scale up adaptation to reduce the negative impacts of climate change. Adaptation is defined as any action that seeks to reduce the negative effects or to capitalize on the positive effects 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 impacts of climate change especially droughts and floods have devised their own mechanisms such as livelihood diversification, crop diversification, cultivation of multiple crops in the same growing season, migration, irrigation, the application of agrochemicals, hunting, charcoal production, small scale mining etc.(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 such as food security, increased income, increased well-being and reduce vulnerability to climate change impacts (DFID, 1999)

It has however been argued that, even though adaptation is essential to reducing vulnerability and building resilience to climatic impacts, not every adaptation strategy to climate change is a good one. Some adaptation measures are ‘maladaptive’ and ineffective in reducing impacts of hazards (Barnett and O’Neil, 2010; Below et al, 2010; Eriksen and Lind, 2009; Carr, 2008). Adaptation strategies that work for one group or from a particular view point may at the same time undermine the livelihoods or resource access of another group (Eriksen and O’Brien, 2007). Adaptation must enhance the adaptive capacity of the poor and reduce the risk to present livelihood sources (Katrina Brown 2011; Ulstrup et al, 2008; Eriksen and O’Brien, 2007). Effective strategies reduce the impacts of climatic hazards, reduce future risk to livelihood activities and are also able to meet the objectives of the adaptors (Jones, 2001).

This work assesses the effectiveness of agricultural household’s strategies for sustainable adaptation to climate change in the Sissala east district of northern Ghana. The intention is to contribute to the policy debate as to how to make adaptation effective in northern Ghana. Following the findings of this work, some recommendations have been made.

1.1 Problem Statement

The numerous debates by scholars about what constitute effective and sustainable adaptation means that adaptation strategies to climate change need to be closely examined within their local and global context taken into consideration their effects on livelihoods and the environment (Adger et al 2005; Katrina Brown 2011).

The recognition of changes in 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 knowledge 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 change including 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 adaptation to climate change in Northern Ghana. Their studies identified significant impacts of climate change in the agricultural sector where erratic rainfall, 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 cope and adapt to the impacts. Similar studies by other researchers revealed differentiated strategies that are used by farmers to reduce the vulnerability of their livelihoods to climate change and build their resilience. These strategies include 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).

However, most of the studies on climate change adaptation in northern Ghana have focused mainly on identifying the strategies that are used by agricultural households to deal with climate related hazards. There is therefore the need to find out whether the identified strategies are actually effective enough in reducing the impacts of climatic hazards and reducing the risk to present livelihoods. Adger et al (2005) argued that adaptation strategies are effective if they are able to meet the objectives of the adaptors while reducing the impacts of hazards and risks to livelihoods. This study goes beyond just identifying farmer adaptation strategies to look at how effective these adaptation strategies are in meeting the expectations of farmers and reducing risk to climatic hazards. This is because, despite the adoption of such strategies, there are still many farmers in northern Ghana who barely produce enough to feed their families let alone producing for sale. Farmers continue to experience poor crop yields and losses in farm income (Laube et al, 2012; Armah et al, 2013).

The need therefore arises to investigate how effective households' adaptation strategies are in meeting their livelihood objectives and mitigating impacts of hazards in the wake of these challenges.

The critical question this study seeks to answer is, 'to what extent is farmer adaptation effective in meeting their aims and aspirations in their quest to build the resilience of their farming systems to climate change? And what are the environmental implications of their diversified livelihood practices such as hunting, artisanal mining and charcoal production? It has been argued that, adaptation should lead to the achievement of farmers' food, income and livelihood security objectives in the face of changing

climatic and socioeconomic conditions, including climate variability, extreme weather conditions such as droughts and floods, and volatile short-term changes in local and large-scale markets (Kandlinkar & Risbey, 2000). But is this the case among farmers in the Sissala east district and for that matter northern Ghana?

The focus of this research work is to find answers to the important questions raised above. It will explore for agricultural household's livelihood objectives and examine the extent to which farmer adaptation outcomes meet their livelihood objectives. It also finds out whether their strategies are able to reduce the impacts of climatic hazards and build their resilience to climate change. The research work does not end there but goes ahead to look at the factors which account for the failure and success of agricultural household's adaptation and come out with some policy recommendations as to how to make farmers' adaptation effective for sustainable adaptation.

1.2 Research Questions

In order to analyze the issues and achieve the stated objectives, the study is guided by the following research questions.

1. In the wake of climate change and other environmental stresses in northern Ghana, what adaptation strategies do agricultural households put in place in order to build their resilience and reduce their vulnerability to climate change impacts?
2. Why do agricultural households employ these strategies?
3. Are their strategies able to reduce climate risks?
4. What are the major factors which account for the success or failure of farmer adaptation in the district?

5. How can agricultural household's adaptation to climate change be made effective for sustainable adaptation to climate change in the Sissala area?

1.3 Objectives of the Study

The broad objective of the study is to assess the effectiveness of agricultural households' strategies in building climate resilience for sustainable adaptation in the Sissala East District. The specific objectives of the research are:

1. To assess the main impacts of climate change in the district.
2. To identify the adaptation strategies of agricultural households to climate change.
3. To detail the livelihood objectives of households and to examine whether their strategies lead to the achievement of their end goals.
4. To outline the factors which account for the success and failure of farmer adaptation.

1.4 Scope of the Study

The study looks at the effectiveness of agricultural household adaptation strategies for sustainable adaptation to climate change in the Sissala east district of the upper west region. The study identifies the adaptation strategies of households in the Sissala east district and tries to look at the goals of farmers in adopting such strategies and how effective these strategies are in meeting the aims and aspirations of households. It then eventually uncovers the various ways and means that effective adaptation can be achieved in the Sissala east district. The Sissala east is chosen because the district is located in one of the poorest region of Ghana and majority of the people live in poverty and depend on natural resources especially agriculture (SEDA, 2014). For example, 76% of the households in the Sissala East District depend on small- scale agriculture for survival (Ministry of Food and Agriculture, 2010). This area is also located in the

warmest and the driest part of Ghana (USAID, 2011, EPA, 2011) which makes the people in the area more vulnerable to climate change impacts than their southern counterparts. The district is also remote with a poorly-equipped meteorological service in the district and the fact that majority of farmers are illiterates makes it difficult to communicate any early warning systems relating to the weather parameters to farmers (MOFA, 2010). Farmers therefore rely mainly on their indigenous knowledge in predicting the weather. Two communities were studied. These are Sakai and Wellembelle. These communities have some difference in terms of their adaption practices. Wellembelle has big irrigation dam that the farmers use for irrigation to produce vegetables in the dry season. It is also located closed to an important marketing centre in the district. Sakai on the other hand does have a seasonal dugout which dries up completely in the main dry season. It will therefore be interesting to find out how these differences inform the adaptation strategies that farmers adopt in these communities, the objectives of the households and how effective these strategies are in meeting their objectives.

1.5 Significance of the Study

This research work will contribute immensely to the search for effective adaptation strategies that will enhance the ability of local people to withstand climate change impacts. It will also contribute to policy decisions which are responsive to the challenges of climate change in Northern Ghana. The work will iron out the determinants of effective adaptation in the area based on an assessment of the individual strategies that are employed by the local people. In particular, the study 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. Last but not least, it will add to existing body of knowledge in the area of climate change adaptation in Northern Ghana

CHAPTER TWO: LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2. 1 Introduction

This section reviews previous literature on four key themes as: concept of adaptation, concept of sustainable adaptation, the concept of effective adaptation, and the adaptation strategies of agricultural households. The reviews will provide a background for adequate investigation, description and analysis of adaptation strategies of agricultural households in the Sissala area to ascertain their effectiveness for sustainable adaptation to climate change. It also describes the conceptual framework for the work.

2.1.1 The concept of adaptation

IPCC (2001) defined adaptation to climate change as adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm so as to take advantage of opportunities. Adaptation could be autonomous or planned. In autonomous adaptation majority of adaptation measures occur impulsively depending on the individual needs and capacities of a given sector of society. Planned adaptation on the other hand results from decisions that have been made based on the awareness that conditions have changed or are about to change. Adaptation could also be proactive where adaptation measures are taken before the impacts of climate change are observed or reactive where adaptation measures are put in place after impacts of climate change have been observed (UNFCCC, 2006).

Nelson et al (2007) defined adaptation as a process of deliberate change in anticipation of or in reaction to external stimuli and stress. The currently observed environmental changes pose a threat to many societies and livelihoods making it important to adapt to

the changing situations and to transform the basic social organization, resource use and settlements (Nelson et al 2007)

According to Car (2008) adaptation is not a change in a single behavior, but a change in a collection of beliefs and practices related to risk and its management that take shape under locally specific conditions of uncertainty. In a setting where individuals experience continuing challenges to their well-being due to open-ended changes in economic and environmental conditions, these beliefs and practices become integral parts of daily decision-making concerning their life and livelihood, making adaptation and livelihood indivisible. This explanation of adaptation marries adaptation and livelihood such that adaptation implies adjustments in livelihood to the changing socio-economic and environmental conditions within the cultural setting and local conditions of the people concerned (Car, 2008).

Mabe et al (2012) defined adaptation to climate change in agriculture production as the adjustment of farming activities or methods in line with changing climatic conditions in order to reduce the potential adverse impacts on food production. To them farmers can achieve the objectives of food security, high income and secured livelihood if they are able to adapt effectively to climate change (Mabe et al, 2012).

2.1.2 The Concept of Sustainable Adaptation

The concept of sustainable adaptation has taken the centre stage in the climate change discourse in both developed and developing countries. Katrina Brown (2011) argued that sustainable adaptation share some similarities with sustainable development hence policy responses and adaptation strategies must deal with climate related issues and at the same time address poverty issues and general development concerns. The concept of sustainable adaptation surfaced as a subset of a bigger debate which seeks to draw

the link between climate change adaptation and sustainable development. Sustainable adaptation measures should be geared towards reducing vulnerability and building the resilience of affected populations through risk reduction activities and poverty alleviation. (Katrina Brown, 2011 also citing Ulstrup et al, 2008).

Sustainable adaptation does not suggest that a specific technology or practice can be identified that will be viable in all places or at all times. 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 possibility that feedbacks and linkages can influence both social justice and environmental integrity over both space and time raises questions about the sustainability of many adaptation responses. Adaptation thus focuses on the need for responses to recognize the interactions between local and global processes, which can create both positive and negative feedbacks' (Eriksen et al, 2010)

In a similar vein, Eriksen and O'Brien (2007) see sustainable adaptation as the intersection between strategies which aim at alleviating poverty on one hand and strategies that aim at reducing the vulnerability of people affected by climate change on the other hand. They argued that, for adaptation to be sustainable, it must address three fundamental issues which are: Enhancing the adaptive capacity of the poor, tackling the factors which consign the poor to vulnerability and reducing the risk to present livelihood. Every sustainable adaptation mechanism must touch on at least one of the above fundamental issues without adversely affecting another. The above views imply that sustainable adaptation must go beyond the normal adaptation mechanisms i.e. it must take into account alleviating poverty, reducing vulnerability and at the same time laying the foundation for longer term adaptation (Eriksen and O'Brien, 2007).

Again, other scholars view sustainable adaptation as a unit of a wide spectrum of mechanisms which integrate the objectives of climate change adaptation and poverty alleviation. Connections exist among ideas towards pro-poor climate change adaptation, community-based adaptation and climate change adaptation which help to alleviate poverty (Tanner and Mitchell, 2008; Ensor and Berger, 2009; Adger et al, 2003)

Siri Eriksen and Katrina Brown (2011) argued that, even though adaptation is a necessary condition in responding to the challenges of climate change little is known about the longer term implications of adaptation itself. Presently we are not certain about whether our adaptation strategies are sustainable in terms of their environmental and social impacts and in improving our wellbeing and reducing poverty.

Barnett and O'Neill (2010) noted that, many responses to climate change are not in line with the basic principles of sustainable development. Some hi-tech solutions and policies for climate change adaptation tend to serve the interest of some groups whiles disadvantaging other groups creating social inequities (Barnett and O'Neill, 2010). The type of measures we employ, the policy frameworks use and local household strategies all affect sustainable adaptation.

McCray et al (2007) argued that, since the emergence of the concept of adaptation there have been a number of trial strategies on adaptation across the world. Some of these strategies have aimed at achieving general development objectives particularly poverty reduction while some have focused on building capacity of people to deal with climate risk and climate change impacts. These strategies have been presented in a form of 'continuum' ranging from a focus on vulnerability to focus on climate impacts. An examination of current adaptation strategies indicate that just a few of such strategies

are in tendon with sustainable adaptation as explained earlier in this work. In fact some of these strategies show that many responses to climate change deviate from sustainable adaptation and have adverse impacts on the environment and the poor people. (McCray et al, 2007; Ensor and Berger, 2009; Katrina Brown, 2011)

Carr (2008) uncovered that, adaptation strengthens and entrenches gender roles in Ghana. Men tend to cultivate crops for sale while the women tend to grow crops for household consumption. Such an approach distributes risks between two different modes of production, where subsistence production can preserve life and well-being in times of market adversity, and market production can provide income to purchase necessities in times of shortage created by environmental shocks. He again noted that the adaptation strategies that were adopted by households were closely linked to the income of the male head of household (Carr, 2008).

In another work by Eriksen and Lind (2009) adaptation was said to have the chance of strengthening or entrenching existing power structures and inequalities and worsening conflicts in Kenya (Eriksen and 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 in Africa brings new risks as a result of complicated marketing. It also has the potential of destroying the ecosystem thereby threatening the sustainability of the environment. Diversifying in to 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 and O'Neill (2010) outlined criteria which could be employed in examining adaptation decisions for their potential adverse impacts. They documented that actions

are maladaptive if they (i) increase emission of greenhouse gases (ii) disproportionately burden the most vulnerable (iii) have high opportunity costs (iv) reduce incentives to adapt or (v) create path dependency. They again stipulated that, an important problem which faces adaptation is the time difference between changes in climate and the changes in institutions.

Adger et al (2005) documented that adaptation to climate change involves decision making among actors. 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 involve basically making policies and regulations which are aimed at building the adaptive capacities of the people and others which are targeted at implementing the policies and the regulations. However the implementation of the policies and regulatory frameworks for adaptation are normally constrained by institutional setups within societies (Adger et al, 2005). The building of the adaptive capacity of the people is contingent on the effective communication of climate change information, raising awareness of the potential impacts of climate change, maintaining well-being, protecting property or land, enhancing economic growth and creating of new frontiers of economic opportunity (Adger et al, 2005). In implementing adaptation decisions, we should seek to reduce the cumulative impacts of climate change, ensure that adaptive measures taken by one organization do not adversely impact upon others, avoid anticipated adverse impact of climate change, and ensure that the distributional of adaptation are minimized(Adger et al, 2005).

2.1.3 Concept of Successful/effective adaptation.

Adaptation actions for Africa must focus on building resilience to climate change at the individual, community, local and central government levels if they are to be effective

(IPCC, 2007). This research work focuses on the individual and community levels to ascertain the effectiveness of individual and community strategies in building resilience for sustainable adaptation.

Some adaptation strategies do not take into consideration the dynamic risks associated with climate change, while others incorporate specific climate information into decisions (Reilly and Schimmelpfennig, 2000).

Adger et al (2005) argued for the following criteria: The effectiveness in adaptation, the efficiency in adaptation, Equity and legitimacy in adaptation, and evaluating success. They explained effectiveness to mean the ability of an adaptation strategy to achieve its intended objectives. It can either be measured in terms of reducing impacts and exposure to them or in terms of reducing risk and avoiding danger and promoting security (Jones, 2001). However, an adaptation strategy may meet its intended objectives but may affect other areas or groups negatively or may have long term adverse consequences. Two key indicators of the effectiveness of an adaptation strategy are therefore robustness to uncertainty and flexibility or ability to change in response to changed situations (Adger et al, 2005). Efficiency in adaptation is explained to mean that adaptation to climate change entails both costs and benefits. These costs and benefits may be private or public. The distribution of such costs and benefits as well as the timing of adaptation actions has implications for the success of adaptation. Equity and legitimacy is measured in terms of who wins and who loses from adaptation decisions as well as who decides on the adaptation to take. It looks at the existing power structures and institutional arrangements in making adaptation decisions. Successful adaptation balances effectiveness, efficiency and equity through decision-making structures (Adger et al, 2005).

The effectiveness of strategies for adapting to climate change depends on the social acceptability of such strategies, the institutional constraints on adaptation, and the place of adaptation in the socio-economic development process. The effectiveness of adaptation is also dependent on globalization and other trends (O'Brien and 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 the science of climate change better than small-scale farmers who only rely on the local explanation of climate change. Commercial farmers also face a higher production risk compared with small scale farmers due to the fact that they make more investment in farming than the small scale farmers. Local knowledge of climate change is therefore important for effective adaptation among the small-scale farmers (Yaro, 2013). In a similar vein Gyampoh et al, 2007 noted that traditional knowledge is key in adapting effectively to climate change but this is often sidelined in national policy making.

Financial barriers, institutional barriers and lack of information on climate change characteristics constraints effective adaptation to climate change adaptation in northeastern Ghana (Antwi-Agyei et al, 2013).

2.1.4 Adaptation strategies of small-scale farmers.

Deressa (2008) documented the common adaptation strategies to climate change among farmers in the Nile Basin of Ethiopia to include: crop diversification, irrigation, changing planting dates, using drought-tolerant varieties of crops, using early maturing

varieties of crops, Soil conservation, tree planting, early and late planting (Deressa, 2008).

In a similar study, Mabe et al (2012) documented that adaptive capacities of rice farmers influence their choice of adaptation strategies to climate change which in turn affects farm output. The following adaptation strategies are used by rice farmers in northern region: Use of chemical/organic fertilizers, mulching, farming on fallowed land, formal irrigation, farming near water bodies, early maturing rice varieties, drought-tolerant rice varieties, mixed cropping, mono-cropping, construction of fire belts, changing planting dates, use of dugouts, building of embankments, integration of trees in rice farms and crop rotation (Mabe et al, 2012).

Also, Armah et al (2013) categorize the following four indigenous adaptation strategies for managing agro biodiversity in northern Ghana : Land and Crop management practices(Raising mounds and ridges, mulching, fallowing of land, use of crop residues and manure application, prevention of bushfires, mixed cropping or farming, Crop rotation, Crop diversification, timing of planting, regular weeding or pest control), Livestock related activities, Engagement in off-farm income generation activities(charcoal production, pito brewing, petty trading, shea butter and dawadawa processing), Production and Marketing strategies.

Gyampoh et al (2008) discovered that even though 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 strategies and challenges include: water rationing, rainwater harvesting, creating awareness on the effects of deforestation along water bodies, sensitizing communities to prevent bush fires, community –based management of forest,

imposition of fines, traditional taboo/forbidden days. The use of fines and taboos is however challenged by modernization and the infiltration of communities by settler farmers and different people who do not have absolute allegiance to traditional authorities (Gyampoh et al, 2008). Indigenous knowledge of agriculture and water management acquired over many years of practice is relied on such as cultivating drought-tolerant crops e.g. cassava, cultivation of vegetables in moist river plains (not sustainable), planting of trees on farms to provide shade (not appealing to farmers due to activities of timber operators) (Gyampoh et al, 2008).

2.2 Conceptual Framework

This research work adopts the DFID Sustainable livelihoods framework approach. The livelihood framework looks at the complex nature of poor people's livelihood. It seeks to understand the various dimensions of a person's livelihood, the strategies and objectives pursued, and associated opportunities and constraints. The livelihood strategies and activities of poor people are often complex and diverse. For rural people agriculture and other natural resource-based activities may play an important role, but rural people also diversify into other activities some of which are linked to agriculture and the natural resources sector and others are not (Ashley and Carney, 1999).

Strategies may include subsistence production or production for the market, participation in labour markets or labouring in the home. Poor urban people also depend on multiple diverse livelihood activities including different employment and self employment activities (Ashley and Carney, 1999; Vogel et al, 2007).

Strategies in this work are examined from the perspective of the household as a unified decision-making unit pursuing a joint strategy with common goals. Poor people usually employ a mix of different strategies especially when resources are to some extent

pooled. A relatively unified household will obviously be able to employ a wider range of strategies than an individual acting alone. This framework explains that individuals or households are vulnerable to shocks, seasonality/sensitivity and trends. These shocks include climate-related stresses such as droughts, floods, pests and disease outbreaks and even general economic meltdowns (Ashley and Carney, 1999; Yaro, 2013). Seasonality here is used to refer to the fact that many rural livelihood strategies especially in agriculture result in seasonal fluctuations in income. This affects livelihood security and people try to reduce seasonal income fluctuations or their vulnerability to them (Yaro and Hesselberg, 2006).

However with the 5 capital resources or livelihood assets (things from which people derive a flow of income or consumption. They are also things people invest in so as to increase future flow of income or consumption) such as natural resources, financial resources, social resources, physical resources and human resources they can cope and alleviate their vulnerability with the help of government and the private sector to achieve their livelihood outcomes or objectives. social resources refers to the socially constructed rules, organisations or relationships also referred to as institutions which can serve productive ends (Vogel et al, 2007; Yaro, 2013). On the whole, the more assets people have the less vulnerable they are to the various shocks and trends. Shocks can wipe out assets very suddenly if they are not protected and adverse trends can result in their gradual deterioration if livelihoods are able to adapt to change. An individual's lack of access to these 5 capital resources means that he/she is highly vulnerable to environmental and economic shocks. However, the government policies and the institutional arrangements as well as other actors or players in the private sector such as Nongovernmental organizations (Farmer-based organisations and other NGOs) involved in livelihood adaptation to climate change all play key roles in the

effectiveness and sustainability of households adaptation strategies to climate change. In other words the ability of agricultural households to meet their objectives in climate change adaptation is largely determined by their access to these 5 capital resources and partly due to government policies on climate change adaptation and the activities of other private sector players. This intend affect the effectiveness and sustainability of farmer adaptation strategies (Ashley and Carney, 1999).

Their objectives or livelihood outcomes may be divided between the effects on livelihood security and the effects on environmental sustainabiliy. Livelihood strategies and outcomes can have positive or negative effects on livelihood assets. Improved access to livelihood assets and the outcome of greater livelihood security expecially increased income, more stable incomes, improve food security, improved wellbeing, reduced vulnerability and risks are usually important objectives in rural livelihood strategies. Environmental sustainability may or may not be an objective and is treated as an outcome variable rather than as an objective (McGray and Bradley, 2007, Kristina, 2012).

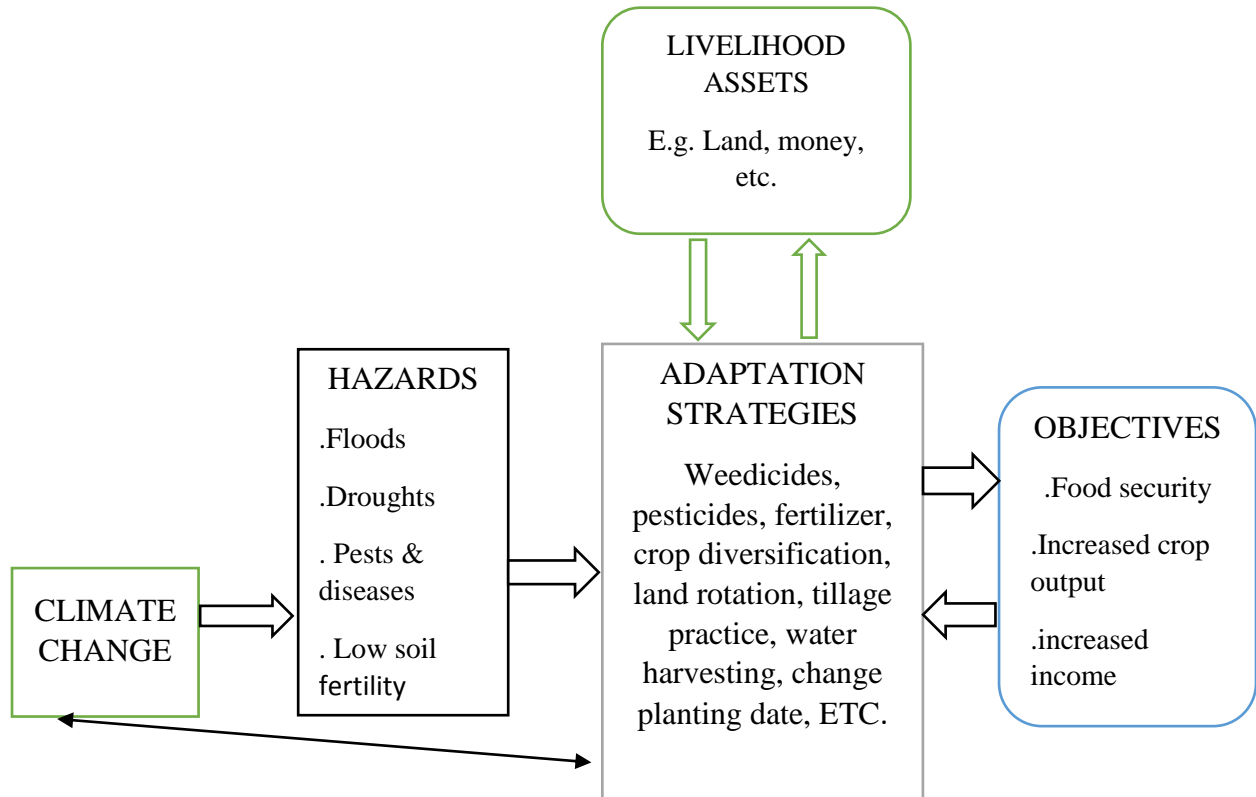
climate change/variability expose the livelihood of the people of Sissala east who are mostly farmers to a lot of risks because of their dependence on rainfed agriculture. This happens in the form of drought spells during farming season, windstorm and floods which destroy crops, farmlands and properties, the incidence of pests and diseases of crops and animals as well as weeds. Households therefore use their own strategies such as livelihood diversification, crop diversification, finding off-farm jobs, migration to other areas in periods of low crop yield and property losses resulting from floods and droughts, hunting, charcoal production, petty trading, livestock production etc. to respond to these climatic threats in other to reduce the risks pose by these climatic

hazards so that they can achieved their livelihood targets of food security, increased household income, stable incomes ,increased crop output and reduce risks.

But how effective these strategies are in meeting the livelihood objectives of households depend on the access to livelihood assets at the disposal of households in the district such as arable land, financial resources, climate information, Agric extension services, irrigation facilities, farm implements and agro-inputs such as chemical fertilizers, weedicides and pesticides. Different households have different levels of access to these livelihood assets which lead to differences in adaptive capacities of households. Vulnerability levels also vary among households due to their differences in adaptive capacities. Depending on what households get from their strategies (livelihood outcomes) they may modify their strategies for better results in the future. The effects of their adaptation strategies may also provide a feedback mechanism to the climate system itself which may be positive or negative.

Below is a diagram which shows the conceptual framework which was adopted and modified from DFID.

Figure 1.1: Conceptual framework for the study



Source: Adopted and modified from DFID (1999)

CHAPTER THREE: THE STUDY AREA AND METHODS OF RESEARCH

3.1 Location of Study Area.

The Sissala East District was established in 2004 by LI.1766 with Tumu as the district capital as part of the decentralization policy of the government of Ghana (GSS, 2014). Geographically, the district is located in the north- eastern part of the Upper West region of Ghana. It falls between Longitudes. 1.300 W and Latitude. 10.000 N and 11.000 N. The district has a total land size of 4,744 sq. km – representing 26% of the total landmass of the region. It shares boundary to the North with Burkina Faso, to the East with Kasen Nankana and Builsa Districts, to the South East with West Mamprusi District, to South West with Wa East and Nadowli Districts and to the West by Sissala West District (NRGP, 2012; GSS, 2014). The location of the district is both an asset and a liability depending on how one analysis it. As an asset its location is good for cross border activities which can promote the development of the local economy. As a liability, the district by its location faces the threat of illegal immigrants from neighbouring countries such as the nefarious activities of Fulani herdsmen which has become a security concern in the district on annual basis. On the whole the district by its location is well positioned for enhanced socio-economic, cultural and political interaction with the neighbouring districts as well as Burkina Faso (MOFA, 2010).

3.1.1 Relief and Drainage

The topography of the district is gently undulating. It is generally characterized by gentle latitudes of between 330 and 365m in the northern part descending to 220m and 290m in the Valley of Sissili River. The area is mainly drained by the Sissili River and its tributaries flowing in the south-eastern direction to join the White Volta. This is

coupled with several tributaries and other unnamed streams (GSS, 2014; SEDA, 2014). These water bodies have potential for supporting agriculture in the dry season but also serve as constraints in roads construction and access to communities during raining season. A significant feature of most of these rivers and streams is the perennial nature of their flows. The flow of the Sissili River itself reduces to intermittent pools in the dry season. Many of these streams in the district could be developed to support dry season farming. The constant drying of the rivers necessitates the drilling of boreholes to supplement the seasonal shortage of water in the district which in one way might have accounted for the out migration of the population during the dry season. The rich valleys of the Sissili River maintain a vegetative cover that provides an abode for wildlife and further protects the land from erosion (MOFA, 2010; NRGP, 2012).

3.1.2 Geology and Soils

With a gently undulating topography, the district is bound with fresh granitic rocks. The granitic and bromine rocks weather fast as a result of low rainfall, high evaporation and sparse vegetative cover to form soils of lesser depths rich in minerals for potential farming. The bromine and granitic geological formations in the district are characterized by meta-sediments and meta-volcanic rock formation. The bromine formation has 65% of yielding underground water. The geology of the district must provide potential for underground water development. There are varieties of soils in the district which support plant growth in various degrees. Types of soils in the district include Savannah ochrosols, Tropical brown earths and Terrace or Alluvial soils. These soils are better for the cultivation of cereals and root tuber crops including millet, maize, sorghum yam and cash crops like cotton (NRGP, 2012). They respond well to the application of organic manure and chemical fertilizers to give high yield. With

adequate rains and good farming practices, these soils have the potentials of improving agricultural production (MOFA, 2010).

3.1.3 Vegetation and Climate

Sissala east district falls within the Guinea Savannah vegetation belt. The vegetation consists of grasses with scattered fire-resistant trees such as the sheanut, the Baobab and Dawadawa trees (MOFA, 2010). Acacia is also a common tree of this vegetation belt. The heterogeneous collections of these trees meet domestic requirements for firewood and charcoal, construction of houses, cattle kraals and fencing of gardens. The shorter shrubs and grasses provide fodder for livestock. This has resulted in high influx of Fulani into the district. Their activities have to be appropriately controlled and managed in order to achieve environmental sustainability and sustainable food security. The sheanut tree is one of the economic assets of the district and head portage has been the most common means of transporting the fruits from the farm to the house. This industry if developed will serve as a major source of livelihood in the district. The forest reserves cover a total area of about 267sqkm and encourage a rich stock of mammalian wildlife (GSS, 2014)

The climate of the Sissala east district is tropical continental as experienced in the northern regions of Ghana. Throughout the year, temperatures are high with a minimum of 23°C at night and a maximum of 42°C during the day and this favours plant. The mean monthly temperature ranges between 21°C and 32°C. The highest monthly maximum temperature rises up to 40°C before the raining season in May with lowest minimum temperature falling to about 12°C in December when the Harmattan winds from the Sahara dries up the vegetation (MOFA, 2010).

The district experiences a single rainy season (May to September/October). The rainfall type is the conventional rainfall type. This affected the entire district but the eastern block was the worst hit. As a result of the single maximum rainfall prevailing in the area, crop production is mostly done during the raining season. However since farming is the major occupation of the people, it means that their major sources of livelihood and income are limited during the dry season. This results in the migration of the youth to the south in search of greener pastures. The total number of raining days ranging between 70 to 80 days in 1999 as compared to 51 days of rain in 2009. This is an indication that the number of days of rain as well as the mean annual rainfall are decreasing in the district (MOFA, 2010). This has implications for food security in the district

3.1.4 Natural Environment

Sissala east district is mainly covered by Guinea savannah vegetation with few savannah supported trees such as the sheanut, Baobab and Dawadawa trees (SEDA, 2014). However, human activities such as farming as farming and bush fires, shifting cultivation, felling of trees for firewood and charcoal production and overgrazing by animals contribute greatly to deforestation and soil erosion in this natural environment (MOFA, 2010). Government institutions and NGOs have instituted measures such as agro-forestry, tree planting and extensive education against bush fires to curtail these problems. However environmentally degrading activities still persist in the district and pose a threat to food security in the area. There is the protection of wildlife mammals and other wildlife species through forest conservation and community management of the reserve. The management of forest and forestry resources is handled at the district level, by forestry services division, NADMO, the Ghana National Fire Service, NGOs and Community-Based volunteers (GSS, 2014).

3.1.5 Spatial Organization

Wellembelle is located at the south-western part of the district along the Tumu -Wa road. It shares borders with Wahabu to the South, Bugubelle to the North, Bechemboi to the north-east and Hellembelle to the south-east. It has a population of 4,080 with an average household size of 4.3 (GHS, 2014). The community has a police station, a health centre, a primary/JHS building and an irrigation dam which households rely on in the dry season to cultivate fruits and vegetables for the local markets. The community also enjoys mobile network services from both MTN and Vodafone Ghana which promotes exchange of information with the rest of the world (SEDA, 2014).

Sakai is also located at the western part of the district along the Tumu-Wa road. It shares borders with Pieng to the east, Duwie to the west, Sakalu to the south and Nankpawie to the North. It has a population size of 2,730 with an average household size of 4.0 (GHS, 2014). Sakai has a small water town project which supply water to homes and vantage points for households to buy. It also has a primary/JHS building. Majority of the people are farmers just like in the rest of the district (MOFA, 2010)

There are 65 communities in the district and development is skewed towards the district capital and its surrounding communities. Despite inadequate provision of basic facilities in the district, the few available ones are not evenly distributed with the exception of electricity (GHS, 2014). Telephone services are more concentrated in Tumu Township and a few communities. Only two communities apart from Tumu have a police station i.e. Bug belle and Wellembelle. The only post office and a magistrate court is located in Tumu. Banking Services run by the Ghana Commercial bank, Agricultural Development Bank and the Sissala Rural Bank are all situated in Tumu and do not serve the banking needs of the people in the district. The only hospital in the district is also located in Tumu (GSS, 2014).

The administrative structure of the Sissala East District is made up of the District Assembly & its secretariat, departments of the District Assembly, 1 Town Council (Tumu) and 4 Area councils (namely Bujan, Wellembelle, Sakai and Nabulo) and 21 Unit Committees. The District Assembly is made up of 25 Assembly men and 7 Assembly women. It is the highest decision-making body and is responsible for the overall development of the district (SEDA, 2014).

3.1.6 Demographic characteristics

The district has a population of 56,370 with an annual growth rate of about 1.7 and the male/female ratio of the population being 96 males to 100 females (GSS, 2014). Tumu, the District capital has 19.03% of the District population and it is the only settlement with the status of a town in terms of population numbers and infrastructure (GHS, 2014). There are however other settlements that are growing in size. These include; Sakai (3797), Wellembelle (3463), Nmanduanu (1564), Nabulo, Nabugubelle (1396), Bugubelle (1368), Kulfuo (1117), Sakalo (809), and Bujan (782). The settlement pattern is highly dispersed and rural by nature. This affects the citing of socio-economic facilities in the district such as boreholes, electricity extension among others (MOFA, 2010)

The Sissala east district has total households of 8,570 living in about 5,852 houses. The average household size in the district is about 8 with 46.5% of them very large with 9 or more people per household (GHS, 2014; GSS, 2014). The mean household size in the rural areas is larger than that of Tumu. The age structure is typically of a young population and basically, more than 85% of the people live in rural settlements. The amenities and assets available to the household is an indicator of its socio-economic status. Most households in the district now have access to electricity. The main source of drinking water is protected wells, boreholes, rivers and streams with the only pipe

system in Tumu and Sakai. A lot of these households share toilet facilities with one or more households' while others do free-range. The settlements lack proper physical planning. Mud and Iron roofs are the major building materials used, especially in the rural communities with few houses being built with cement blocks and aluminum roofing sheets which are mostly predominant in the Tumu Township (SEDA, 2014).

The main fuel for cooking in most of the households is firewood (80%) and charcoal (19%) with the remaining 1% using LPG. More than 70% of households own basic items such as radios. The common means of transport among households are motorcycles and bicycles. Most individuals and households have farming as their main occupation. The over dependence on rain-fed agriculture renders most of the households unemployed during the long dry spells which directly hamper growth in family income (MOFA, 2010).

The level of formal education among adults is very low where about 92% of the total population has not had any formal education. This makes it difficult to estimate household income and expenditure because it is not possible for families to keep records on their income and expenditure. However, it could be generalized that household expenditure is on basic needs such as food, shelter and clothing. The subsistence nature of their economic activities means that many households merely make ends meet (GSS, 2014).

The district is made up of different cultural practices. This dynamic culture has been handed to the present generation by their forefathers through experience and reflection in an attempt to fashion and harmonize co-existence with the environment. Some of the positive cultural practices of the citizenry are the celebration of the "paaraGbiele" festival which is celebrated once every year (SEDA, 2014). The Sissalas, like any other

tribe in Ghana have their own social gathering like which include; outdoorings, wedding, burials dressing and the like. The Kasena in the eastern corridor, the Dagaabas dotted in the district also their unique cultures which can be harmonized to improve the district development. Despite the diverse cultural practices, the people of the district have a strong enthusiasm for communal labour (GSS, 2014).

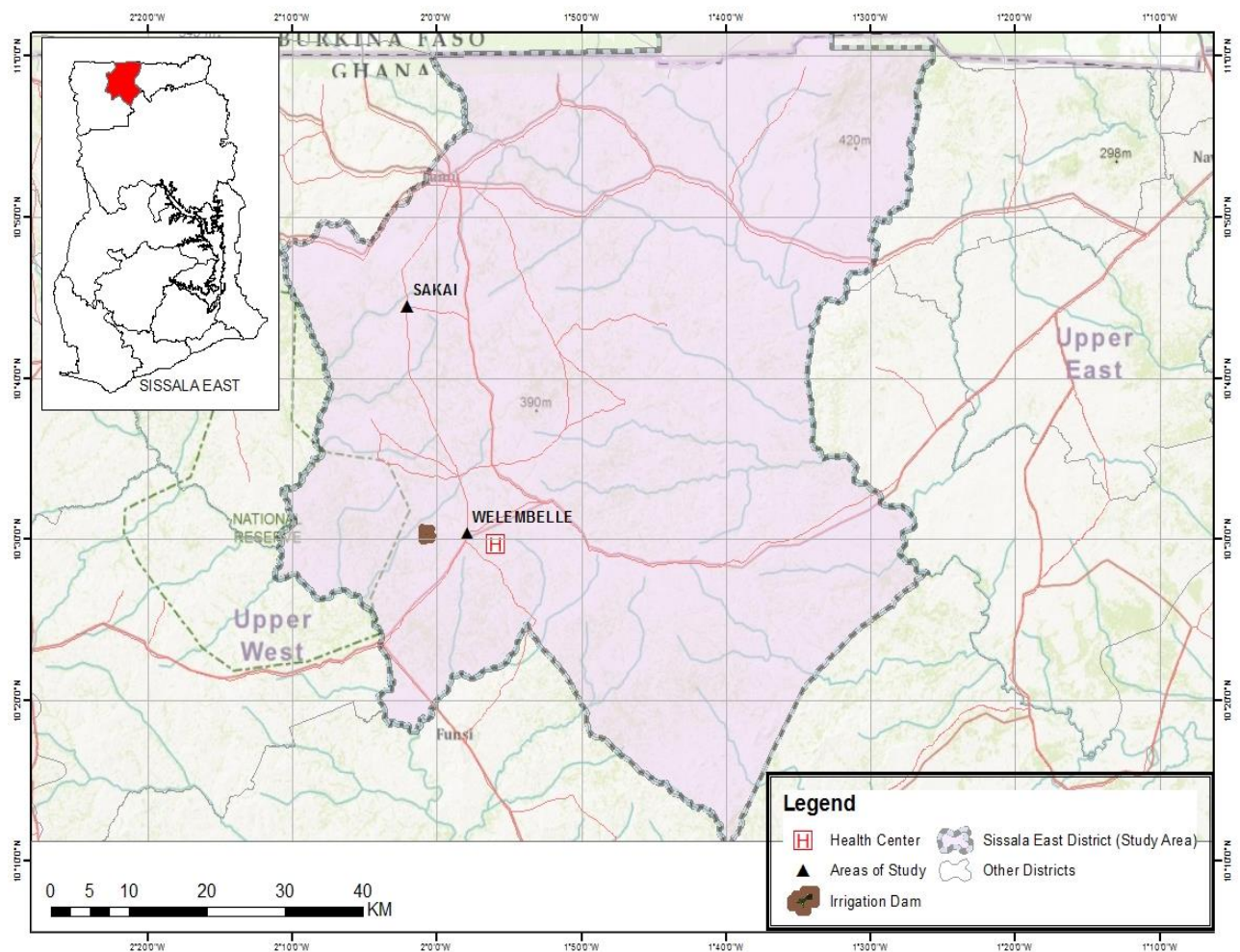
The district is owned by Sissala who make up 88% of the population. However, there are migrant groups in the district comprising the Kasenas (5%), Dagaabas (3%), Moshies (2%), and 2% of other ethnic groups (MOFA, 2010). Despite this ethnic composition in the district, the people co-exist peacefully. On the other hand the religious composition of the district includes; Moslems (81%), Catholics (10%), Traditionalists (5%), and others accounting for about 4%. Despite the variance in the religious composition of the district, cordial relations exist among these religious groups. The cordiality prevailing among these religious groups serves as a catalyst for developmental programmes and projects in the district. Each religious celebration is done with the participation of other religious groups (GSS, 2014; MOFA, 2010).

3.1.7 Structure of Local economy

The agricultural sector is the largest sector in the district constituting about seventy-six percent (76%) followed by the service and commerce sector with fifteen percentage (15%). The industrial sector has the least share of the local economy with only nine percent (9%) contribution to the district economy. The district is basically rural with more than eighty percent (80%) of the people living in rural settlements and are engaged in farming (MOFA, 2010; GSS, 2014). This makes agricultural related activities the predominant activities employing the greatest portion of the population. The people practice subsistence farming with only a few engaged in commercial cultivation of crops such as cotton. The main crops cultivated in the district include

millet, maize, Sorghum and rice. The rest are groundnut, cowpea, yam and cotton. Animal rearing plays a secondary role in the district. Types of animals reared include; cattle, sheep, goats, donkeys, swine and poultry (NRGP, 2012). In all there are ten dams in the district that contain water up to sometime in the dry season. Two rivers also drain the district to the east and north-west i.e. the Sissili and Wahabu rivers. These are the main sources of captured fisheries, but the activities of the fishers are difficult to capture for quantitative estimates (MOFA, 2010). Below is a map of Sissala east district showing the study area and the selected communities for study?

Figure 2.1: Map of the Study Area Showing the Study Communities.



Source: Authors own, 2015.

3.2 Methods of Research

The Multi-method approach was adopted. The use of multiple methods in a single research enhances the validity of the research work since results from one method could be used to cross check results from other methods. It also broadens the scope of the research and facilitates understanding of the research work (Teye, 2012; Creswell et al 2007, Creswell, 2003). The quantitative method in this work was questionnaire while the qualitative methods were in-depth interviews, Focus group discussion and observation.

3.2.1 Questionnaire Survey

A Structured questionnaire was used and covered various themes in the study. Background information of respondents: Questions covered characteristics of respondents such as age, number of years in community, sex, marital status, education, household size, income sources and ownership of assets. This enabled the researcher to partly answer the research questions on factors which account for the success/failure of farmers' adaptation strategies in the Sissala East District. Farmers' perceptions of climate change: farmers were questioned on whether they thought the climate is changing, the causes and effects (floods and drought) of such changes on their livelihood using climatic elements such as temperature and rainfall. This is because, perception of climate change informs adaptation strategies.

Adaptation strategies: Questions bordered on the kind of crops and livestock produced, strategies adopted and how the various strategies adopted were able to reduce the impacts of hazards. This helped in answering the research questions on the kind of adaptation mechanisms that are put in place by farmers in the Sissala east district and whether such strategies are effective in reducing climate risks.

Livelihood objectives of households: Respondents were also quizzed on what their real intentions were in adopting various strategies. Parameters such as food security, increased crop yield, and increased family income were used. The researcher also sought to know whether farmers have realized any improvements along these parameters over time. This helped to answer the research question regarding the purpose of farmers' adaptation and whether their adaptation leads to the achievement of their end goals hence, the effectiveness of their adaptation.

Institutional support: Questions concerning sources, availability and affordability of inputs, presence of supportive organizations, membership of such organizations and the kind of support given were asked. This helped the researcher to answer the research questions on factors which account for success and failure of farmer adaptation and how to make farmer adaptation more effective for sustainable adaptation

3.2.1.1 Sampling techniques and procedure

Sample size-A total of two-hundred and (210) household heads were selected from the two study communities. One-hundred (100) respondents were selected from Sakai and one-hundred and ten (110) respondents from Wellembelle. The sample size for the communities was selected based on the population of each community and using the Yamane table (1967). Sakai has a total population of two-thousand, seven-hundred and thirty (2730) people with six-hundred and eighty-two households (682) while Wellembelle has a total population of four-thousand and eighty (4080) people with a total household of nine-hundred and forty-one (941) (GHS, 2014).

Sampling procedure - Systematic sampling was used to select houses in which various household heads or their representatives were selected to answer questions on the questionnaire. At the planning stage of this work, the intention of the researcher was to get a list of houses in each community from the District Assembly or MOFA. But the

Assembly did not have such data. Meanwhile the numbers that were written on the houses in the communities by some organizations had all disappeared because most of the houses were built with bricks. So, the researcher re-numbered the houses himself with the help of some people he hired to help me for the purpose of this work. There were 303 houses in Sakai and 446 houses in Wellembelle. Dividing this by the sample size of 100 and 110 for Sakai and Wellembelle respectively, the researcher got 3 as skip interval for Sakai and 4 for Wellembelle. A random procedure was then used to select the starting house. So respondents were systematically selected in every 3rd house in Sakai and in every 4th house in Wellembelle. In houses where there were more than one household, the researcher asked for the actual landlord of the compound. If he was not around his wife or elderly son/daughter was chosen to answer questions on the questionnaire. This was done in order to save time and reduce the cost of travelling. The data was collected between late December and early January, when a lot of households were still busy on their farms doing harvesting and some were even sleeping in their farms. Given the fact that this exercise is time bound, it was difficult for the researcher to wait and revisit the same houses on different occasions.

3. 2. 2 In-depth Interviews

A total of eight (8) interviews were conducted. The researcher interviewed the two chairpersons of the maize farmers Association in Sakai and Wellembelle communities, the two officers in charge of crops and livestock at the Ministry of Food and Agriculture (MOFA) in the Sissala East district and 4 other experienced farmers (two from Sakai and two from Wellembelle) 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 farmers 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 effectiveness of individual adaptation strategies to climate change. The data collected from interviews was used to explain emerging patterns from the questionnaire survey. These enabled the research to answer the research questions provided in the work above. The interviews were done using 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 respondents while ensuring that respondents respond to all questions and provide strong basis in organizing and analyzing data (Kitchin and Tate, 2000; Creswell, 1998).

3.2.3 Focus Group Discussion

The group discussions were cautiously crafted in order to obtain important views and opinions of farmers on their livelihood objectives and the effectiveness of their adaptation practices in a free and fair atmosphere. Questions bordered on the themes outlined above under interviews which guided the researcher to answer the relevant research questions. Group discussion serve as a platform for the farmers to express themselves and debate on pressing issues hence the synergy of ideas was gained (Krenger, 1988). Even though some participants might feel reluctant to voice out some opinions due to shyness or fear of embarrassment, group discussions may introduce different dimension to one-on-one interview on the same issue (Kitchen and Tate,

2000). Group discussions of weather and climate often result in higher levels of farmer response (Orlove et al. 2010a, b).

A total of four (4) FGDs were conducted in the two study communities. Two FGDs were done in Sakai and two in Wellembelle. In each community, one group was made up of only women and one group was made up of only men. The constitution of the groups was based on single gender because, the study area just like other parts of northern Ghana is a patriarchal society where families are headed by men and family decisions are basically men's decisions. Women therefore, are not free to debate with men in such communities (Teye et al, 2015). Participants were selected for group discussion based mainly on recommendations by some community members. Respondents for FGDs were selected because most of them are known for their experience in farming, ability to increase crop yield and ability to speak freely in public by their community members.

3.2.4 Direct Observation

Direct observation was also employed to look at farmers' land-use practices, harvesting techniques for crops and rain water and also some of the off-farm activities of the people in the area. Farmers were seen thrashing their maize 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 on daily basis loading maize onto long vehicles owned by companies and individuals. It helped the researcher to answer the research question on the adaptation strategies that are adopted 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 between observation and interview is that, interviews are self-reports of

experiences, opinions and feelings whereas observation relies on the observer's ability to interpret what is happening and why (Kitchin and Tate, 2000). The major advantage of observation is its directness. Rather than asking people about their views and feelings, you watch what they do and listen to what they say (Frankfort-Nachmias and Nachmias, 1996). The directness makes the research findings valid as it focuses on people actions or activities rather than what they say.

Sources of Secondary data - journal articles, text books, MOFA reports, Documents from SEDA

3.2.5 Data analysis

Quantitative data from questionnaires was analyzed using the software for Statistical Package for Social Scientists (SPSS) and STATA software for Binary Logistic Regression. Within the SPSS package, descriptive statistics was used. Frequency tables were generated to test for the level of popularity of the selected adaptation strategies of households such as irrigation, water harvesting, crop diversification, varying of planting dates, the use of chemical fertilizers, compost/manure, tillage practices, land rotation, migration to urban areas, changing consumption, cover cropping/mulching and the use of weedicides/pesticides. Even though 24 strategies have been put on the questionnaire the first 12 most adopted strategies were chosen for the analysis. The frequency and percentages of households' objectives for adopting the above strategies was also analyzed and described from frequency table. Cross tabulations were also used to examine the strategies that households adopted or did not adopt against the effectiveness of such strategies in reducing the impacts of hazards such as floods and droughts. Again, cross tabulations and bar graphs were also used to examine the effectiveness of households' strategies in meeting their objectives (such as to achieve food security, increased family income and increased crop output). For presentation,

Simple frequencies, cross tabulation and bar graphs were used to describe and discuss results obtain from the field.

Binary logistic regression models captured, how certain characteristics of households influence, their livelihood objectives and their adaptation strategies. These demographic characteristics include sex, household size, and education. Other household characteristics such as presence of other sources of income, and ownership of radio, television and cell phone were also used in the models.

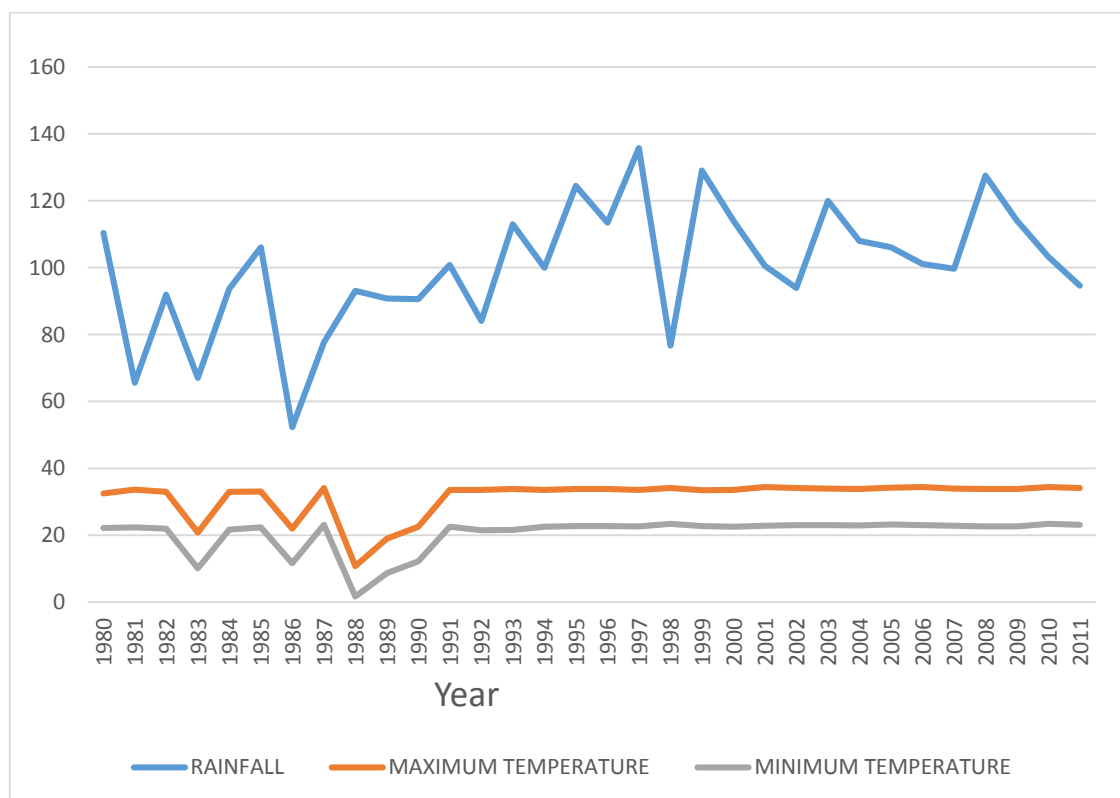
Qualitative data from interviews and focus group discussions was manually analyzed. The interviews and focus group discussions were recorded on the field using my phone. These recordings were transcribed i.e. they were all typed into my computer. Various themes were outlined such as the perceptions of climate change, strategies of households, the objectives of households and the effectiveness of household strategies. Codes were assigned to these themes. Responses that fitted the same theme were given the codes of those themes. At the end of the coding, I then cut out all responses with the same code and pasted them under the theme that they matched.

CHAPTER FOUR: FARMER PERCEPTIONS OF CLIMATE CHANGE AND ADAPTATION STRATEGIES

This chapter discusses the issue of climate change using farmer perception and secondary data. This is because, perceptions of local farmers on climate change influence their adaptation strategies (Yaro, 2013). Farmer perceptions on rainfall and temperature are compared with meteorological data, even though the two do not always match (Ovuka and Lindqvist, 2000). It goes ahead to look at the strategies that agricultural households use to adapt to climate change/variability.

4.0 Evidence of Climate Change/Variability and Its Impacts.

Figure4. 1: Trends in Temperature and Rainfall in Wa, 1980-2011.



Source: Ghana Metrological Service, 2015

Temperature and Rainfall data from Wa in Fig 4.1 above, shows a generally increasing trend in both maximum and minimum values of temperature with inter-annual

variability from 1981 to 2011 and a generally decreasing trend of rainfall with, again, inter-annual variability within the same period in the UWR. This was in tendon with household perception on climate change/variability in the area. Households perceived a declining rainfall and an increasing temperature in the area. Earlier studies by Teye et al (2015) established a similar pattern in the upper east region.

4.1 Households Perceptions of Climate Change

There were varied opinions among respondent's temperature and rainfall changes. These are the two most important elements of climate which affect the livelihood of agricultural households in the study area (Gyasi et al, 2006). This is presented on table 4.1 below.

Table 4.1: The perceptions of respondents on rainfall and temperature (%)

Perception	Rainfall	Temperature
Increased	2.4	66.2
Decreased	73.2	7.6
Extreme Fluctuations	21.0	21.9
No change	0.5	1.4
Don't Know	2.9	2.9
TOTAL	100	100
	N=210	N=210

Source: Field Survey, 2014

4.1.1 Rainfall

Rainfall is an important climatic element which households depend on for their farming activities. This is basically because agriculture in the area is rain-fed. Respondents were asked whether in their view rainfall has changed over the last 30 years by increasing; decreasing, fluctuated extremely or there has not been any change. The views of

respondents are presented in table 4.1. Majority of the people believed there is a declining rainfall pattern in the area. About 70% of total respondents said the amount of rainfall in the study area has decreased over the last 30 years, while about 20% of the people think that there were extreme fluctuations in rainfall. Even though very few people have no knowledge of the nature of rainfall in the area, the number is still significant (2.9%). The declining rainfall pattern in the area poses a serious risk for the people's livelihood (farming) which is rainfall dependent and requires an adjustment of livelihood activities to be in line with the rainfall pattern.

4.1.2 Temperature

The views of respondents showed an increasing trend of temperature in the area within the last 30 years. From Table 4.1, about 66% of total respondents said temperature has increased over the last thirty years in the area while about twenty percent said there were extreme fluctuations of temperature in the area. Only about 3% of the people have no knowledge on the temperature trend in the area. The increasing trend and extreme fluctuations in temperature has direct effects on farming activities in the area.

Consistent with results of some earlier study elsewhere (Gyampoh et al 2008; Teye et al, 2015), households in the Sissala east district have local knowledge of climate change. The people are observant and are able to detect any changes in their environmental conditions based on their traditional knowledge of their environment. They do this by using, the flowering and fruiting of plants, the behaviour of certain insects, ants, earthworms and migratory birds as well as the disappearance of certain water bodies. Landaana who is an experienced farmer in Wellembelle said, "*our fathers told us that, when we see ants carrying their eggs in groups looking for places to keep them, it means that the rains are about to come. Also the years in which the Dawadawa trees bear more fruits are years of heavy rainfall. Again when the wind starts blowing*

towards the east for a long time, it is likely to rain on that day”. Interviews with some farmers also revealed that, they pick information about whether parameters from radio stations within their catchment area. Vogel (2007) documented that, through awareness creation programmes, climate change is now a household name. There is RADFORD FM in the district capital where programmes on farming and climate are discussed on Fridays in Sissali. The communities also fall within the catchment area of RADIO UPPER WEST. These are media through which awareness on climate change is created. A lot of households own communication gadgets. The breakdown includes mobile phones about 85%, television about 75%, and radio sets about 84%, and these things allow them some access to weather information. Sikiri in Sakai said *‘I listen to Fridays programmes on my small radio concerning our work and the rains and I get a lot of information which helps me in my farming’*. Another farmer said, *“I have a radio which was sent to me by my son who is teaching in Kulfuo and every day I listen to local news on farming and the weather and I also listen to the Friday programme on farming. And when experience farmers and officers are talking I learn from them. Sometimes I want to also call and contribute to the programme but here we do not have network. These days they really talk a lot about our rain and our crops”* (Maani a farmer in Sakai)

4.2 impacts of climate change in the area

Identified impacts of climate change in the area include increased incidence of droughts, floods and rainstorms which lead to low crop yield, loss of lives and properties, increase incidence of pests and diseases of plants and animals, the disappearance of some water bodies and increasing aridity of the soil as a result of increased evaporation. This is in line with results of some earlier studies (Dietz et al, 1999, Gyasi et al 2006, Gyampoh et al 2008; Derbile, 2010; Teye et al, 2015). For

example, the 2007 northern floods alone destroyed 1,171 houses, 4,691 acres of crops and farmland, 11 bridges and 11 human lives (NADMO, 2007). Variable rainfall and high temperatures has led to low crop yield, low production in livestock and the use of diversified livelihood strategies such as hunting and charcoal production which further cause deforestation and land degradation (MOFA, 2010). Farmers think that the declining rainfall coupled with increasing temperature has led to the drying of their water bodies and increasing desiccation of the soil which negatively affect agricultural production. They said that pests and diseases of crops and livestock and even biting insects of man have become very common and aggressive in their farms. *'We used to get a lot of water from Nabuuro even in the dry season, but now we don't get any water in that river in the dry season because, the rains don't fall enough anymore and the place is always hot. Even the mosquitoes are now hostile in the farm and in the night when the place is hot. Our crops also suffer a lot'*. These are the words of Sindoo a farmer in Sakai.

4.3 Livelihood objectives of households

Agricultural households cultivate crops and animals with the intention of achieving at least one of the following major objectives: 1) Food security 2) Increased household or family income 3) Increased crop output (DFID, 1999). Adger et al (2005) argued that adaptation is effective if it leads to the achievement of the livelihood objectives of adopters. Food security in this work is looked at in terms of households having access to adequate and nutritious food throughout the year. Income (wealth) was measured by calculating the money value of all farm products, livestock and money from other non-farm sources. Crop output was examined in terms of the quantitative change in the output of major crops (number of bags or number of tubers). Their adaptation strategies could therefore be said to be effective if they led to the achievement of their livelihood

objectives (Adger, et al, 2005; Mabe et al, 2012). Different households had different aims for cultivation of various crops and livestock. The percentage distribution of responses has been shown on table 4.2 below.

Table 4.2: The Percentages of respondents' combination of different Objectives.

OBJECTIVES	Percentage	KEY
1	7.1	1 = food security
1,2	24.8	2 = Increased family income
1,2,3	52.0	3 = Increased crop output
1,2,3,4	2.9	4 = other objectives
1,2,4	0.5	
1,3	6.7	
1,3,4	0.5	
1,4	0.5	
1,5	0.5	
2	1.4	
2,3	1.9	
3	1.0	
4	0.5	
Total	100.0	
	N=210	

Source: Field Survey, 2014

Most households in the area aimed at achieving multiple objectives in the same growing season. Whiles about 55% of respondents targeted at least three objectives to

achieve in each growing season, only about 10% of respondents targeted only one objective to be achieved in each farming season. The rest constituting about 34% aimed at achieving two objectives only, in each farming season. Food security and increased family income were the main targets for overwhelming majority of respondents.

Interviews with farmers revealed that, there is a growing emphasis on increasing crop output and family income more than achieving food security due primarily to social change and improvement in farming technology. In contrast to this, Molua (2002) implied that food security is the main concern of rural households elsewhere. Farmers argued that, in time past, the main purpose of farming in the area was to produce enough food to feed the household throughout the year (food security). But in recent times, because of the increasing cost of education of their children, increased cost of inputs and the payment of utility bills most farmers now farm for money to the extent that some even sell the little food they produce to pay school fees at the expense of food security for the household. *“We want to get food to eat, but now food is not our target. We want money to pay school fees of our children, our light and water bill. This means that we have to produce crops that we can easily store and sell later for money. If it is because of food alone, we will not be suffering too much like this”*. These are the words of Juaha, a native farmer of Sakai. Sakai was connected to the national grid in 2003 and now also has a water project which was completed in 2007. Wellembelle was also connected to the national grid in 2012 (SEDA, 2015). Given these modern facilities in the communities, households must now get money to pay for these services. Again, the use of tractors, weedicides and chemical fertilizers (Mabe et al, 2012) has made farming easier than before such that individuals who now have money cultivate on a very large scale as a result most households now farm for money.

Also the penetration of middlemen (Wala women and Ashanti women) into the communities has made all kinds of crops now marketable. *“Sometime past, groundnuts for instance was not sold in the market. We used to produce it for house use especially in periods of sacrifices to the gods when it was used to prepare gmandaaro (‘white soup’). Now farming is also easy if you have money”* (Maani, an experienced farmer in Sakai). Groundnuts now has market value and a bag is currently sold at GHC 70 in the area.

4.3 Adaptation Strategies of Households

An initial survey of literature reveals that numerous strategies have been adopted by agricultural households to deal with climate related hazards in the Northern Savanna ecological zone (Derbile, 2010; Mabe et al, 2012; Armah et al, 2013). Twenty-four (24) most common ones were selected and sent to the field for confirmation to be sure that, farmers still use these strategies so that, their effectiveness in meeting the objectives of households and reducing impacts of climate change (Jones, 2001; Adger et al, 2005) could be examined. The twelve (12) most adopted strategies from the survey have been used for the analysis in this work. This theme looks at the current level of adaptation of these strategies among household in the area using selected variables. Some of these strategies include; irrigation, the use of water-harvesting techniques, crop diversification, changing planting dates, the application of chemical fertilizer, compost/manure, tillage practices, land rotation, seasonal migration to urban areas, reducing expenses by changing consumption and the use of weedicides among others.

4.2.1 Weedicides/Pesticides

Table 4.3: Level of adoption of weedicides against location, sex and age

WEEDICIDES/PESTICIDES			
VARIABLES	Adopted	Not adopted	Total
Community			
Sakai	97(97%)	3 (3%)	100(100%)
Wellembelle	110(100%)	0(0%)	110 (100%)
Sex			
Male	180(98%)	3(2%)	183(100%)
Female	27 (100%)	0 (0%)	27 (100%)
Age			
20-30	74 (100%)	0 (0%)	74(100%)
31-40	66 (97%)	2 (3%)	68 (100%)
41-50	42 (100%)	0 (0%)	42 (100%)
51-60	16 (100%)	0 (0%)	16 (100%)
60+	9 (90%)	1 (10%)	10 (100%)

Source: Field Survey, 2014

That people noted that weedicides were adopted even in pre-climate change areas. From table 4.3, the use of weedicides/pesticides was the most popular adaptation strategy among households in the study area. Mabe et al (2012) identified the use of agrochemicals as an important adaptation strategy to climate change. Location plays a significant role here. Whiles all respondents in Wellembelle (100%) adopted weedicides; about 97% of respondents in Sakai used them. Also, all female respondents (100%) adopted the strategy compared to their male counterparts (98%). Younger farmers (100%) adopted the strategy more than older farmers (90%). This is probably because; younger farmers are more averse to weeding than the older farmers.

Respondents argued that, low rainfall and heat promotes the growth of weeds and pests of crops and livestock. They have therefore adopted weedicides, herbicides and pesticides in order to control weeds and pests on their farms. This, they did, by spraying the weedicides and herbicides on the farm before and after planting their crops. Luki said, *“These days because the rains don’t fall enough for us to sow our crops and the place is always hot, the weeds grow very fast and the insects and small animals are*

common, so we use these chemicals to save our crops” (Field Survey, 31-12-2014). Different types of weedicides and herbicides were applied depending on the type of weeds that grew on the farm and the type of crops that were cultivated.

4.2.2 Chemical Fertilizer

One of the popular adaptation strategies among households in the area was the use of chemical fertilizer (Mabe et al, 2012). More households in Wellembele (99%) adopted fertilizer than those in Sakai (97%). All female respondents (100%) used fertilizer compared to their male counterparts (98%). The strategy was also embraced more by older farmers (100%) than younger farmers (96%). See table 4.4 below. The people said that due to declining rainfall and continuous cultivation of the land, the soil fertility kept reducing, hence the need for fertilizer application. *“The soil is not more fertile because of how the rain has changed and people use crop varieties that are new. So if you don’t apply fertilizer, you will not get anything”*. These are the words of Batong, an old farmer.

Table 4.4: Level of adoption of chemical fertilizer against location, sex and age

CHEMICAL FERTILIZER			
VARIABLES	Adopted	Not adopted	Total
Community			
Sakai	97(97%)	3(3%)	100 (100%)
Wellembele	109(99%)	1(1%)	110 (100%)
Sex			
Male	179(98%)	4(2%)	183 (100%)
Female	27(100%)	0(0%)	27 (100%)
Age			
20-30	71(96%)	3(4%)	74 (100%)
31-40	67 (99%)	1(1%)	68(100%)
41-50	42(100%)	0(0%)	42(100%)
51-60	16(100%)	0(0%)	16(100%)
60+	10(100%)	0(0%)	10(100%)

Source: Field Survey, 2014

4.2.3 Crop diversification

Table 4.5: Level of adoption of crop diversification against location, sex and age

CROP DIVERSIFICATION			
VARIABLES	Adopted	Not adopted	Total
Community			
Sakai	98(98%)	2(2%)	100(100%)
Wellembelle	108(98%)	2(2%)	110(100%)
Sex			
Male	180(98%)	3(2%)	183(100%)
Female	26(96%)	1(4%)	27(100%)
Age			
20-30	73(99%)	1(1%)	74(100%)
31-40	67(99%)	1(1%)	68(100%)
41-50	41(98%)	1(2%)	42(100%)
51-60	16(100%)	0(0%)	16(100%)
60+	9(90%)	1(10%)	10(100%)

Source: Field Survey, 2014

Deressa (2008) and Armah et al (2013) identified crop diversification as important adaptation strategies among rural households. From table 4.5, the planting of different crops in the same season was not so much a factor of location, Sex and Age since an average of about 97% of respondents in all categories cultivated different crops in the same season. They have embraced crop diversification in order to spread the risk across different crops. They cultivated different crops in the same growing season such as maize, yam, groundnuts, millet and beans (Mabe et al, 2012). Even different varieties of the same kind of crops are cultivated. Preference was given to the drought resistant and those varieties with shorter gestation periods because they argued that the rainfall amounts and duration kept decreasing by the years. They said, cultivating many crops at the same time, reduced their vulnerabilities to shocks associated with droughts and floods. Lasaani said, *“You see, every year I grow maize, groundnuts, beans and millet. Even the maize I grow both the white one and the yellow one. If some of the crops don’t*

do well, some will do well. We don't trust the rain again so we grow the crops that mature fast and can also withstand drought".

Women cultivated basically legumes such as groundnuts, beans and vegetables while their husbands cultivated basically cereals and grains. Amina said, *"because our husbands take all the money from the farm, we sow groundnuts, beans and a little maize if not we cannot get fertilizer to apply money. Come and help us"*. Carr (2008) documented that, women tended to produce crops for household consumption while men produced basically for the market.

Households in Wellembele cultivated Maize and Yam on a larger scale than their counterparts in Sakai who cultivated Maize, a little yam and more of groundnuts and beans.

4.2.4 Changing Planting Date

Table 4.6: Level of adoption of changing planting dates against location, sex and age

CHANGING PLANTING DATE			
VARIABLES	Adopted	Not adopted	Total
Community			
Sakai	98(98%)	2(2%)	100(100%)
Wellembele	100(91%)	10(9%)	110(100%)
Sex			
Male	174(95%)	9(5%)	183(100%)
Female	24(89%)	3(11%)	27(100%)
Age			
20-30	69(93%)	5(7%)	74(100%)
31-40	65(96%)	3(4%)	68(100%)
41-50	40(95%)	2(5%)	42(100%)
51-60	14(88%)	2(12%)	16(100%)
60+	10(100%)	0(0%)	10(100%)

Source: Field Survey, 2014

Due to the variable nature of rainfall in the area, households also kept changing their planting dates in accordance with the onset of the new rains. From table 4.6, more than 90% of respondents changed their planting dates in accordance with the onset of the rains in both communities greater number of male (95%) respondents changed their

planting dates compared to their female (89%) counterparts. Old farmers (100%) had more variable planting dates than young farmers (93%). Farmers used their own traditional ways of determining when the rains started coming and when it would stop raining such as the appearance of certain birds and insects, wind direction, heat, flowering and fruiting of certain plants among others (Gyampoh, 2007). When they failed to time properly they lost out because, their crops either died or gave them poor yield. According to them, years that they got lucky, they got bumper harvest. *‘When we see the ants carry their eggs around we know that it is going to rain, we also look at the fruits of Dawadawa and other plants. But sometimes we are not lucky so we lose a lot. We need your weather people to tell us more about the rain so that we can plant our crops well’*. These are the words of Wiabetiri an experienced farmer in Sakai.

4.2.5 Land Rotation

Table 4.7: Level of adoption of land rotation against location, sex and age

LAND ROTATION			
VARIABLES	Adopted	Not adopted	Total
Community			
Sakai	94(94%)	6(6%)	100(100%)
Wellembelle	98(89%)	12(11%)	110(100%)
Sex			
Male	171(93%)	12(7%)	183(100%)
Female	26(96%)	1(4%)	27(100%)
Age			
20-30	66(89%)	8(11%)	74(100%)
31-40	62(91%)	6(9%)	68(100%)
41-50	39(93%)	3(7%)	42(100%)
51-60	16(100%)	0(0%)	16(100%)
60+	9(90%)	1(10%)	10(100%)

Source: Field Survey, 2014

Studies by Gyasi et al (2006) and Armah et al (2013) documented that land rotation is the primary means of managing the fertility of the land in poor rural communities. Land rotation was identified as a common practice among households in the study communities as shown on table 4.7 above. A higher percentage of respondents in Sakai

(94%) rotated their land than their counterparts in Wellembele (89%). Also, more females (96%) than males (93%) rotated their land, and older farmers (90%) than younger farmers (89%) rotated their land. The people said they adopted land rotation as a strategy of adapting to decreasing soil fertility resulting from high temperatures and reduced rainfall. On the contrary, some of those who did not adopt the strategy said that there was shortage of land due to population growth. Luki again said, *“We change the land because the rainfall is poor which make the soil infertile and also now the crops like a lot of fertilizer and if you cannot buy fertilizer you change the land and look for a fertile place so that you can come back to it later when it is ok. But some have finished the whole of their grandfathers’ land so they now have no places. Some of them also reduce the years they leave the land to rest”*

4.2.6 Tillage Practice

Table 4.8: Level of adoption of Tillage practice against location, sex and age

TILLAGE PRACTICE			
VARIABLES	Adopted	Not adopted	Total
Community			
Sakai	92(92%)	8(8%)	100(100%)
Wellembele	108(98%)	2(2%)	110(100%)
Sex			
Male	158(86%)	25(14%)	183(100%)
Female	21(78%)	6(22%)	27(100%)
Age			
20-30	61(82%)	13(18%)	74(100%)
31-40	56(82%)	12(18%)	68(100%)
41-50	37(88%)	5(12%)	42(100%)
51-60	16(100%)	0(0%)	16(100%)
60+	9(90%)	1(10%)	10(100%)

Source: Field Survey, 2014

Over 80% of households adopted tillage practices on their farms. Gyasi et al (2006) noted that minimal tillage using crude implements such as hoe and cutlass protect the soil as against the use of modern implements such as tractors. But again, location, sex and age influenced the adoption of the strategy with more households in Wellembele

(98%) adopting the strategy than their counterparts in Sakai (92%). More male (86%) respondents adopted the strategy than female (78%) respondents. Older farmers also adopted the strategy more than younger farmers. They use tractors and bullocks to till the land before sowing their seeds. Some of them, who could not afford the cost of tractor services and did not also have bullocks, manually tilled their farmlands with hoes. They argued that, because of low rainfall, the soil was hard and needed to be loosened before their crops could grow well. Some also said tilling the land before sowing makes weed control easy. Maani argued *“because our soil is hard and the rains are not reliable, if you don’t till the land you will lose. And when you till the land before you sow, the weeds don’t grow early. Our only problem is how to pay the tractor people, because they charge too much”* (Field Survey, 6-1-2015).

4.2.7 Cover Cropping/Mulching

Table 4.9: Level of adoption of cover cropping against location, sex and age

COVER CROPPING/MULCHING			
VARIABLES	Adopted	Not adopted	Total
<i>community</i>			
Sakai	85(85%)	15(15%)	100(100%)
Wellembelle	80(73%)	30(27%)	110(100%)
<i>Sex</i>			
Male	147(80%)	36(20%)	183(100%)
Female	25(93%)	2(7%)	27(100%)
<i>Age</i>			
20-30	56(76%)	18(24%)	74(100%)
31-40	53(78%)	15(22%)	68(100%)
41-50	31(74%)	11(26%)	42(100%)
51-60	15(94%)	1(6%)	16(100%)
60+	10(100%)	0(0%)	10(100%)

Source: Field Survey, 2014

Cover crops are crop planted primarily to manage soil erosion, soil quality, water, weeds, pests, diseases, biodiversity and wildlife in an agro ecosystem (Armah et al, 2013). More farmers in Sakai (85%) cultivated cover crops than in Wellembelle (73%). Also, female (93%) and older farmers (100%) cultivated more cover crops than male

and young farmers respectively. Farmers in the study area cultivated different types of leguminous crops which protected the soil and also fixed nitrogen to the soil. These crops basically include different types of beans, groundnuts and Bambara beans. These crops were normally the minor crops as the main crops are normally cereals and grains. See table 4.9. Seidu, an experienced maize farmer said “*We grow some minor crops which I think help the soil against erosion especially beans, groundnuts and even yam. The leaves of these kinds of crops are broad and prevent the rain from causing erosion*”. *I think these crops also make the soil good*”.

4.2.8 Change consumption

Table 4.10: Level of adoption of changing consumption against location, sex and age

CHANGING CONSUMPTION			
VARIABLES	Adopted	Not adopted	Total
Community			
Sakai	58(58%)	42(42%)	100(100%)
Wellembelle	89(81%)	21(19%)	110(100%)
Sex			
Male	126(69%)	57(31%)	183(100%)
Female	27(100%)	0(0%)	27(100%)
Age			
20-30	51(69%)	23(31%)	74(100%)
31-40	48(71%)	20(29%)	68(100%)
41-50	32(76%)	10(24%)	42(100%)
51-60	12(75%)	4(25%)	16(100%)
60+	9(90%)	1(10%)	10(100%)

Source: Field Survey, 2014

From table 4.10 above, the strategy was more popular among households in Wellembelle (81%) than in Sakai (58%). It was also more common with females (100%) than male farmers (69%) and even more so, with the older farmers than younger farmers. In periods of shortfalls in production due to floods and droughts households reduced the number, quantity and also changed type of meals they consumed. This helps them to reduce expenses and managed the little food they had throughout the year. Some however argued that, it was rather important to look for

supplementary sources of income and food such as hunting, charcoal production and gardening. Others said that, they rather relied on their relatives who are in towns and cities for support so that; they could maintain the same level of consumption without difficulty. Saani a farmer Wellembelle said, *“My first born is a good hunter and my wife knows how to produce charcoal properly. So if we don’t get enough food from our farm we hunt and my wife also produce charcoal and sells and we buy food and continue to eat the same way we have been eating”*(Field Survey, 3-1-2015). Nemei also said, *“Two of my children are teachers one in Techiman and one in Funsi, and when I don’t get enough food from my farm, they send me money to buy food. So I don’t change the things and the way I eat”*.

4.2.9 Water Harvesting

Table 4.11: Level of adoption of water harvesting against location, sex and age

WATER HARVESTING			
VARIABLES	Adopted	Not adopted	Total
Community			
Sakai	39(39%)	61(61%)	100(100%)
Wellembelle	77(70%)	33(30%)	110(100%)
Sex			
Male	100(55%)	83(45%)	183(100%)
Female	27(100%)	0(0%)	27(100%)
Age			
20-30	43(58%)	31(42%)	74(100%)
31-40	34(50%)	34(50%)	68(100%)
41-50	24(57%)	18(43%)	42(100%)
51-60	7(44%)	9(56%)	16(100%)
60+	8(80%)	2(20%)	10(100%)

Source: Field Survey, 2014

Studies by Gyampoh (2008) and Derbile (2010) noted that, rural households use local materials such as pots to harvest and store rain water from roof tops in the raining season. From table 4.11 above, over 50% of respondents harvested rain water in the raining season. More households in Wellembelle (70%) harvested water than in Sakai (39%). Also, all females (100%) harvested water while only about 54% of males

harvest water. Plastic containers and big pots and basins are used to collect falling rain water from roof tops during the raining season. This was used for bathing and cooking. However, a good number of households did not harvest rain water. Some of them said they did not like rain water, some also said they did not have money to buy bigger containers for harvesting water. A few respondents said they taboo rain water because they have rain Gods in their families. *“Harvesting rain water is good because you can use it for washing, bathing and some even drink it and some people do that, but for us in this house, we taboo rainwater because we have a rain God which makes the rain fall but when my daughters marry and move out of this house they can harvest and use it”*. These are the words of Kontongboku a great hunter in Sakai.

4.2.10 Migration to urban areas

Table 4.12: Level of adoption of migration against location, sex and age

MIGRATION			
VARIABLES	Adopted	Not adopted	Total
Community			
Sakai	66(66%)	34(34%)	100(100%)
Wellembelle	42(38%)	68(62%)	110(100%)
Sex			
Male	95(52%)	88(48%)	183(100%)
Female	22(82%)	5(18%)	27(100%)
Age			
20-30	38(51%)	36(49%)	74(100%)
31-40	40(59%)	28(41%)	68(100%)
41-50	38(91%)	4(9%)	42(100%)
51-60	15(94%)	1(6%)	16(100%)
60+	0(0%)	10(100%)	10(100%)

Source: Field Survey, 2014

Laube et al (2011) argued that, people migrate from northern Ghana when food stocks run down due to low production caused by floods or droughts. During periods of poor harvest resulting from droughts or floods, some household members migrated to urban areas to do non-farm jobs to get money which was used to support the household. From table 4.12 above, migration rate was higher in Sakai (66%) than in Wellembelle (38%)

and also higher among females (82%) than male (52%) respondents. Younger farmers tend to migrate more than the older farmers. Malik a farmer in Sakai said *“Last year when our maize spoil because water ate part of our farm, my first born ran to Kumasi and was following tractors which carry wood..... He got some money and bought two pockets of zinc. He came back in February and we molded bricks and built a house for him and he has just married”*. Some of those who did not migrate to urban centres thought that, migration was not the solution to their problem but rather preferred to stay back home and find home-grown solutions. *“How on earth will I move away from my ancestor’s land and go to another person’s town and leave my people behind because I want money? No way. There are so many things we can do here to survive. I can even borrow food and money from my people and farm the next year. I prefer to stay here and find solutions to my problems. Nowhere is better than my home”*. These are the words of Lan, a farmer in Sakai.

4.2.11 Irrigation

Table 4.13: Level of adoption of irrigation against location, sex and age

IRRIGATION			
VARIABLES	Adopted	Not adopted	Total
Community			
Sakai	0(0%)	100(100%)	100(100%)
Wellembelle	70(64%)	40(36%)	110(100%)
Sex			
Male	56(31%)	127(69%)	183(100%)
Female	26(96%)	1(4%)	27(100%)
Age			
20-30	28(38%)	46(62%)	74(100%)
31-40	20(29%)	48(71%)	68(100%)
41-50	16(38%)	26(62%)	42(100%)
51-60	9(56%)	7(44%)	16(100%)
60+	8(80%)	2(20%)	10(100%)

Source: Field Survey, 2014

Gyasi et al (2006) documented the limited application of irrigation as a challenge to effective climate change adaptation in northern Ghana. From table 4.13, the application

of irrigation in farming was low in the area. Only 30% of respondents adopted irrigation. This is because, out of the two communities studied, only Wellembelle has an irrigation dam. The irrigation dam in Wellembelle is a brainchild of MOFA/IFAD/IDA collaboration. It was completed in 1996 (key informant). Only households in Wellembelle (64%) adopted irrigation and a higher percentage of females (96%) than males (31%) adopted the strategy. Also, older farmers practiced irrigation more than younger farmers. Households in Wellembelle said irrigation cushioned them against production shortfalls in their main farms in periods of droughts and floods. Households made gardens especially in the dry season in project areas where they cultivated mainly vegetables and fruits. Proceeds from the sale of their vegetables and fruits were invested in their main farms and part used to pay school fees and light bill. Households cultivated different types of vegetables and fruits during the dry season basically for sale in the local markets. *“For us in Wellembelle we make a lot of gardens in the dam site and grow pepper, onions, tomatoes, cabbage, Okra and even mangoes. We harvest these things and sent them to Bugubelle market and sell and we also eat some in our homes so we don’t buy vegetables again. We get a lot of money and we buy fertilizer for our farms also pay fees and light bill. It gives us job as well”* (Mallam sumani, a farmer in Wellembelle).

4.2.12 Compost/ manure

Table 4.14: Level of adoption of compost/manure against location, sex and age

COMPOST/MANURE			
VARIABLES	Adopted	Not adopted	Total
Community			
Sakai	32(32%)	68(68%)	100(100%)
Wellembelle	34(31%)	76(69%)	110(100%)
Sex			
Male	58(32%)	125(68%)	183(100%)
Female	19(70%)	8(30%)	27(100%)
Age			
20-30	21(28%)	53(72%)	74(100%)
31-40	20(29%)	48(71%)	68(100%)
41-50	13(31)	29(69%)	42(100%)
51-60	8(50%)	8(50%)	16(100%)
60+	6(60%)	4(40%)	10(100%)

Source: Field Survey, 2014

The application of compost/manure to farms is not a widely practiced strategy among households in the area. About 30% of respondents adopted the strategy. From table 4.14, a higher percentage of female farmers and older farmers apply manure/compost compare to the other categories. Also, more farmers in Sakai (32%) used manure than their counterparts in Sakai (31%). Some farmers used it as a supplement to chemical fertilizer. Majority of households do not use compost/manure for their farming activities because they thought that it promoted the growth of weeds on their farms. Some also said, they did not have any means of transport to carry it to their farms. They therefore preferred to use it in their home gardens. They depended basically on chemical fertilizer or the natural fertility of the soil. *“Manure or compost is good but when we use it on the farm a lot of weeds grow which are difficult to control and we have to buy special weedicides for them. We only use it in our small garden where we grow vegetables. Apart from that we cannot carry it to the farm. It is difficult”* (Lanseni, a maize farmer).

4.3 Binary Logistic Regression on how some Characteristics of households and strategies affect their livelihood objectives

The study sought to examine strategies adapted by farmers and how these strategies determined lead to achievement of livelihood objectives of households. A binary logistic regression model was estimated using several strategies that the farmers adopted and some other demographic characteristics. These demographic characteristics include sex, household size, and highest level of education for the respondent. Other household characteristics such as presence of other sources of income, and ownership of radio, television and cell phone were also used in the model.

4.3.1 Crop output

From Table A, the entire model was significant at 1% as a p-value of 0.0003 was obtained. The Pseudo R-square for the model is 0.1707 which implies about 17.1% of changes in the dependent variable were explained by the independent variables. The dependent variable specified in this model is, increased crop output. The results showed that an existence of other income sources, ownership of cell phone, and intensification of irrigation, land rotation and seasonal migration to urban areas strongly influenced crop output.

Farmers with other income sources were twice more likely to increase their crop output than those without other incomes sources. This difference was significant at 10 percent; p-value of 0.09. On the other hand, respondents with cell phones were about 3.6 times less likely to increase their crop output compared to respondents without cell phones. This was also significant at 5%; p-value of 0.044. This was not expected since cell phones facilitate the exchange of climate information (Vogel, 2007). But it is likely some farmers used part of their income to acquire cell phones instead of reinvesting the money in their farms. The adoption of irrigation strongly influenced crop output.

Farmers who adopted irrigation were about 2.8 times more likely to increase their crop output than, those who didn't adopt this strategy. This was expected since irrigation provides means of farming (Gyasi et al, 2006). However, respondents who practiced land rotation were about 3.4 times less likely to increase crop yield than those who cultivated on the plot of land continuously. This was not expected. Similarly, respondents who seasonally migrated to urban areas were over 2 times less likely to increase their crop output. This was expected since such farmers may be less serious with their farm work compared to those whose stay back home.

4.3.2 Family income

From table B, the entire model was significant at 1% as a p-value of 0.0085 was obtained. The Pseudo R-square for the model is 0.2020 which implies that, about 20.2% of the changes in the dependent variable are explained by the independent variables. The dependent variable specified in this model is the objective for increased family income. The main predictors of increasing family income were, education, ownership of television, ownership of plough, use of water harvesting strategies, and seasonal migration to urban areas. Respondents who occasionally migrated to urban areas were 3 times more likely to increase their family's income than, those who did not seasonally migrate to urban areas. This difference was significant at 5%; p-value of 0.026. Also, respondent who practiced water-harvesting were slightly over 3 times more likely to increase their family's income than households which didn't harvest water; p-value of 0.015. Similarly, respondents who owned ploughs were about 2 times more likely to increase their family's income compared to respondents without these assets. These differences were significant at 10 percent; Ph-value at 0.079. However, respondents with formal education were rather twice less likely to increase their family's income.

4.3.3 Food Security

This could not be analyzed because of perfection in responses. More than 95% of respondents chose food security as an objective.

4.3 Discussion

This chapter has revealed that, the impacts of climate change already weigh heavily on households' livelihood activities in the Sissala area. Floods and droughts affect farm production among some agricultural households through destruction of farmlands, reduction of soil fertility resulting from leaching of nutrients, erosion, and increasing desiccation of the soil, increase incidence of weeds, insects and pests which farmers grapple with. This is consistent with results of some earlier studies (Dietz et al, 1999, Gyasi et al 2006, Gyampoh et al 2008; Derbile, 2010; Teye et al, 2015). For instance, Derbile (2010) found out that, climate change caused low agricultural production and loss of lives and property leading to poverty in the upper east region. These revelations require serious interventions and concerted efforts by both public and private sectors players to develop a climate-resilient agriculture in order to sustain livelihoods among agricultural households in Northern Ghana.

In consonance with the IPCC (2007) reports, the general perception of agricultural households about climate change is that climate change is real. They reported decreasing rainfall and an increasing temperature trend for the last 30 years. This implies that households have local knowledge of climate change. Interviews showed that this knowledge is based on local events such as the movement of the wind and the moon, the flowering of certain plants and the appearance of some living things such as crawling and flying insects, migration patterns of some birds. Some households also have rain gods in their homes which they believed provide certain kind of information concerning the weather. This finding gives weight to the argument of Gyampoh et al

(2007) and Orlove et al (2010a), that the rural households have very useful indigenous knowledge about climate change which can be tapped and fed into climate policy in building the resilience of rural livelihoods to climate change.

It was also realized that modern technology plays a part role in raising the awareness of the people on climate change in the study area. The people listen to two radio stations in the area. This includes RADFORD FM and RADIO UPPER WEST. Programmes concerning farming and weather are run on these stations in the local languages (Sissali and Dagaare/Waale). Some experienced farmers, community leaders and professional experts in agriculture are sometimes invited to RADFORM FM to discuss farming issues including climate change. Phone lines are opened for people to contribute in Sissali. This finding corroborates the argument of Vogel et al (2007) and Yaro (2013) that, technological revolution and awareness creation programmes have made climate change a familiar thing among households in Ghana.

The main livelihood objectives of farmers identified in the area included food security, increased crop output and in increased household income (DFID, 1999). Most scholars in the adaptation literature have assumed that, rural farmers adapt to climate change with the intention of achieving mainly food security. For example, Deressa (2008) and Molua (2012) implied that, rural farmers elsewhere adapt to climate change purposely to achieve food security. But this work has shown that farmers intend to achieve multiple objectives in each growing season with emphasis on increasing family income over food security, because of the need for money to pay school fees and utility bills.

Households employ multiple strategies simultaneously in other to reduce climate risks. This resonates with the findings of Ofori- Sarpong (2001), Deressa (2008), Deribile (2010) and Mabe et al (2012). Derbile (2010) documented that local people adopted

drought-tolerant crops, chemical fertilizer, shallow ground water irrigation and migration to urban areas among others as some important coping mechanisms among households in the Upper East region. Similarly, Mabe et al (2012) and Armah et al (2013) outlined crop diversification, weedicides, and land rotation, the changing of planting dates, irrigation and tillage practices as adaptation strategies that are employed by rural rice farmers to deal with climate risks in Northern Region.

The most popular adaptation strategies included; planting different crops in the same growing season in other to spread the risks among different crops, changing planting dates in accordance with the start of rains, the use of chemical fertilizer to deal with the problem of declining soil fertility associated with increasing aridity of the soil and loss of soil nutrients through erosion and leaching, using weedicides/pesticides to deal with increased incidence of weeds growth and pests of crops and practice land rotation. Again, most of the households also used cover cropping/mulching and also reduced household expenditure by changing consumption. A lot of households employed water harvesting techniques to harvest and store rain water for household consumption and migration to urban areas except for those who taboo rain water due to their gods. Elsewhere in northern Ghana, Laube et al (2011) argued that, seasonal migration is induced by food shortages. As evident in the earlier findings of Gyasi et al (2006), the limited application of irrigation is a challenge for effective adaptation in the area. This is because only Wellembelle has an irrigation dam where vegetables and fruits are cultivated and sold in local markets for money. Compost/manure was poorly adopted in the area because; households thought that, it promoted the growth of weeds on their farms.

Location, sex and age of farmers influenced their adaptation strategy. More farmers in Wellembelle than in Sakai adopted weedicides/pesticides, chemical fertilizer, crop

diversification, irrigation, tillage practices, changing consumption and water harvesting techniques. Households in Sakai tended to be more migratory, cultivated more cover crops, changed their planting dates, applied manure/compost, and rotated their land than their counterparts in Wellembelle. Again, more females adopted cover crops, harvested water, adopted irrigation, changed consumption, rotated their farm land and migrated than their male counterparts. In line with this, Carr (2008) argued that, females cultivate crops that are basically used for household consumption while males produce for the market. While older farmers adopted land rotation, cover crops, change consumption, tillage practice, water harvesting, changing planting dates and chemical fertilizer than the younger farmers.

Results from binary logistic regression analysis, identified other income sources, irrigation, land rotation, ownership of cell phones and migration as the factors which influenced crop output on one hand. On the other hand, migration, water-harvesting, ownership of ploughs and formal education influenced family income. Farmers who migrated to urban areas were less likely to increase their crop output but stood a better chance of increasing their income. This resonates with the argument of Laube et al (2011). The practice of irrigation increased crop output (Gyasi et al, 2006). Water-harvesting and ownership of ploughs helped to increase farmers' income. Farmers with other income sources were more likely to increase their crop output than those who relied on only farming. This was expected since such farmers were able to buy farm inputs and applied on their farms (Derbile, 2010). However, the model indicated that, land rotation and education were not important in realizing farmers' objectives.

CHAPTER FIVE: DETERMINANTS OF EFFECTIVE ADAPTATION

5.0 Introduction

In order for an adaptation action to be effective, it must reduce impacts of hazards and risks associated with climate change and at the same time, meet the objectives of those who employ that strategy (Jones, 2001; Adger et al, 2005). This chapter looks at the effectiveness of households strategies from the view point of farmers and brings out factors responsible for their effectiveness. These factors are then categorized into community level factors and individual level factors. It then examines the individual strategies using responses from differentiated farmers such as the poor farmers, non-poor farmers and the rich farmers and brings out the determinants of successful adaptation.

5.1 Households' Perspectives on effective adaptation

The study has revealed that households have common views on what constitute success or effective adaptation. Households argued that their adaptation can only be effective if it leads to an increase in the number of bags they get from their harvest of crops in the case of cereals and legumes or number of tubers in case of root tubers. Climate change affects crop output (SNC, 2011; Deressa, 2008). Effective adaptation should also be able to sustain a reasonable output over the long term. They said that their family sizes keep changing so if they are not able to increase output they will not be able to feed the increasing numbers. Their farming must give them enough food throughout the year and also money. Saaka said *"You can't say your farming season is good if you don't get plenty harvest of crops which will also give you money and food. You must get a lot of crops for food and for money". It is when this happens that, we say we are successful.* They also said that social change has brought about increasing cost of school fees and payment of utility bills hence adaptation can only be effective if it is able to increase

their household income. Luki argued that *“Now we farm not because we want only food. We want money to pay our children school fees and also water and light bills. Sometimes when we go to hospital they ask us to buy certain things so if you don’t have money how do you do all these things? If you have money you can even buy food from this village”*. They also said they need money to be able to buy farm inputs.

According to the people certain factors influence the success or failure of their adaptation efforts. These are categorized into community and individual level factors.

5.2 Community Level Factors (non-climatic) which Affect Effective Adaptation

Significant spatial variations and similarities were noticed between the two communities which affect effective adaptation. These variations are explained by some basic factors such as location (by way of proximity to markets), presence of irrigation facilities, and health care and communication infrastructure in the communities which affect adaptive capacities. Antwi-Agyei et al (2013; O’Brien and Leichenko, 2000) documented that financial barriers, institutional barriers and lack of information on climate change characteristics affect effective adaptation.

Table 5.0: Community level factors which affect effective adaptation

WELLEMBELLE	SAKAI/WELLEMBELLE	SAKAI
<ul style="list-style-type: none"> ➤ Irrigation Dam ➤ Relatively high household income ➤ Proximity to market centres ➤ Presence of health Centre ➤ Presence of MTN/Vodafone Services 	<ul style="list-style-type: none"> ➤ Modern technology of farming. ➤ Farmer-based organizations ➤ Arable land and economic trees. ➤ Subsidized fertilizer ➤ Alleged Hoarding and smuggling of subsidized fertilizer. 	<ul style="list-style-type: none"> ➤ Small town water project. ➤ Activities of Fulani Herdsmen.

Source: Field Survey, 2015.

5.2.1 Availability of Irrigation Facilities in the community

Households in Wellembelle are less vulnerable to the impacts of floods and droughts than their counterparts in Sakai due to the opportunity for irrigation in their community which gives them alternative means of survival in periods of crop failure resulting from floods and droughts and promotes effective adaptation. Laube et al (2011) argued that farmer-driven irrigation plays a critical role in adaptation process. Wellembelle has an irrigation dam. The dam was constructed in 1989 and the channels through which water is distributed from the dam to the gardens were constructed in 1996. The project was a product of MOFA/IFAD/IDA collaboration (Wellembelle Assemblyman, 2015). Households make gardens in the project area and cultivate basically vegetables and fruits which are sold in local markets for money. Irrigation increases household income and provides an escape route from hunger (Mabe, 2012; Derbile, 2010).

During focus group discussions, participants in Wellembelle said during periods of crop failure in the area due to poor rainfall they are able to raise money from the produce from their irrigation gardens and buy food to supplement their household feeding, pay school fees of their children and also invest the rest in their main farms in the next farming season. They buy fertilizer and weedicides and also pay for tractor services in tilling the land. They also use the water from irrigation dam to build their houses in the dry season. *“For us here we thank God for the Dam. We grow our tomatoes, mangoes, onions, okra and a lot of things from our gardens using the dam water. We get money and we use some to buy fertilizer and weedicides for our farms* (Saaka, a farmer in Wellembelle). Households in Sakai do not have the same adaptive capacity since the community does not have any irrigation dam and residents do not do any farming in the dry season. *“Here if you don’t know how to do some hunting and charcoal burning, you just sit down and wait for the rains to start coming. Some of the*

youth go to Kumasi and Techiman in the dry season to look for other jobs to do since there is nothing to do here. The Wellembelle people are better than us. Some of them get more money from their gardens than their farms. Our daughters are even married in that village” (Siitu, a farmer)

5.2.2 Household income

Table 5.1: Differences in Estimated annual income between Wellembelle and Sakai

Community	Estimated Annual Income in Ghana Cedi						Total
	1-2,000	2,001-4,000	4,001-6,000	6,001-8,000	8,001-10,000	10,000 +	
Sakai	31%	45%	13%	3%	4%	4%	100%
Wellembelle	34.5%	20.9%	14.5%	10%	6.4%	13.6%	100%
Total	32.9%	32.4%	13.8%	6.7%	5.2%	9.0%	100%

Source: Field Survey, 2014

Again, Carr (2008) documented that household adaptation strategies are influenced by income of the male household head. Average household income level was higher in Wellembelle than in Sakai. From the study, the five highest earning households were all from Wellembelle. They earned GHC (80000, 28000, 24500, 21500, and 21000 respectively) and five least income earners were all from Sakai. They earned GHC (120, 900, 1200, 1500, and 1800 respectively) annually. This compared with the average household size of 4.0 and 4.3 for Sakai and Wellembelle respectively (GHS, 2014) shows that households in Wellembelle earned more income per year than their counterparts in Sakai and arguably have more adaptive capacities. The adaptive capacity of household is largely influenced by access to resources (DFID, 1999) During an interview with the MOFA officer in charge of crops in the area he said that *“households in Wellembelle do not only depend on their main farms, some of them do a lot of trading, some make gardens in irrigation project area and cultivate vegetables and sell for money. Even they farm on a large scale because some of them have their own tractors. They produce a lot of maize which they sell. One person can get about*

300bags of maize in a year and you can imagine the value for yourself” (key informant).

5.2.3 Relative location of the community and proximity to marketing centres

In terms of its relative location, Wellembelle is better placed than Sakai. The community is closer to Wa the regional capital of UWR than Sakai. Most of the resident of the community go to Wa to buy their things where prices are lower than in any other town in the region. Access to marketing facilities is important for effective adaptation (Antwi-Agyei et al, 2013; Deressa, 2008). The community is also close to Bugubelle which has the second biggest market in the district where households easily go on market days to sell their produce and also buy what they need from the market. They therefore enjoy lower prices of goods and services and other trading opportunities such as petty trading than those in Sakai. On the other hand, most of the residents of Sakai do their shopping in the district capital where prices are said to be the highest in the region. *“We the people in this Wellembelle village, we buy most of our things from Wa. There prices are lower than in Tumu and other places. Sometimes when we have a lot of maize to sell we send it to Wa or Techiman. It is better there. But as for things like tomatoes, garden eggs, onions, mangoes we sell most of them in Bugubelle market”*(landana, a farmer). On the other hand, households in Sakai mostly sell their produce in the community or the neighbouring Burkina Faso. Asante and Waala Middlemen and women come to the community to buy farm produce. Some of them do this through their local agents in the community who are mostly community members. They pay lower prices for the produce. *“The Asante women and the Waala women are always here to buy our produce. But sometimes the prices they pay for our produce are not good for us so we sometimes send our produce to Leo in Burkina Faso but there too the custom people worry us”*(Maani, a farmer in Sakai). Households in Wellembelle

earn more from their farm produce and pay lower prices food goods and services compared to those in Sakai and are therefore able to save more money which build their adaptive capacity and reduce their Vulnerability.

5.2. 4 Health care infrastructure

Wellembelle has a health Centre where residents easily go for treatment of various diseases cutting down the cost of travelling to other places for treatment. This facilitates effective adaptation to climate change because the people said they get a lot of malaria and Scorpion stings when the weather is hot and they go to the health Centre in the community for treatment. O'Brien and Leichenko (2000) argued that institutional constraints and general development could affect adaptation. *“These days the mosquitoes bite us a lot and we get fever and the scorpions too, especially when the rains stop for a longtime and the place is hot so we go to the health Centre up there for treatment. The nurses are always here”* (Ndoo, a farmer). Sakai on the other hand has a CHPS compound (currently in the process of being upgraded to a health Centre), which is a lower level health service provider and only give first aid and refer patients to the district hospital for treatment. Households therefore travel all the way to Tumu which is about 15km away for medical care and have no chance of cutting down on transportation cost. *“Here anytime we are sick the nurse will give you only Para and tell you to go to Tumu hospital. They don't give any better drugs so we always spent money going to Tumu. Government should give us a big hospital”* (Luri, yam farmer).

5.2.5 Availability of communication services for exchange of information

Laube et al (2011) argued that lack of climate information and institutional barriers affect adaptation. Households in Wellembelle enjoy full coverage of mobile services from MTN and Vodafone. The masts of the two companies are in the community. This

facilitates exchange of climate information and information on prices of farm produce and inputs in other areas which is key for effective adaptation. Sulemani a farmer in Wellembelle said *“I always call my people in Techiman to find out if maize price is good over there before I decide to send my maize there. Sometimes too I receive some text messages from MTN and I let my son read them for me since I cannot read. Sometimes the messages are about rainfall and things concerning our farming. This helps me a lot”*. On the other hand, households in Sakai pick up network signals of MTN intermittently from Tumu since the community does not have such services. It was also revealed that even though ownership of cell phones, radio and television sets is high in both communities, more households in Wellembelle own cell phones, radio and television sets than in Sakai. Whiles about seven-six percent (76%) of households in Wellembelle owned cell phones, radio and television sets, 73% of households in Sakai owned cell phones, radio and television sets. This implies that in terms of access to information it is likely the households in Wellembelle will be better placed.

5.2.6 The use of modern technology of farming

During FDGs, participants argued that the application of modern technology of farming has made farming so easy. The use of different kinds of agrochemicals such as chemical fertilizers, weedicides, pesticides, rodenticides and the use of tractors and combine harvesters has made it easy for farmers in both communities to scale-up production. These technological inputs are now available at the district Centre and even in the communities and farmers buy and use for their farming activities. One participant by name Sidiki said *“nowadays farming has become so easy for us especially for those who have money. All sought of chemicals are now sold here even in this our village. Now it is about your money. If you have money nowadays you can easily farm and become somebody without any problem.....They don't go to farm like we use to do,*

you see them sitting under mango trees even in the raining season but they get more harvest from their farms than we use to get". During data collection, I observed that a lot of tractors were carrying what is popularly called "Convan" and moving from farm to farm upon request by farmers to harvest maize for farmers at a fee. "Convan" is the local term for combine harvester. Some of these tractors and combine harvesters are owned by farmers within the communities and some of them are also brought into the communities by people from elsewhere for business purposes.

5.2.7 Presence of farmer-based organizations in the study communities.

Another factor which aid farmer adaptation is the Presence of farmer-based associations and other private organizations in the area. Farmers revealed that, there are a number of private organizations in the communities of study which do business with them. These organizations include: Masara N'arziki, Orlam Ghana Ltd, Akate farms and the Government of Ghana's Savanna Accelerated Development Authority (SADA) projects. These organizations give a lot of support to farmers in a form of supply of technological inputs (agrochemicals). Agrochemicals such as fertilizers, weedicides, insecticides, rodenticides and herbicides are given to farmers on loan on group basis and farmers used their produce to pay for the cost of these inputs after harvesting. For example, Masara N'arziki a farmer-based association which seeks to create wealth for farmers through Maize, supplies fertilizer, hybrid seeds and other inputs to farmers on loan in groups. They go into contractual arrangement with farmers on modalities of repayment of cost of inputs and how to recover debt from defaulting farmers. They use the current market price of maize as basis for calculating the cost per 50kg of maize and this gives them the number of 50kg bags of maize to collect from each farmer per 5 acres of maize after harvesting. *"It is difficult for us if we don't collect fertilizer and other chemicals from these people because we don't have money to buy these things.*

They give these things to us when we are in a group, and we pay back when we harvest the maize. Sometimes we gain, sometimes we lose because if you don't get enough of the maize to pay them you have to pay with money from your pocket". These are words of Zaabu a maize farmer in Sakai. The group system serves us insurance for the association such that when one farmer does not get enough maize to pay the company, other group members come in and pay with their maize. Each farmer cultivates a minimum of 5 acres of maize to qualify you for inputs. A farmer receives the following inputs on loan from the association per 5 acres of maize: 15 bags of NPK, 10 bags of Sulphate of Ammonium, 5 litres of herbicides and 5 litres of weedicides. Upon harvesting, a farmer is required to give the association 114 of 50g (5700kg weight of maize) bags of maize to offset the loan (Key informant).

5.2.8 Availability of arable land and economic trees in the area

The study communities fall within the Guinea Savannah vegetation belt with vast arable land for crop production. The soil is suitable for the cultivation of cereals and grains, root tubers such as yam and legumes such as beans and groundnuts (MOFA, 2010). The vegetation consists of grasses with scattered fire-resistant trees such as the sheanut, the Baobab and Dawadawa trees. The heterogeneous collections of these trees meet domestic requirements for firewood and charcoal, construction of houses, cattle kraals and fencing of gardens. The shorter shrubs and grasses provide fodder for livestock. This has resulted in high influx of Fulani into the district. The sheanut tree is one of the economic assets of the district and head portage has been the most common means of transporting the fruits from the farm to the house. This industry if developed will serve as a major source of livelihood in the district (MOFA, 2010). Households get supplementary income from the sale of sheanut, fuel wood and charcoal which facilitates adaptation to climate change. *"As for the land for farming it is there how to*

buy fertilizer is the problem. Our wives also go to the bush and collect sheanut and dawadawa. They prepare them and use some for food and sell some. Those women who are hardworking get a lot and sell for money and some even help their husbands to build with the money and even buy fertilizer for their husbands to farm for the family”(Haluri, a woman farmer in Sakai).

5.2.9 Accessibility of subsidized fertilizer in the communities

The district started the Ghana Government fertilizer subsidy programme in with the rest of the country in 2008. In the first and second years of this programme coupons were used by farmers to acquire fertilizer from retailers. Because of the problems associated with the coupon system, it was replaced with a waybill system in 2010. In 2008, NPK, UREA and Sulphate of Ammonia were received from the regional MOFA office and distributed to farmers in the district. A total of about 8,250 bags of fertilizer were purchased by the farmers using coupons that year. In 2009, another NPK, UREA and Sulphate of Ammonia were received again from regional MOFA offices in Wa and distributed to farmers. Farmers bought about 17,050 bags that year. For 2010, a total of 70,117 bags of NPK, Sulphate of Ammonia and UREA were purchased by farmers (MOFA, 2010).

5.2.10 Alleged hoarding and smuggling of subsidized fertilizer to Burkina Faso by some political actors

Individual interviews and group discussions revealed that, some individuals allegedly hoarded and smuggled subsidized fertilizer across borders to Burkina Faso in the night to make money. Eriksen and Lind (2009) argued that, adaptation has the chance of entrenching existing power structures and inequalities if not checked. Also, institutional weaknesses can adversely affect adaptation (laube et al, 2011). The subsidy makes Ghana’s fertilizer relatively cheaper than that in neighbouring countries. In other to get

rich overnight, some individuals connived with security agencies and take the fertilizer to Burkina Faso in the night. This creates artificial shortages at the time that the product is needed most by farmers which limits the adaptive capacities of some farmers and affects effective adaptation to climate change. Seidu a farmer in Wellembelle said, *“Some politicians now spoil the good policies put in place by government themselves. Some of them want to become rich at all cost because their party is in power. They keep the fertilizer and send it to Burkina Faso in the night and sell them for big money and we have police and our custom officers also at the borders. Even within the community they secretly sell to their party members first before the rest of the people can get”*.

5.2.11 Activities of Fulani herdsmen

Eriksen and Lind (2009) argued that, adaptation can sometimes breeds conflicts and inequalities in society. Because the vegetation of the area favours cattle rearing, there has been mass influx of Fulani herdsmen in to these communities. They come with a lot of cattle from Burkina Faso and add them to the ones given to them by native farmers to take care of. Their cattle destroy the land and farms of native farmers. Disputes between these native farmers and Fulani herdsmen whose cattle destroy crops are mostly settled at the chief’s palace. According to some participants during a focus group discussion, some of the Fulani herdsmen even beat native farmers on their farms. Lilixy, a farmer in Sakai said, *“Our chief and some of the elders value the Fulani herdsmen more than some of us because they collect cows from the Fulani people. When their cattle go to destroy our crops and we bring them to the chief’s palace, the chief support them. Some of the Fulani people even chase our wives in addition because they get a lot of money from stolen cattle”*.

5.3 Individual Level Factors (non-climatic) which Affect Effective Adaptation to Climate Change

Individual level factors such as poverty, experience or knowledge of farming, illegal sale of inputs contracted on loan by some farmers, the lack of believe in some strategies, lack of money and laziness were revealed as issues which affect effective adaptation to climate change in the area.

5.3.1 Poverty coupled with the increased cost of inputs and tractor service

Households find it difficult to buy inputs for farming and construct their own wells and bores for watering their crops. This was exacerbated by the increase cost of tractor services and agro inputs last year as a result of increase prices of fuel. Laube et al (2011) and Antwi-Agyei et al (2013) identified institutional and financial factors as barriers to effective adaptation in Northern Ghana. Deribile (2010) also identified poverty as a major hindrance for effective adaption. About 14% of those who did not adopt water harvesting in the area cited lack of finance as the reason. Again about 25% Of those who did not adopt irrigation said lack of finance is their main problem. Whiles about 3% of those who did not adopt tillage practices said they did not have money to pay for cost of tractor services. *“Tilling the land before sowing is a good thing. It helps the crops to do well when you sow them but if you do not have bullocks and no money to hire a tractor what do you do? You can use the hoe to do small and leave the rest like that and so on it, when the crops germinate you start weeding the place. The price of everything has increased so we do not know what to do. If we have money we can even construct boreholes and wells also, and water our crops when the rain stops”* (Landana, a farmer). The cost of tilling an acre of land increased from GHc40 the previous farming season to GHc65 last farming season. They also complained about high cost of fertilizer, weedicides and pesticides. The cost of a bag of fertilizer

increased from GHc40 in 2013 to GHc100 in 2014 as a result, poor farmers had to reduce the number of acres they cultivated the previous year since they couldn't buy enough fertilizer for their farms. Those who maintained the same farm size could not apply enough fertilizer which led to poor output of crops particularly maize (Chairman of Masara maize farmers in Sakai, 2015). Only the well-to-do households and those who received substantial remittances from relations were still able to buy enough of inputs for their farms.

5.3.2 Experience or knowledge of farming

It was also revealed that some of the farmers did not have enough farming experience to be able to apply some of the strategies and succeed. Gyasi et al (2006) noted that, farmer knowledge is critical for success in farming. About 25% of respondents who did not adopt compost/manure cited lack of knowledge of the strategy as the main challenge. Again about 4% of respondents lacked knowledge on the practice of land rotation. Similarly, about 2% of respondents did not have knowledge on how to vary their planting dates, while 19% of respondent did not know how to harvest rain water. Luki an experienced farmer in Sakai said *“Some of our youth don't want to learn from us. When we teach them they say we are suffering from old age problems. Some of them are lazy so they don't want to do any hard work. Some even don't know when to start sowing their crops. Some stand and apply fertilizer which spread it and make the weeds grow. I get angry with them all the time... they don't have the knowledge”*

5.3.3 Illegally selling inputs contracted on loan by some farmers

Individual interviews revealed that, some individuals sell the inputs (fertilizer, weedicides and herbicides) that they collect on loan from the organizations which do business with them in the community to their colleague farmers at reduced prices instead applying them to their farms. Again poverty is an important issue here (Derbile,

2010). Such farmers therefore record poor yield and always default in paying back their loans. *“Some of our people are not serious. When they collect fertilizer and the spraying chemicals, they sell some of them to people cheaply and use the money to buy cigarette and quick action drug for their farm work. Some of them also use the money to hire a tractor to till their land. This make them lose a lot and they cannot pay the company when they harvest their crops and they cry”*(Field Survey, 30-12-2014).

5.3.4 Laziness on the part of some farmers

Group discussions also showed that some farmers are very lazy and always failed to take care of their farms. Because of that they record poor yields. They do not weed their farms and allow weeds to destroy their crops. Some even lose their crops to bush fires in the main harvesting season because of the weeds on their farms. They also refused to construct fire belts when other farmers are doing that. *“Some of the farmers because of their laziness they collect fertilizer and apply it to their farms like that without weeding the place. This makes the weeds to grow and spoil their crops and they don’t get anything better. Some of them rather stay at home and drink alcohol around and their wives rather go to farm. They don’t care about anything especially my junior uncle”*.(Saani, a farmer in Wellembelle).

5.3.5 Lack of belief in some of the strategies

It was also revealed that some individuals did not believe in some of the strategies and therefore failed to adopt them. About 18% of respondents did not believe in changing their consumption as a way of coping with low yields which lead to food shortage. Again, about 40% of respondents did not believe in migration to urban areas to look for non-farm jobs while about 11% do not believe in harvesting rainwater. *“Why should I change the way I eat? I do not believe that is the best because when I die, I will not eat again. I will find another way of looking for more food for my family even if I have to*

go and work in peoples farm to get food I will do that if my crops spoil. As for travelling out of here, no way! I can do a lot of things here to care for my family”
(Saani, a yam farmer).

5.4 Effectiveness of Strategies in Reducing Impacts of Hazards and Meeting

Objectives of Households

The effectiveness of households’ strategies in reducing risks through a reduction of impacts of hazards such as floods, droughts and pests and diseases of crops on household livelihood and in helping households achieve food security, increased crop output and income varied across different income groups. The income groups were categorized into poor farmers GHC (1-5,000), non-poor farmers GHC (5,001-10,000) and rich farmers GHC (10,000+). Mabe et al (2012) argued that farmers are able to achieve food security, high income and livelihood security if they are able to effectively adapt their livelihood to climate change.

5.4.1 Weedicides/Pesticides

From Table 5.2 below, farmers with different characteristics largely thought that the use of Weedicides/pesticides was effective in reducing impacts and meeting their livelihood objectives. Whiles about 98% of poor farmers though that, weedicides/pesticides were effective in weeds and pests control, all (100%) non-poor and rich farmers said the strategy was effective. More experienced farmers (100%) equally found the strategy more effective than farmers with less experience (70%). Again, a higher percentage (96%) of farmers in Wellembele found the strategy more effective than their counterparts in Sakai (89%). Yaro (2013) documented that farmer knowledge of climate change is very fundamental for success in climate change adaptation. This means that, experienced farmers, farmers with higher income and

farmers located in Wellembelle were more likely to succeed with the strategy than the inexperienced and poor farmers as well as those located in Sakai.

Table 5.2: Effectiveness of Weedicides/Pesticides against selected variables

WEEDICIDES/PESTICIDES			
VARIABLES	Effective	Not Effective	TOTAL
Wealth			
poor	163(98%)	93(2%)	166(100%)
non-poor	25(100%)	0(0%)	25(100%)
Rich	19(100%)	0(0%)	19(100%)
Location			
Sakai	89(89%)	11(11%)	100(100%)
Wellembelle	105(96%)	5(4%)	110(100%)
Experience			
20-30	52(70%)	22(30%)	74(100%)
31-40	56(82%)	12(18%)	68(100%)
41-50	42(100%)	0(0%)	42(100%)
51-60	16(100%)	0(0%)	16(100%)
60+	10(100%)	0(0%)	10(100%)

Source: Field Survey, 2014

Climate change breeds pests and diseases of crop and influence the growth of weeds (Deressa, 2008; SNC, 2011). Personal interviews and group discussions with some farmers indicated that climate change especially periods of droughts and floods promote the growth of weeds and insects which destroy crops hence the need for weedicides, herbicides and pesticides to control weeds and pests on their farms. *“Now because of how unpredictable the rain is, if you don’t use these chemicals, the weeds and the animals will spoil all our crops and we cannot feed our children. We don’t have people to weed our farms because, most of our children go to school”* (Batong, a 51-year old farmer in Sakai). Some of them said when they sow their seeds and the rains do not come within the next three days pests such as rodents and some type of birds such as partridges and doves remove all the seeds they put into the soil. This prevents them from germinating properly hence they either have to re-sow or lose out

on their crops. However, with the use of pesticides and rodenticides, they mix these chemicals with the seeds and sow and the pests die when they eat. This stops them from removing the seeds from the soil. *“Now when we want to sow maize or groundnuts we add some DDT to the seeds before we put them into the soil. So that if the rain does not come within the next three days, the scent from the DDT prevents rats and birds from removing the seeds from the soil. Some of them eat the seeds and die. Some of them become weak and remain on the farm till we go to meet them. My children catch them and use as meat”* (Maama, a maize farmer in Sakai). Insecticides are also mixed with grains and legumes and store to prevent boring insects from eating them. This helps households to prevent post-harvest losses and be able to store enough food for times when the rains do not come early and hunger sets-in. Adaptation must reduce poverty and vulnerability to climate change effects (Eriksen et al, 2010)

Poor farmers said, they collect these chemicals from sellers and organizations on credit and payback in kind with their crops after harvesting. They said that these sellers and organizations inflate the prices for them and think that if government comes in to subsidize these chemicals it will help them to be more effective in their adaptation efforts. *“Most of us collect the chemicals on credit from some people who sell them here and also from Masara Company, because we don't have money to buy them. So when we harvest, we use our crops to pay. We want government to come and help us. These people are cheating us but we do not have other options”* (Moomen, a 45-year old farmer in Wellembelle). Given the fact that, closed to 80% of the people fall within the low income bracket, it means that majority of the people collect these things on credit. Barnett and O'Neill (2010) documented that adaptation actions sometimes breeds inequalities among groups in society.

Some non-poor and rich individuals said they pay cash for the chemicals and use them on their farms instead of collecting them on loan because, they think that the sellers will cheat them if they do so. During group discussions, some of the farmers said *“as for the spraying chemicals, it is better to buy them and use. If you collect them on loan, the sellers and the organization will cut your head because they want to use us to make their money”* (Luri, a farmer in Sakai). They said, they make more profit when they buy the chemicals and apply them on their farms instead of taking them on loan.

Farmers in Wellembelle found the strategy more effective than their counterparts in Sakai because average household income and farm size were found to be higher in Wellembelle than in Sakai hence the need to use more of these chemicals. *“Here we farm a lot so if you do not use weedicides, you cannot weed the whole farm with your hands”* (Saaka, a 40-year old farmer in Wellembelle). Wellembelle is also closer to marketing centres than Sakai. Mabe et al (2012) said that adaptation is easier when farmers have opportunities for marketing and can also afford farm inputs without major hindrances.

Some participants during focus group discussion however argued that, the use of weedicides and pesticides has promoted laziness among the youth. The youth no longer want to stay in the farm and weed seriously. They go and spray the farm twice in the farming season and they do go there again until harvesting time. Because of that some of their farms get weedy again after some time but they do not care. This is the reason why these days a lot of people lose their crops to bushfires. Their farms are no longer cleared of weeds. Again, the weedicides and pesticides that are used by households sometimes bring about livestock disease and even death of livestock. Some households spray the chemicals on weeds around their houses to keep the place free of weeds and when animals such as goats, sheep and cattle the grasses the very day the spraying is

done, they begin to run diarrhea and some of them even die as a results. One man said, *“The use of weedicides and pesticides in our homes has reduced our animal population. Some of our goats and sheep eat grasses that are sprayed with these chemicals and die and some fall sick and we have to bring the veterinary people to come and treat them at a cost. I used to have a lot of goats which sleep around my house in the evening but now most of them have died because they have eaten chemicals sprayed on weeds. This is very bad. Sometimes too, some people will poison some mice to death in their homes with these chemicals and throw them around. Our dogs and cats eat and also die”* (Jesper, a 61-year old farmer in Wellembelle). In line with this, Reilly and Schimmelpfennig (2000) noted that adaptation may sometimes produce unintended adverse effects on the people.

A participant in a group discussion angrily complained that some wicked farmers use some of the chemicals such as DDT for inland water fishing in rivers and streams which destroy livestock. *“Some of these our people are wicked. They put DDT into water to catch fish. They have killed all my cows. God will punish all those who do that”* (Lanseni, a 36-year old farmer in Sakai). This practice pollutes water bodies, destroys livestock and leads to the drying up of streams in the area. Some experience farmers believed that, the excessive use of these chemicals is reducing that natural fertility of the soil.

Even though Weedicides/pesticides are generally effective in weeds and pests control among farming households in the wake of climate change, non-poor and rich households who have the financial resources to use these things on cash-and-carry basis derived maximum benefits from their application and find their use more effective than the poor households who contract these things on loan and end up being exploited. A farmer located in Wellembelle is likely to have more access to these chemicals than

their counterparts in Sakai. Again, the use and misuse of these chemicals due purposely to lack of knowledge or ignorance leads to pollution of inland water bodies and a reduction of livestock population widening creating inequality between livestock producers and crop farmers (Barnett and O'Neill, 2010). Again, Adger et al (2005) argued that adaptation strategies must promote equity and legitimacy among the people involved. Farmer education and subsidies from government can address these hiccups and will go a long way to close the gap between rich and poor households.

5.4.2 Chemical Fertilizer

Table 5.3: Effectiveness of Chemical Fertilizer against selected variables

CHEMICAL FERTILIZER			
VARIABLES	Effective	Not Effective	TOTAL
Wealth			
poor	162(98%)	4(2%)	166(100%)
non-poor	25(100%)	0(0%)	25(100%)
Rich	19(100%)	0(0%)	19(100%)
Location			
Sakai	87(87%)	13(13%)	100(100%)
Wellembelle	107(97%)	3(3%)	110(100%)
Experience			
20-30	67(91%)	7(9%)	74(100%)
31-40	66(97%)	2(3%)	68(100%)
41-50	40(95%)	2(5%)	42(100%)
51-60	16(100%)	0(0%)	16(100%)
60+	10(100%)	0(0%)	10(100%)

Source: Field Survey, 2014

The use of chemical fertilizers is a common practice among agricultural households in northern Ghana (Mabe et al, 2012). About 98% of poor farmers and all non-poor and rich farmers (100%) said the strategy was effective in reducing the impacts of poor soil fertility on crop output and meeting their livelihood objectives. Farmers in Wellembelle (97%) were more successful with the strategy than their counterparts in Sakai (87%) Also, experience farmers (100%) found the strategy more effective than the

inexperienced farmers (91%). See table 5.3. This means that, farmers who were located in Wellembele and those with higher income and experience were more likely to succeed with the strategy.

Soils in the study area are generally laterites and are hard to cultivate (MOFA, 2010). In a focus group discussion, some participants said that during periods of droughts, the soils become deficient in moisture and are hard hence crops are not able to get the needed nutrients from the soil. And also during periods of floods, there is loss of nutrients in the soil hence the need for the application of chemical fertilizers for crops to do well. They argued that chemical fertilizers increase crop output and help them to get food and money from their farms. *“Floods and drought have spoilt the soil and our crops are all getting used to fertilizer, so when you do not have money to buy fertilizer, that year, you and your family will die from hunger since your crops will fail you”* (Dagbesiwie, a farmer in Sakai)

Just as in the case of weedicides/insecticides, poor households in the areas acquire fertilizer on loan from sellers and organizations. They pay back after harvesting their crops. *“We collect fertilizer from Masara and sometimes from Elliasu and his brothers and we pay back after we have harvested our crops. They always increase the price because we are not going to pay immediately but what can we do?”* (Abassiwe, a 37-year old farmer in Wellembele). Some of them also said they search for fertile land after some period of farming on their current land since they cannot buy fertilizer. Some offer their labour for fertilizer others depend on remittances from relatives to buy fertilizer. *“.....as for last year, I called my uncle in Kumasi and he sent me GHC 700.00 through mobile money and I bought 7bags of fertilizer for my farm. But the other year I went and farm in Juari’s farm for three weeks and he bought me 3 bags of fertilizer”* (Bayeki, a maize farmer in Sakai).

Non-poor households store their produce especially maize up to the time their prices go up in the market. They sell them and use the money to buy fertilizer for their farms. *“Since we have food to eat, we keep our maize up to the time farming starts that is the time the price is good. We then sell them and buy fertilizer with the money. This helps”* (Samata, a 49-year old woman in Wellembelle).

The rich households buy the fertilizer in the dry season when the price of fertilizer is low and store for the next farming season. Some also travel to areas where the price is low and buy in bulk. *“..... me and my family because our farm is very big, we buy some of the fertilizer in the dry season and keep. At that time the price is low so you gain or in the farming season I send my first born to go and buy the fertilizer from Techiman because when the people bring it here they increase the price too much. They cheat us”* (Tangia, a farmer in Sakai)

Farmers in Wellembelle have higher adaptive capacities due to their high average household income, proximity to marketing centres and opportunity for irrigation and are more successful with the use of fertilizer than their counterparts in Sakai.

On the other hand some of the people said the long term impacts of the use of chemical fertilizers are more than the short term benefits during individual interviews. Katrina Brown (2011) argued that adaptation strategies must be friendly to the environment if they are to be sustainable. Luki an experienced farmer in Sakai said, *“these days strange stomach troubles are there.... a lot of people go for hernia operation in the hospital from this community these days. Why? It is all because we eat these chemicals without knowing. Our local crops cannot do well now without fertilizer because the soil has changed”*. They said fertilizer has changed their soil condition so the local varieties

of crops cannot do well unlike in the past and that fertilizer contains chemicals which pollute their water bodies and gives them sickness when they drink it.

Chemical fertilizer is widely used in the area to improve soil fertility. Farmers in Wellembele have higher adaptive capacities due to their high average household income, proximity to marketing centres and opportunity for irrigation and are more successful with the use of fertilizer than their counterparts in Sakai. However, poor farmers find themselves exploited due to the fact that they have to acquire fertilizer through hiring their own labour to rich farmers spending little time on their own farms or get it on loan and pay higher prices for it. Non-poor and rich farmers however derive maximum benefits from the application of fertilizer due to their financial power. This widens inequality between rich and poor farmers in the area. Armah et al (2013) argued that farmers with higher income and opportunities for marketing are more successful in their adaptation strategies for agro biodiversity loss than the poor farmers.

5.4.3 Planting Different Crops

Crop diversification is an important adaptation mechanism to climate change and climate variability in the area. Gyasi et al (2006) argued that the planting of different crops is an important land management strategy in the wake of climate change among rural households. Carr (2008) noted that women cultivate crops for household consumption while men produce crops for the market. Farmers with different characteristics largely said the strategy was effective in reducing impacts of hazards such as droughts and floods. About 97% of poor farmers said the strategy was effective the rich farmers (100%). Also, more experienced farmers (100%) than younger farmers (95%) found the strategy effective. Income and experience of farmers were the major drivers of success in adopting the strategy. This was expected.

Table 5.4: Effectiveness of crop diversification against selected variables

CROP DIVERSIFICATION			
VARIABLES	Effective	Not Effective	TOTAL
Wealth			
poor	161(97%)	5(3%)	166(100%)
non-poor	25(100%)	0(0%)	25(100%)
Rich	19(100%)	0(0%)	19(100%)
Location			
Sakai	98(98%)	2(2%)	100(100%)
Wellembelle	108(98%)	2(2%)	110(100%)
Experience			
20-30	70(95%)	4(5%)	74(100%)
31-40	61(90%)	7(10%)	68(100%)
41-50	42(100%)	0(0%)	42(100%)
51-60	16(100%)	0(0%)	16(100%)
60+	9(100%)	0(0%)	10(100%)

Source: Field Survey, 2014

Experienced farmers (100%) farmers found crop diversification more effective. Poor farmers cultivate basically legumes such as beans and groundnuts and root tubers such as yam and vegetables which require little or no fertilizer. They also produce fowls, Goats and Sheep. They find this very effective in promoting food security. *“I cultivate beans, groundnuts, yam and a little maize. I can’t buy plenty fertilizer that is why. These crops cannot all fail me at the sometime so we always get food to eat”*. We produce some millet too for our TZ in the night. My wife also grows okra and pepper” (Baluri, a farmer in Sakai)

Whiles farmers in Wellembelle cultivate more cereals, grains and vegetables, their counterparts in Sakai cultivate cereals and legumes.

Non-poor households produce more cereals and grains and produce little legumes and tubers. They also produce livestock basically cattle *“We cultivate a lot of maize and millet about 15 acres and small groundnuts and beans. We sell a lot of the maize and*

eat the millet and the beans. We also do about 1000 yam mounds so that we can use the yam for our farm work in the farm..... for cows we have about 25 of them” (Aziz, a farmer in Sakai)

The rich households emphasized more on the production of cereals and grains such as maize and millet. They cultivate large acres of maize, millet and Guinea corn. Those who produce yam do it big too. They also keep large herds of cattle with hired Fulani herdsmen. Umbanda a wealthy farmer in Wellembelle said “.....because I want to be national best farmer one day. I like farming a lot. I hope you people will let the government know what I am doing here. I cultivate 60 acres of maize, 25 acres of Guinea corn, 11,000 yam mounds and I have my own Fulani man who takes care of my cattle which are about 150. I also have about 45 sheep in the house” (Jabuni, a wealthy farmer in Wellembelle)

During discussions, some of the people said that the strategy helps in reducing the risk of losses associated with the cultivation of single crop in the wake of droughts and floods. They cultivate different types and varieties of crops some of which are water-loving and some are drought-tolerant. Also crops with different gestation periods are cultivated. Some farmers even do mixed cropping. This helps farmers to spread the risk of climate-related farm losses across many crops such that when one crop fails as a result of floods or droughts, other crops compensate for the losses. This helps to build resilience of households’ livelihoods to climate change. Eriksen and O’Brien (2007) noted that adaptation is sustainable if it is able to reduce risks to present livelihoods. Lansana said, “I cultivated maize with Masara, and cotton with Orlam Ghana and I also cultivated yam and groundnuts on my own in 2013. In that year, cotton did not do well because the rains started very late so we could not sow early..... my yam did not do well but my wife and I got a lot of groundnuts and we sold some to pay our

daughter's school fees who is now in the second year in SHS". Farmers who ran into debt when they do contract farming with companies sell crops from other fields and pay for the cost of inputs supplied to them by these companies. Some respondents said the strategy is difficult to practice because of decreasing soil fertility resulting from continuous cultivation and low soil moisture. Every crop that is cultivated now needs some form of inputs for it to do well. However, due to pervasive poverty in the area farmers are not able to buy inputs for many crops at the same time. Kaasi a farmer in Wellembelle said "Now every crop needs fertilizer even groundnuts. So if you do not have money to buy fertilizer and hire labour and you cultivate many crops, you will only waste you seeds. You will not get anything that is why I always cultivate one crop so that the little money that I get I use it to buy fertilizer".

The cultivation of different crops in the same growing season is effective in reducing risk associated with climate change and helping households achieve their livelihood objectives. IPCC (2007), Adger et al (2003) documented that adaptation actions are effective if they are able to reduce risks and build resilience at the individual and community levels. Whiles poor farmers basically cultivate legumes and vegetables which are consumed or sold immediately after harvesting for little value because they cannot be kept for long, non-poor and rich farmers cultivate more of grains and cereals which can be preserved for a longtime in other to maximize profit in the market. The strategy is more effective for Non-poor and rich farmers who have more financially resources to cultivate crops that have market value and can be stored for a long time. A farmer located in Wellembelle is likely to be largely producing cereals and vegetables.

5.4.4 Change Planting Date

Table 5.5: Effectiveness of Changing Planting date against selected variables

CHANGING PLANTING DATE			
VARIABLES	Effective	Not Effective	TOTAL
Wealth			
poor	150(90%)	16(10%)	166(100%)
non-poor	23(92%)	2(8%)	25(100%)
Rich	18(95%)	1(5%)	19(100%)
Location			
Sakai	98(98%)	2(2%)	100(100%)
Wellembelle	100(90%)	10(10%)	110(100%)
Experience			
20-30	66(89%)	8(11%)	74(100%)
31-40	63(93%)	5(7%)	68(100%)
41-50	40(95%)	2(5%)	42(100%)
51-60	15(94%)	1(6%)	16(100%)
60+	9(90%)	1(10%)	10(100%)

Source: Field Survey, 2014

In other to adapt to the changing rainfall pattern, households vary the dates for planting their crops from season to season. Armah et al (2013), Gyasi et al (2006) identified variation in planting dates in accordance with the on-set of rains as an important strategy in minimizing farm losses associated with climate change and acknowledged the importance of the knowledge of farmer in achieving success. The strategy was largely found to be effective in reducing impacts and meeting livelihood objectives of farmers. Whiles 90% of poor farmers thought it was effective; almost 92% of non-poor farmers and close to 95% of rich farmers said varying planting date was effective in reducing the impacts of hazard and reduces their vulnerability to drought related losses. More experienced farmers (90%) found the strategy, effective than younger farmers (89%).See table 5.5 above

Qualitative data revealed that poor farmers are the least successful with this strategy because of lack of knowledge or experience with the rain patterns in the area compared with the rich farmer. Also, the poor farmers don't have enough grains to re-sow after

the first sowing has failed to produce good germination. MOFA Officer in charge of crops said *“a lot of the poor farmers rely on only their local knowledge about the weather so their seeds mostly fail to germinate after sowing. So they have to sow a number of times in the same season. Some of them don't even have enough seeds to go and sow for the second time when the first attempt is not successful”*

Rich farmers on the other hand have better knowledge of the rains because of their frequent interaction with extension officers who give them technical assistance. They also have money to buy enough hybrid seeds from MOFA for sowing. *“..... as for some of the large scale farmers, they consult as a lot because they don't want to lose. They face a lot of risks so they are careful. Some of them even buy our seeds every year and plant. A lot of them have the experience now about the rainfall pattern which is critical”* (MOFA Officer in charge of crops)

The local knowledge of rainfall is insufficient in reducing the risks of climate uncertainties and must be blended with technical scientific knowledge systems for effective timing of the raining season (Vogel, 2007; Yaro, 2013). The poor farmers are less successful with changing planting dates due to their reliance on only their local knowledge and experience about rainfall while rich farmers are more successful with the strategy as a result of their reliance on both local knowledge and scientific knowledge systems due to frequent interactions with MOFA officers and their ability to afford hybrid seeds which are easily adaptable to the changing climate.

5.4.5 Land Rotation

Table 5.6: Effectiveness of Land rotation against selected variables

LAND ROTATION			
VARIABLES	Effective	Not Effective	TOTAL
Wealth			
poor	154(93%)	12(7%)	166(100%)
non-poor	24(96%)	1(4%)	25(100%)
Rich	19(100%)	0(0%)	19(100%)
Location			
Sakai	94(94%)	6(6%)	100(100%)
Wellembelle	98(89%)	12(11%)	110(100%)
Experience			
20-30	69(93%)	5(7%)	74(100%)
31-40	63(93%)	5(7%)	68(100%)
41-50	40(95%)	2(5%)	42(100%)
51-60	16(100%)	0(0%)	16(100%)
60+	9(90%)	1(10%)	10(100%)

Source: Field Survey, 2014

Land rotation or what is also known as bush fallowing is a traditional way for land conservation among the local people. It is one of the common strategies for preserving the fertility of the soil for future cultivation in the Sissala east District. According to Gyasi, (2006) the bush fallow system proceeds on rotational basis around fixed settlements and conserves biodiversity through controlled use of fire to clear vegetation on a selective basis, use of non-burnt vegetation for mulching, minimal tillage, use of environmentally friendly low-impact tools and intercropping often among trees left in situ (Gyasi, 2006). This strategy was largely found to be more effective among rich farmers (100%) than poor farmers (93%) and more effective among farmers in Sakai (94%) than those in Wellembelle (89%). Younger farmers (93%) also found the strategy more effective than older farmers (90%). This is probably because Wellembelle has a higher population than Sakai and land fragmentation could be more common leading to longer fallow periods.

Land rotation is frequently practiced by poor farmers due to their small farm sizes and their inability to buy fertilizer hence the need to rotate the land in order to restore lost nutrients. *“For those of us who cannot buy fertilizer, rotating the land is important. It makes the soil become fertile again and we go back and farm there. Our farms are also small ones so we can always move them. I cultivate only 4 acres and I change the land every 5 years”* (Haluri, a woman farmer in Sakai). Non-poor farmers on the other hand change the land after 15 years of continuous cultivation because they can buy chemical fertilizer to fertilize their farmland and also due to their large farm sizes. *“I use fertilizer to farm on the same land for about 15 years before I move to the next land because now the land is scarce and my farm is about 28 acres which is not easy to change”*(Osman, a rich farmer in Sakai). The rich farmers however have longer fallow periods because their farm sizes are very large so they cannot easily change their land. *“It is not easy to get vast and fallow land. The farmers are increasing every day so land is becoming scarce. Even the women are now farming seriously. We can farm on the same land for over 25 years before we look for another land. If the nutrients are reducing, we use fertilizer. My farm is about 90 acres so I cannot easily find another big land which is fertile for me and my family”* (Silaburi, a rich farmer in Wellembelle).

Fallow periods are longer in Wellembelle than in Sakai because farmers in Wellembelle have higher adaptive capacities and large farm sizes and can afford more fertilizer.

Fallow periods vary across different categories of farmers and space in the practice of land rotation in the area. Poor farmers have shorter periods than non-poor and rich farmers due to the low scale of production among poor farmers and their inability to buy enough fertilizer to fertilize their farmlands. Rich farmers have longer fallow periods than poor farmers. The system of farming is however challenged by certain non-climatic factors (social change processes) such as rapid population growth in

communities and the gradual breaking down of the extended family system which has led to increasing scarcity of land and fragmentation of agricultural holdings. I therefore acknowledge that, soil fertility lost cannot be attributed to only climate change but could also be due to continuous cultivation of the land.

5.4.6 Tillage Practice

Tillage practice is a common practice among households in Northern Ghana (Antwi Agyei et al (2013). This is basically due to the nature of the soil in Northern Ghana which is lateritic and hard and therefore needs to be loosened on annual basis (MOFA, 2010). Poor farmers (85%) found the strategy more effective than rich farmers (79%). Again, farmers in Wellembelle (88%) found the strategy more effective than their counterparts in Sakai (82%), while older farmers (90%) were more successful with this strategy than younger farmers (81%).

Table 5.7: Effectiveness of Tillage Practice against selected variables

TILLAGE PRACTICE			
VARIABLES	Effective	Not Effective	TOTAL
Wealth			
poor	141(85%)	25(15%)	166(100%)
non-poor	19(76%)	6(24%)	25(100%)
Rich	15(79%)	4(21%)	19(100%)
Location			
Sakai	82(82%)	18(18%)	100(100%)
Wellembelle	97(88%)	13(12%)	110(100%)
Experience			
20-30	60(81%)	14(19%)	74(100%)
31-40	54(79%)	14(21%)	68(100%)
41-50	36(86%)	6(14%)	42(100%)
51-60	16(100%)	0(0%)	16(100%)
60+	9(90%)	1(10%)	10(100%)

Source: Field Survey, 2014

A lot of poor farmers use environmentally low impact implements such as the hoe and Bullocks to till their farmland. "Because the tractor operators charge too much I

always use my hands or my bullocks to till my farm before I plant my crops. Last year they were charging GHC 65 for each acre of land they tilled. We need help". (Benin, a farmer in Sakai). The non-poor farmers hire tractors to till their land while some of the rich farmers own their own tractors and combine harvesters while some hire and use. Tilling the land is more effective among the rich farmers because they have large farm sizes and also produce basically cereals and grains which need the soil to be constantly loosened. *"We only use tractor to till our land because our farm is very big. We don't have our own tractor so we hire one every year but some of the farmers have bought tractor and 'convan"* (Samsideen, a 42-year old maize farmer in Wellembelle)

In an interview with Sumani, a farmer in Sakai, he said, *"These days the rains don't come as we want. So the soil is always dry and hard and when we till, it becomes loose and anytime that it rains the water easily enters the soil no matter how small the rain is..... There are some crops if you don't till the land and you sow them, they don't do well at all"*. They said that tilling the land before planting their crops helps to control weeds on their farm leading to higher crop yields and increased income.

The practice is more effective in Wellembelle because, farmers in Wellembelle produce on a larger scale and can afford more tractor services than their counterparts in Sakai.

Tillage practices are much more effective among non-poor and rich farmers because of their medium and large scale production approaches to farming than the poor and inexperienced farmers. Poor farmers are not able to pay for the services of tractor operators as a result they use either hoes or bullocks which have limited impacts on the environment than the use of tractors by the non-poor and rich farmers.

5.4.7 Cover Cropping/Mulching.

Table 5.8: Effectiveness of Cover Cropping/Mulching against selected variables

COVER CROPPING/MULCHING			
VARIABLES	Effective	Not Effective	TOTAL
Wealth			
poor	163(98%)	3(2%)	166(100%)
non-poor	18(72%)	7(28%)	25(100%)
Rich	10(53%)	9(47%)	19(100%)
Location			
Sakai	85(85%)	15(15%)	100(100%)
Wellembelle	80(73%)	30(27%)	110(100%)
Experience			
20-30	59(80%)	15(20%)	74(100%)
31-40	53(78%)	15(22%)	68(100%)
41-50	33(79%)	9(21%)	42(100%)
51-60	15(94%)	1(6%)	16(100%)
60+	9(90%)	1(10%)	10(100%)

Source: Field Survey, 2014

Cover crops are crop planted primarily to manage soil erosion, soil quality, water, weeds, pests, diseases, biodiversity and wildlife in an agro ecosystem (Gyasi et al 2006). Farmers in the study area cultivate different types of leguminous crops which protect the soil and also fix nitrogen to the soil. These crops basically include different types of beans, groundnuts and Bambara beans. These crops are normally the minor crops as major crops are normally cereals and grains. Poor and older farmers are more successful with the cultivation of cover crops than the rich and young farmers.

Poor farmers (98%) and experienced (90%) farmers cultivated more cover crops when compared with non – poor (72%) and rich farmers (53%). Farmers in Sakai (85%) found cover crops more effective than their counterparts in Wellembelle (73%). This is because; these crops require little or no fertilizer and are suitable for the situation of the poor farmers. They cultivate a lot of yam, beans and groundnuts and these crops give cover to the soil. “.....because I cannot buy fertilizer I grow 3 acres of groundnuts, 2 acres of beans and a little of millet which we use for TZ and I sell some of the

groundnuts and beans to pay my daughter's school fees and light bill. I also produce small yam for eating in the farm. This is what helps us....." (Hillia, a farmer in Sakai)

Non-poor and rich farmers cultivate more cereals and grains with little emphasis on cover crops. This is because they can afford fertilizer for their farms. They also argued that if they cultivate cover crops like beans and groundnuts on a large scale, they cannot harvest since harvesting cover crops is difficult. *"Officer, we grow our crops on a large scale. If I grow 30 acres of groundnuts or beans, how do I harvest them? There are no machines for harvesting groundnuts and beans. That is why we produce more maize even though we buy a lot of fertilizer so that the tractor operators can harvest them for us with their 'Convan'. This is what we do to make life easy for us here"* (Bakuruba, a 69-year old farmer in Sakai).

The poor and experienced farmers whose main emphasis is on growing crops which require little or no fertilizer because of their poor financial position in society are more successful with the growing of cover crops. Non-poor and rich farmers however produce mainly cereals and grains which are easy to harvest but require a lot of fertilizer due to their medium and large scale of production respectively. Cultivation of cover crops is therefore associated more with farmers with low adaptive capacities.

5.4.8 Change Consumption

Table 5.9: Effectiveness of Changing Consumption against selected variables

CHANGE CONSUMPTION			
VARIABLES	Effective	Not Effective	TOTAL
Wealth			
poor	117(70%)	49(30%)	166(100%)
non-poor	21(84%)	4(16%)	25(100%)
Rich	14(74%)	5(26%)	19(100%)
Location			
Sakai	78(78%)	22(22%)	100(100%)
Wellembelle	79(72%)	31(28%)	110(100%)
Experience			
20-30	48(65%)	26(35%)	74(100%)
31-40	51(75%)	17(25%)	68(100%)
41-50	35(83%)	7(17%)	42(100%)
51-60	11(69%)	5(31%)	16(100%)
60+	7(70%)	3(30%)	10(100%)

Source: Field Survey, 2014

More than 70% of all categories of farmers in the area said that changing their consumption behaviour in difficult times of food shortages caused by flooding and droughts is effective in ensuring food security throughout the year. However, rich farmers (74%) found the strategy more effective than poor farmers (70%). This was not expected. Also, it was more effective for older farmers (70%) than younger farmers (65%). Farmers in Wellembelle (72%) were less successful with the strategy than their counterparts in Sakai (78%). See table 5.9 above.

The poor farmers simply changed the type and quantity of the meals they consumed. *“We are not fortunate like the rich people. We eat yam in the farm but when the yam finishes we boil maize and chew in the farm until we get some beans. The years that the rains don’t fall enough the yam doesn’t do well so we boil maize and chew throughout the farming season. Sometimes we even reduce the quantity of maize we boil because we have to manage. Sometimes we eat once in a day”* (Jabuni, a farmer in Sakai) Non-

poor and rich farmers only changed the type of meals without changing the quantity of the meal type they consumed. *“We eat only yam in the farm, but if the yam fails due to poor rains, we eat beans in the farm. Sometimes I let my wives prepare TZ in the house and bring it to the farm in the afternoon. Once in a while we also buy some yam in the market. We don’t reduce the quantity of whatever food we eat. Some people do but we don’t do that. You will grow lean and everybody will know. Why? Why?”*(Juawie, a farmer in Wellembelle)

The approach to changing consumption during periods of crop failure varied across different categories of farmers and location. Poor households changed the type and quantity and even the number of times they consumed, non-poor and rich households simply changed only the type of meals consumed, whiles maintaining the same level of consumption since they produce more than they can consume. The strategy was more effective for the poor farmers, experienced farmers and farmers in Sakai than in Wellembelle.

5.4.9 Water Harvesting

Table 5.10: Effectiveness of Water Harvesting against selected variables

WATER HARVESTING			
VARIABLES	Effective	Not Effective	TOTAL
Wealth			
poor	82(49%)	84(51%)	166(100%)
non-poor	19(76%)	6(24%)	25(100%)
Rich	17(90%)	2(10%)	19(100%)
Location			
Sakai	39(39%)	61(61%)	100(100%)
Wellembelle	77(70%)	33(30%)	110(100%)
Experience			
20-30	42(57%)	32(43%)	74(100%)
31-40	34(50%)	34(50%)	68(100%)
41-50	24(57%)	18(43%)	42(100%)
51-60	7(44%)	9(56%)	16(100%)
60+	8(80%)	2(20%)	10(100%)

Source: Field Survey, 2014

The harvesting of rain water in the raining season for household consumption is practiced among households (Deribile, 2010; Antwi-Agyei et al, 2013). While more than 70% of non-poor and rich households were successful with harvesting rain water, only 49% of poor households were successful with the strategy. 57% of both experienced and younger farmers said the strategy was effective. The strategy was also more effective among households in Wellembelle (70%) than their counterparts in Sakai (39%). This was expected because Sakai has a water supply system unlike Wellembelle where residents rely on borehole water.

The strategy is more effective in Wellembelle than in Sakai because, Sakai has a small town water supply system which distributes water to homes and designated points for collection and use but households in Wellembelle rely on few boreholes and dams.

Some poor households still live in thatch and mud houses and therefore cannot harvest water from their roof tops. Some of those who live in zinc-roofed houses complained that they do not have money to buy big plastic containers and pots or construct underground tanks to collect and store rainwater. *"...as you can see my house is not roofed with zinc so how can I harvest water from there"* (Baluwie, a farmer in Sakai). Another farmer said that *"to harvest rain water, you must have big containers and pots. We don't make them here, and we have to go somewhere and buy them, and we don't have that kind of money. So we don't harvest rainwater. We are lucky water is not expensive here"* (Samari, a farmer in Wellembelle)

Non-poor and rich households have their houses roofed with zinc and are better placed to harvest rainwater. They buy big plastic containers and pots and place them at vantage points around the buildings to collect rainwater. No underground tank was seen or reported in the study communities. *"Each of my wives has two rubber drums and a*

big pot. We sent for the drums from Kumasi. As for the pots we bought them from Duwie where they make a lot of pots and we hire a tractor to go and bring them here. They are now about 8 years old. They can last for even 20 years that is why we bought them” (Baluri, a farmer in Sakai).

During focus group discussion, the people said harvesting rain water helps them to save money that they spend buying water for household use. *“It helps us to stop using our money to buy water always which is very good and it is also good for watching things”*(chapuri, a 44-year old farmer in Wellembelle)

Some said rainwater cannot be kept for long. They also said they have rain Gods in their homes which forbid them from drinking rain water in their homes. *“Harvesting rain water is good because you can use it for washing, bathing and some even drink it and some people do that but for us in this house we taboo rainwater because we have a rain God which makes the rain fall but when my daughters marry and move out of this house they can harvest and use It”* (Kanton-Gboku, a 48-year old farmer in Sakai)

Harvesting rainwater is a more effective strategy among non-poor and rich households than the poor households because the non-poor and rich households have the material resources for harvesting and storing water which manifests in their block and zinc-roof houses and the presence of big containers and therefore have a higher adaptive capacity than the poor households some who still live in thatch houses and cannot afford water storage containers. It is also more successful in Wellembelle than in Sakai.

5.4.10 Migration to Urban Areas

Table 5.11: Effectiveness of Migration against selected variables

MIGRATION TO URBAN AREAS			
VARIABLES	Effective	Not Effective	TOTAL
Wealth			
poor	91(55%)	75(45%)	166(100%)
non-poor	7(28%)	18(72%)	25(100%)
Rich	2(11%)	17(89%)	19(100%)
Location			
Sakai	67(67%)	33(33%)	100(100%)
Wellembelle	42(38%)	68(62%)	110(100%)
Experience			
20-30	40(54%)	34(46%)	74(100%)
31-40	38(56%)	30(44%)	68(100%)
41-50	17(41%)	25(59%)	42(100%)
51-60	1(6%)	15(94%)	16(100%)
60+	0(0%)	10(100%)	10(100%)

Source: Field Survey, 2014

The phenomenon is an age-old one among the inhabitants of Northern Ghana where rainfall is seasonal and alternatives jobs are limited (Gyasi, 2006). Also, Laube et al, (2011) documented that, migration in northern Ghana is induced by food shortages. Migration to urban areas in periods of low crop production was found to be more effective among poor farmers and young farmers than the old, non-poor and rich farmers. While 55% of poor farmers said the strategy is effective, less than 30% of non-poor and rich farmers said it is effective. More households in Sakai (67%) migrated than in Wellembelle (38%). Younger farmers tended to be more migratory (54%) than older farmers (0%). This was expected because; younger farmers have more energy to move about and are more adventurous. Average household income was also higher in Wellembelle than in Sakai and this probably accounted for the difference.

Poor farmers have very limited adaptive capacity and depend only on their crops and their own labour. They don't have cattle and a lot of sheep and goats that they can sell

when crops fail so they tend to migrate to urban areas in such of alternative means of survival. *“Last year when my son completed JHS and we realized that our crops were not going to do well because the rain did not come properly, I advised him to go to Kumasi and find Job to do because I don’t have cows and sheep that I can sell He got money to buy his things..... I know my son is good and his teachers keep telling me that he is very good. He got aggregate twelve (12) and he is now in Kanton Senior High School. I know God will bless him to become a big man in future”* (Luriwie, a farmer in Sakai)

Non-poor and rich farmers tend to have more knowledge about the rainfall pattern because of their close association with the extension officers who give them technical advice so they hardly lose out badly even though they face higher risks. Most of them also have cattle which they hire Fulani herdsmen to take care of and ten to fall on these animals in periods of low crop output. *“I rely so much on the agric officers. Some of them are my friends and they visit my farm always and I give them yam and some fowls. They will tell you to do this and that. So when other farmers are not getting anything, we get something. But if it is so bad, I sell some of my cows and farm again. I don’t allow my children to move to other towns because they will cause problems”* (Seidu, a farmer in Sakai).

On the contrary, some of the participants argued that the strategy has affected them negatively because some of their children go to the urban centres and rather come back with a lot of problems such as strange diseases that are not known to them. Some of the girls also get pregnant and some even remained there and get married to people their families do not know. *“.....and my daughter went to Kumasi and fell sick last year and the brother went and brought her and we treated her and she has ran back there again. Just last week I heard that she is married to a Dagomba man. We don’t even know the*

man. It is painful. I cannot forgive her if she does not go to school again” (Saani, a maize farmer)

Poor and inexperienced farmers have a higher propensity to migrate to urban areas for alternative employment avenues because of their low level of resilience to the vagaries of the weather due to their reliance on only crops and their low knowledge of farming than the non-poor and rich farmers who have high resilience due to their ability to access technical advice and their ownership of cattle and other livestock. Also, farmers in Sakai tend to be more migratory than those in Wellembelle due to low resilience. Laube et al (2011) argued that Migration is induced by food shortages in rural areas.

5.4.11 Irrigation

Table 5.12: Effectiveness of Irrigation against selected variables

IRRIGATION			
VARIABLES	Effective	Not Effective	TOTAL
Wealth			
poor	47(28%)	119(72%)	166(100%)
non-poor	16(64%)	9(36%)	25(100%)
Rich	8(42%)	11(58%)	19(100%)
Location			
Sakai	0(0%)	100(100%)	100(100%)
Wellembelle	70(64%)	40(36%)	110(100%)
Experience			
20-30	28(38%)	46(62%)	74(100%)
31-40	21(31%)	47(69%)	68(100%)
41-50	16(38%)	26(62%)	42(100%)
51-60	3(19%)	13(81%)	16(100%)
60+	3(30%)	7(70%)	10(100%)

Studies by Atwi-Agyei (2013), Mabe et al (2012), and Armah et al (2013) identified small scale irrigation as an important adaptation mechanism to low rainfall in northern Ghana. During this period, households use dam water from communities that have dams to produce basically vegetables in their gardens for local markets and also for

household consumption. A greater number of non-poor farmers (64%) said irrigation is effective compared to the poor (28%) and rich farmers (42%). Also, the strategy was more effective in Wellembelle (64%) than in Sakai (0%). This is because, Wellembelle, unlike Sakai has an irrigation dam. The strategy was also more effective among younger farmers (38%) than older farmers (30%).

Poor and older farmers mostly produced vegetables in their gardens in project area. They usually focused on the immediate future. The non-poor farmers on the other hand planted mangoes and moringa plants in the project area. Some cultivated a little bit of banana and plantain. The rich farmers only fed their livestock with the Dam water *“I grow only onions, cabbage, pepper and tomatoes because need money immediately to buy fertilizer for my farm and pay my son’s fees. Those who already have money are those who grow those mangoes and the banana and the bitter leaves down there. Some of them only bring their animals to the dam to drink the water. Their animals drink a lot of the water”* (Maani, an experienced farmer)

The poor farmers said, during periods of crop failure in the area due to poor rainfall, they are able to raise money from their irrigation gardens and buy food to supplement their household feeding, pay school fees of their children and also invest the rest in their main farms in the next farming season. They buy fertilizer and weedicides and also pay for tractor services in tilling the land. They also use the water from irrigation dam to build their houses in the dry season. Their animals also drink from the Dam though some of them complained that crocodiles in the Dam water kill their animals when they go there to drink water. Additionally, they argued that making gardens with sticks from the bush is difficult since they have to go and cut the sticks in the bush and carry them home. *“We want the government to help us with wire so that we can fence our vegetables because of animals. Now getting the sticks is difficult. People have cut*

all. We go far to get correct sticks” (Luki, a farmer in Sakai). I observed that most of the gardens in the project area were made with wood and these gardens according to them are strengthened every year with fresh wood from the bush. This destroys the natural vegetation. The free range system of keeping animals is practiced in the area; it is therefore difficult to grow crops in the project area without fences since the animals destroy their crops. Barnett and O’Neill (2010) argued that adaptation actions are not sustainable if they adversely affect the environment.

The practice of irrigation is effective in mitigating the poor against the impacts of climate change as it provides an escape route from hunger and situations of lack of money. Adger et al (2005) noted that strategies are effective if they lead to the achievement of livelihood objectives while reducing impacts of climate change. Proceeds from the sale of vegetables are a funding source for the main farms of the poor farmer and in meeting household obligations. There is however, limited application of irrigation in the study area primary due to inadequate irrigation facilities. It is also effective among young farmers than old farmers. Its practice must however be regulated as the continuous use of wood from the bush for gardens on annual basis may eventually lead to the desertification of the area.

5.4.12 Compost/ manure

Table 5.13: Effectiveness of Compost/Manure against selected variables.

COMPOST/MANURE			
VARIABLES	Effective	Not Effective	TOTAL
Wealth			
poor	55(33%)	111(67%)	166(100%)
non-poor	7(28%)	18(72%)	25(100%)
Rich	12(63%)	7(37%)	19(100%)
Location			
Sakai	32(32%)	68(68%)	100(100%)
Wellembelle	34(31%)	76(69%)	110(100%)
Experience			
20-30	21(28%)	53(72%)	74(100%)
31-40	24(35%)	44(65%)	68(100%)
41-50	15(36%)	27(64%)	42(100%)
51-60	9(56%)	7(44%)	16(100%)
60+	5(50%)	5(50%)	10(100%)

Source: Field Survey, 2014

Even though a lot of farmers do animal rearing as a secondary occupation in the area (MOFA, 2010), the use of manure and compost for farming is a less popular strategy. Whiles less than 34% of the poor and non-poor farmers find the strategy to be effective, about 63% of rich farmers said the strategy is effective in mitigating impacts. The strategy was more effective among older farmers (50%) than younger farmers (28%). It was also found to be more effective in Sakai (32%) than in Wellembelle (31%).

The Poor households who use manure carry it directly in buckets and sucks from kraals and their homes where they keep their livestock to their farmers and backyard gardens. *“Sometimes my wives carry the cow and fowl faeces and we drop it in some parts of our farms since the agric people say it is good. But what we realize is that where we put these faeces in the farm”* (Luki, a farmer in Sakai)). Non-poor and rich households construct structures where manure and household refuse are kept and later transported to their farms and gardens upon decomposition. *“.....it is good but my farm is very big*

so put it in just a small part. We construct some pit with cement and we keep the animals and fowl shit there for it to rot and we use the bullock cart to move it to the farm. Weeds come and we spray them with chemicals. But we use fertilizer more since the farm is big” (Kantongboku, a farmer in Sakai)

Most of the people said, they only used manure in their backyard gardens. They argued that manure promotes the growth of weeds on their farms. If they applied more manure on their farms in a particular year crops will do well but they also spent more money buying weedicides and pesticides. *‘Some of the weeds that grow on the farm when cow faeces are used on the farm even resist some weedicides. We therefore have to use a different kind of weedicides on such weeds which are difficult to get. When we do not get that one we use hired labour to weed our farms which is very costly”* (Jabuni, a farmer in Sakai). Some farmers also said that, because of the stealing of cattle by Fulani herdsmen, it has become difficult to get manure to apply to their farms since their cattle have been stolen. Others said the strategy is good but they do not have any means of transporting manure or compost to their main farms. Many farmers also believed that maize produce using manure or compost does not taste so nice when roasted compared with the one that is produce without manure. Those who believed in the effectiveness of the strategy in reducing impacts said *“when manure or compost is applied to the soil, it is difficult for the soil to lose its nutrients.....it also keeps our compounds neat and helps us avoid paying fines to sanitary inspector”*(Dagbesiwie, a farmer in Sakai).

Even though the application of manure/compost to the soil is good for soil enrichment, its use is very low and less successful among poor and non-poor farmers in the area because it promotes the growth of weeds on their farms putting an additional burden of weeding the farm on regular basis. Rich households construct structures to store

manure and can also buy weedicides for weed control and are therefore indifferent to the use of manure/compost.

5.5 Social Change Processes (Non-climatic Factors) Which Have Affected the Effectiveness of Some Traditional Adaptation Mechanisms over Time.

As society is dynamic, practices and processes within it keep changing and these changes either affect the society core function either positively or negatively. Individual interviews with some experienced people within the study area revealed that some of the adaptation strategies which were used by the farmers have dwindled in their effectiveness due to some social change processes (non-climatic factors).

5.5.1 Breakdown of the extended family system

The extended family system which was the basic building block of every community in the north has gradually given way to the nuclear family system which emphasis more on individual success at the expense of family success. The cultivation of more land has been attributed to the situation where every family member together with his wife and his children now has their own farm. Luki, an experienced farmer in Sakai said, *“In time past, every extended family had a single farm where every member of the family works. So therefore, there were few farms in each community hence land for cultivation was not a problem. But now everybody has his own farm. So my family which used to have only one farm now has more than ten farms. Each of my children and their wives now has their own farms. They don’t mind me again so I also struggle in my garden. Fertile lands for farming have been exhausted”*. This situation has affected the effectiveness of bush fallowing as an adaptation measure to declining soil fertility associated with climate change. And has made shifting cultivation impossible to practice in the area. We now have reduced fallow periods and in most cases people now have to continuously cultivate on the same piece of land because there are no more

virgin lands anywhere. At the same time, poverty makes it difficult for farmers to buy inputs to re fertilize their farmlands. The increasing number of individuals who now own their own farms has led to the shortage of land and has affected the effectiveness of bush fallowing as an adaptation option.

5.5.2 Population Growth and the Use of Modern Farming Technology

There has been a change in farming technology from the use of hoe and cutlass to the use of tractors and other farm implements and chemicals. Today's farming technology destroys the land. The use of tractors for tilling the land turns the top soil upside-down. The poor soil is brought to the top and good one sent down leading to poor crop yield. Sumani, an experienced farmer said that *"tilling the land with bullocks is the best but few farmers now use bullocks for tilling their land because they can no longer take care of bullocks. Their children have to go to school and also the stealing of cattle has become rampant"*. According to the people, population growth and the use of modern farming technology have led to increasing shortage of farm land and decreasing soil fertility due to continuous cultivation of the land. This is also acknowledged by Gyasi et al (2006). Farmers who have money easily cultivate on very large scale and more people now engage in farming than in the past. This they said has affected the effectiveness of bush fallowing as an adaptation mechanism to declining soil condition associated with poor rainfall and high temperature. Plots of farmlands that were left to fallow for some time after a period of farming in order for them to regain lost fertility are now cultivated on frequent basis. Fallow periods are now very short. This has led to declining soil fertility. The rapid increase in population of the communities has led to increasing scarcity of land and fragmentation of agricultural holdings with the need for intensification practices. But again poverty has been cited as a barrier for proper intensification.

5.5.3 Creation of game reserves

Government policy on the creation of game reserves in order to preserve certain life forms for posterity has led to the taking away of part of the arable land for the two communities to form the Gbele game reserve. The communities have therefore exhausted the remaining land for cultivation but must continue to fragment it. Participants in a focus group discussion argued that, the most fertile part of their arable land has been protected by the government as a game and wildlife reserve known as the “Gbele Game reserve”. This has made it difficult for them to have adequate land to rotate. The forest reserve has taken our land and we now want to farm on it. *“We are pleading with government to release part of it for us to farm and feed our children if not we don’t have enough land to farm on it.....”* (Sumaila, An experienced farmer).

5.5.4 Western education and the Development of Amenities.

Interviews with farmers revealed that, the objectives of households in farming have changed over time. In time past, the main purpose of farming was to produce enough food to feed the household throughout the year. But in recent times the increasing cost of education of their children, increased cost of farming and the payment of utility bills has made most farmers to now farm for money to the extent that some even sell the little food they produce to pay school fees at the expense of food security for the household. *“I must get money from our farm to pay school fees of my children and water and electricity bills. Four of my children are in school.....now it not like the first when we did not have these things here”* (Chapuri, a farmer in Wellembelle).

5.6 Binary Logistic Regression analysis on Strategies

Irrigation: The model was significant at 1%; p-value of 0.0000. Respondents from Sakai were over 321 times less likely to adopt an intensive irrigation strategy in adapting to climate change as compared to those in Wellembelle. This was expected because Sakai unlike Wellembelle does not have an irrigation dam (SEDA, 2014). The respondents who wanted to increase their crop output, were about twice less likely to intensify irrigation compared to those didn't want to increase their crop output; p-value of 0.056. See Table C in Appendice D.

Water- harvesting : From table D in Appendice D, households from Sakai, were about 2 times less likely to adopt water harvesting strategy as a way of coping with climate change than those from Wellembelle; p-value of 0.087. This was also expected because Sakai has a water supply system unlike Wellembelle (SEDA, 2014). On the other hand, people aged 61 years or older were about 9 times more likely to adopt a water harvesting strategy. This people were care takers of children during the day and were more likely to home when the rains are coming. However, households with more than 20 members were about 5 times less likely to harvest water compared to those with not more than 10 members; p-value of 0.012. This was not expected. Similarly, households whose income has been decreasing were about 3.6 times less likely to adopt a water harvesting strategy than those whose income has been increasing. This was expected. Also, farmers who wanted to achieve high yields were about 3 times less likely to adopt this strategy compared to those who didn't want to increase crop yield. On the contrary, farmers whose objective was to increase their family's income were about 4 times more likely to adopt a water harvesting strategy.

Change planting date: This model was significant at 5% given a p-value of 0.0165 from a binary logistic regression. Farmers from Sakai were about 4.6 times more likely

to change their planting date compared to those from Wellembelle. Similarly, farmers who had the intention of increasing their crop output were about 4.7 times more likely to change their planting date. However, households with decreasing income were much unlikely to change their planting date; about 4.5 times less likely compared to those with increasing family income. This difference was significant at 1% given a p-value of 0.009. See Table E in Appendice D.

Tillage practice: From table F, farmers whose objective was to increase crop output were about 3 times more likely to adopt tillage practices; p-value of 0.009. Also, farmers from Sakai were about 2.7 times more likely to adopt tillage practices compared to those from Wellembelle. On the other hand, farmers with decreasing family income were about 4.5 times less likely to adopt this, compared to those with increasing family income; p-value of 0.018. See table F in Appendice D.

Cover cropping / mulching: Sakai farmers were about 4.5 times more likely to adopt this strategy than Wellembelle farmers. These differences were significant at 1%; p-value of 0.002. On the other hand, farmers with the intention of reaping higher yields were about 3.5 times less likely to practice cover cropping. See table G.

Land rotation: The land rotation model was significant at 10%; p-value of 0.0907. The results indicate that male farmers were about 10 times more likely to rotate their farm land than female farmers. This was however, significant at 1%; p-value of 0.002. See table H in Appendice D

Migration to urban areas: Farmers whose objective was to experience an increased crop output were about 4 times more likely to seasonally migrate to urban areas than those without this objective. Also, respondents from Sakai were over 5 times more likely to seasonally migrate to urban areas as compared to those from Wellembelle. On the

other hand, respondents aged 51-60 years and above 60 years were about 4 and 7 times respectively, less likely to occasionally migrate to urban areas as compared to those aged 20-30 years, respectively. These differences were significant at 5% each. See table I in Appendice D

Change in consumption: The factors that influenced respondents change in consumption strategy are geographical location of the respondent, age, household size, and the respondent's quest to increase family income and crop output. Respondents from Sakai were about 2 times less likely to change their consumption compared to those in Wellembelle as means to adapt to climate change. On the other hand, respondents aged 41-50 years were about 3 times more likely to change their consumption compared to those aged 20-30 years. Also, respondents who wanted to increase their family income and crop output were twice more likely to change to their consumption than those who didn't have these objectives. Furthermore, households with more than 20 members were about 3.4 times more likely to change their consumption. See table J in Appendice D

5.7 Discussion

Results of binary regression analysis which are largely in tendon with other results presented in this work have shown that, location, sex, age, household size and the livelihood objective of the household are important characteristics of households which influence the effectiveness of their adaptation. This resonates with the argument of Armah et al (2013). Consistent with the DFID (1999) framework, results of this work indicates that, the success of a household's adaptation is contingent on the wealth, knowledge and location of the household. The framework shows that, access to social, financial, natural and human resources are key determinants in building resilience to climate change (Ashley and Carney, 1999). Non-poor and rich households who can

afford to use weedicides/pesticides and chemical fertilizer on cash-and-carry basis are more successful with the strategies than the poor farmers who contract these things on loan, and pay higher prices or hire their own labour to the rich farmers and end up spending little time on their own farms because they have to work for rich farmers in other to get money to buy these chemicals. Again, farmers located in Wellembelle have higher adaptive capacity and are more successful with their adaptation than those in Sakai due to the fact that Wellembelle has an irrigation dam high average household income and its closed proximity to important marketing centres. This supports the work of Mabe et al (2012), who argued that farmers who have high adaptive capacity are more successful with increasing output of rice through the use of chemical fertilizer in northern region than farmers with low adaptive capacity. Derbile (2010) also found out that, poor farmers work for the rich farmers on their farms in other to get food and money and some of them also give their daughters to rich people to marry in other to get support from their in-laws as an adaptation mechanism to climate change.

Again, rich farmers are more successful with changing planting dates in accordance with the on-set of rains because they have more knowledge of rains patterns than the poor farmers due to their close association with agric extension officers. Through these contacts, scientific knowledge systems are combined with the indigenous knowledge systems to the benefit of the rich farmers. Laube et al (2011) identified poverty as barrier to effective climate change adaptation.

This corroborates the argument of Yaro (2013), who found out that large scale farmers face a higher production risks but understand the science of climate change better than the small scale farmers in Ghana. This work has shown that, the knowledge of climate is a critical determinant of success in building sustained livelihoods for the poor rural households in the Sissala area and must be factored into climate policy.

Similarly, non-poor, experienced and rich farmers are more successful with tillage practices and water harvesting due to their ability to pay for tractors services and also buy water storage containers respectively. Rich and experience farmers cultivate on a large scale and higher tractor services to till their land compare to the poor farmers who use basically hoe and cutlass to till their land because of their small scale production. Farmers in Wellembelle are more successful with the strategy because of their higher adaptive capacities. Gyasi (2006), coming from a land management perspective found out that, traditional farmers use environmentally low impact techniques such as the use of hoe and cutlass technology and minimal use of fire to manage their land. But in relating this to household income, this work has shown that ,it is because most of these farmers are poor and cannot produce on a large scale neither can they hire tractors to till their land, hence the use of crude implements and techniques for farming.

Migration and the cultivation of cover crops (basically legumes and yam) is a more effective strategy for the poor farmers than the other categories of farmers. The inability of Poor farmers to afford fertilizer and other inputs consigned them to the cultivation of basically Legumes and little millet. They also have a higher propensity to migrate. Farmers in Sakai tend to migrate more than their counterparts in Sakai due to their low adaptive capacities and lack of alternative farming opportunities. Van der Geest (2011) identified migration in northern Ghana as a purely environmental problem. But this work has shown that, it is rather the poor households who cannot effectively adapt to the environment who migrate more. So it has more to deal with poverty than the environment per say.

In line with this, Laube et al (2011) found out that, seasonal migration takes place when food stocks in northern peasant households run drastically low especially in years with poor harvest. This work has shown that migration level varies among different

categories of farming households and that it is the poor household members who migrate more in years of low harvest due to their low adaptive capacities. The location of the household is also an important determinant of migration. Provision of subsidized inputs to the poor farmers and guaranteed markets for their produce will increase their adaptive capacities and build their resilience to climate change which will subsequently reduce migration to urban centres in difficult times in search of alternative jobs.

Proceeds from the sale of vegetables provide alternative funding source for the poor farmers in buying farm inputs and in meeting household's obligations making the strategy more a success for the poor than the rich farmers. Irrigation development can significantly increase the adaptive capacities of poor farmers in the area. This also validates the argument of Mabe et al (2012), that formal irrigation enhances the adaptive capacity of poor households in northern region. In the practice of land rotation, poor farmers have short fallow periods than the rich farmers due to the inability of the former to artificially enrich the soil with chemical fertilizer hence rotate the land more frequently than the rich farmers. Gyasi (2006) viewed this as a traditional land conservation practice. But variation in the frequency of rotation between poor and rich farmers means that it is driven by household wealth. Fallow periods vary between the two communities because of their difference in spatial location with Wellembelle more strategically located than Sakai. The significance of spatial location has therefore been justified by this work.

It is however revealing that some of the adaptation mechanisms of households in the area are like a double-edge sword cutting from both sides. Whiles these strategies provide a means to achieving livelihood objectives and reducing impacts of climatic hazards in the short-run, the long term likely impacts of some of the strategies on the

environment and on the people threaten their sustainability. What Barnett and O'Neill (2010) described as a pathway to maladaptation.

The use and misuse of weedicides/pesticides especially for fishing and for spraying of backyards and farms reduces livestock population in the area, affect human health and the environment negatively due to low knowledge. This confirms the argument of Eriksen and O'Brien (2007) that adaptation can sometimes produce unintended negative effects which may threaten its sustainability. This situation also causes inequalities between livestock and crop producers, since crop producers who used such chemicals will gain while livestock producers lose out. Eriksen and Lind (2009) again, argued that adaptation is not sustainable if it creates inequalities in society.

The unintended effects of irrigation could be desertification of the area due to continuous use of wood for gardens annually in the project area. Fence gardens are strengthened every year with fresh wood from the bush. In line with this, Barnett and O'Neil (2010) argued that adaptation could lead to unintended negative effects on the people and the environment and could be maladaptive in the long run. Even though compost/manure is effective, it is less patronized by households in the area.

Farmers used hybrid seeds which they get on loan together with other inputs from organizations in the district. Their own local varieties of crops have now been abandoned limiting their choices and they depend on these organizations every year for seeds and inputs which creates dependency relations and exploitation by paying higher prices for inputs. Barnett and O'Neill (2010) argued that strategies are maladaptive if they create path dependency and disproportionately burden the poor.

CHAPTER SIX: FINDINGS, CONCLUSION AND RECOMMENDATIONS

6.0 Introduction

The main aim of this study is to assess the effectiveness of agricultural households' strategies. This chapter presents the major findings of the work and draws a conclusion. It goes ahead to make recommendations for future research and for policy.

6.1 Findings

Findings are presented along the major themes of this work. These include, climatic threats/impacts in the Sissala area, households' objectives and adaptation strategies and the determinants of effective adaptation.

6.1.1 Climatic threats/impacts in the Sissala area

Identified climatic threats/impacts in the Sissala area include: Incidence of droughts, floods, rainstorms, pests and diseases, and the ever increasing unpredictability of rainfall which continue to threaten livelihoods of agricultural households. Droughts, floods, pests and rainstorm have already caused losses to crops, farmland, human life, public buildings, road infrastructure and other personal properties in the past.

6.1.2 Household Objectives and Adaptation Strategies

The study has revealed that, the main objectives of agricultural households in Sissala area in adapting their livelihood to climate change through diverse strategies are to achieve: food security increased family income and increased crop output. Most households target more than one objective in each growing season. The additionally contribution that this work makes to literature is that, it has unraveled the seeming shift of emphasis in terms of households' objectives from achieving food security to increased crop output and family income due to the need to pay for the cost of social

services such as school fees, water and electricity bills and meeting other household obligations. Farmers argued that, even though they produce to feed their families, they focus on getting money to pay schools of their wards, water and electricity bills. They therefore produce more maize and groundnuts which can easily be stored for longer time periods awaiting price increase in the market.

Location factors and the characteristics of household influence their adaptation strategies. More farmers in Wellembelle than in Sakai adopted weedicides/pesticides, chemical fertilizer, crop diversification, irrigation, tillage practices, changing consumption and water harvesting techniques. Households in Sakai tend to be more migratory, cultivate more cover crops, change their planting dates, apply manure/compost, and rotate their land than their counterparts in Wellembelle. Again, more females adopted, cover crops, water harvesting, irrigation, changing consumption, land rotation and migration than their male counterparts. Whiles older farmers adopted land rotation, cover crops, change consumption, tillage practice, water harvesting, changing planting dates and chemical fertilizer than the younger farmers.

6.1.3 Determinants of Effective Adaptation

The success of adaptation to climate change is contingent on the wealth of the farmer, sex, Knowledge/experience of farmer and location, presence of other income sources. These determinants cause variations in levels of effectiveness or success of adaptation among different categories of farmers in the area. Farmers located in Wellembelle have higher adaptive capacity and are more successful with their adaptation than those in Sakai due to the fact that Wellembelle has an irrigation dam, relatively `high average household income and its closed proximity to important marketing centres.

Non-poor and rich farmers are more successful with the use of weedicides/pesticides and chemical fertilizer because they have the money to buy these things with cash and

pay lower prices compare to the poor farmers who get these inputs on loan and pay higher prices for them. Experienced farmers are more successful with these strategies than the inexperienced ones. Again, the rich farmers and older farmers are more successful with changing their planting dates in accordance with the on-set of rains than the poor farmers. Also, with crop diversification, while poor farmers are more successful with the cultivation of different kinds of legumes, non-poor and rich farmers effectively cultivate basically cereals and grains as well as yam.

Non-poor and rich farmers effectively adopt tillage practices better than the poor farmers because of their large scale production and their ability to hire tractor services. In the practice of land rotation, fallow periods are shorter for poor farmers than the non-poor and rich farmers because the latter can afford more fertilizer for soil enrichment. The propensity for poor households' members to migrate to urban areas in periods of crop failure is higher than that of the rich households. The former are also more successful with the practice of irrigation than the latter in the area because, output from irrigation gardens provides a major source of funding for the former.

There are long-term threats pose by some of the adaptation strategies of farmers. The use and misuse of weedicides/pesticides and chemical fertilizer pollute water bodies, reduce livestock population and create inequalities between livestock and crop producers. The continuous use of would for irrigation gardens could lead to the desertification of the area. Compost/manure which is environmentally friendly is lowly patronized in the area due to reducing livestock population.

This work contributes effectively to the adaptation debate by showing that the mere identification of adaptation strategies as done by many scholars in literature is not enough in assessing the effectiveness of adaptation. It is the characteristics of the

household coupled with the internal dynamics associated with each strategy which determine success in adopting each strategy. Differentiated policies should be formulated for different categories of farmers considering their adaptive capacities and vulnerability levels in order to reduce inequalities and make adaptation more effective.

The work has also revealed certain underpinning factors which affect effective adaptation in the area. The presence of an irrigation dam, MTN/Vodafone mobile services, health centre and the close proximity to marketing centres all in the case of Wellembelle, enhance the adaptive capacity of households. Sakai has a small town water supply system which supports adaptation to droughts. More importantly the presence of farmer-based organizations, availability of arable land and economic trees and the use of modern technology of farming in the area provide opportunity for adaptation in both communities. However, alleged hoarding and smuggling of subsidized fertilizer and the nefarious activities of Fulani herdsmen negatively affect households' adaptation efforts in the area. Again, laziness, inexperience, poverty and illegally selling farm inputs contracted on loan on the part of some individual farmers negatively affect their adaptive capacities.

6.2 Conclusion

Farmers in the Sissala area have knowledge of climate change through both traditional means and awareness creation, via electronic media and mobile communication. Based on this knowledge, they have devised mechanisms such as crop diversification, the use of Weedicides/Pesticides, Chemical fertilizer, changing planting dates, land Rotation, tillage practice cover cropping/mulching change consumption, water harvesting, migration, irrigation, compost/manure among others to deal with the situation. This work gives credence to the arguments of Gyampoh et al (2007), Orlove et al (2010), Derbile (2010), Laube et al (2011), Mabe (2012) and Armah et al (2013) on the same subject as shown in the work above.

Due to the need to pay for social services, farming households' objectives have shifted from achieving food security to enhancing family income. Location factors and characteristics of households influence the adaptive capacities of farmers. Also the success of adaptation strategies adopted depend on wealth of the farmer, gender, experience and the ecological conditions of the community where farms are located. This resonates with the argument of Armah et al (2013) and also consistent with the DFID (1999). The framework shows that, access to social, financial, natural and human resources are key determinants in building resilience to climate change (Ashley and Carney, 1999).

There are however, long-term threats pose by some of the adaptation strategies of farmers. The use and misuse of weedicides/pesticides and chemical fertilizer pollute water bodies, reduce livestock population and create inequalities between livestock and crop producers. Eriksen and Lind (2009) argued that strategies are not sustainable if they create inequalities in society. The continuous use of would for irrigation gardens could lead to the desertification of the area. In line with this, Barnett and O'Neil (2010)

documented that adaptation could sometimes produce unintended negative effects on the environment which could lead to maladaptation in the long-run. Compost/manure which is environmentally friendly is lowly patronized in the area due to reducing livestock population.

This work contributes effectively to the adaptation debate by showing that the mere identification of adaptation strategies as done by many scholars in literature is not enough in adaptation. It is the characteristics of the household coupled with the internal dynamics associated with each strategy which determine success in adopting each strategy. Older farmers, experienced farmers and rich farmers are more successful with the strategies than young, inexperienced and poor farmers.

This work has shown the relevance of the DFID (1999) conceptual model which explains that rural households are vulnerable to shocks including floods, droughts, pests and diseases and can cope and alleviate their vulnerability depending on the resources at their disposal and the with the help of government and the private sector. The strategies that are used may also have a feedback mechanism on the climate system (Ashley and Carney, 1999). From this study, farmers with more financial resources and experience (human resource) are more successful in their adaptation than poor and inexperienced farmers. Access and control of resources are there important determinants of successful adaptation. The use and misuse of agrochemicals and the cutting of wood for making gardens in irrigation project area impact negatively on the environment which in the long-run may have a feedback mechanism with the climate system.

6.3 Recommendations

Vigorous poverty reduction interventions should be pursued by government in the area. Farmers should be given interest-free loans to enable them buy farm inputs. This will enhance their adaptive capacities.

Farmer-led negotiations should drive deals between farmers and organization which do business with farmers in the district especially when it comes to input pricing and the pricing of the final products to avoid exploitation of poor farmers by such organizations in contract arrangements. This will also reduce conflicts among actors involved.

Future research should examine the real impacts of weedicides/pesticides on animal health and livestock population and on the environment. But in the short-term farmers should be given training to build their capacity on the use of agrochemicals in order to prevent their misuse. Also, differentiated policies should be formulated for different categories of farmers considering their adaptive capacities and vulnerability levels in order to reduce inequalities and make adaptation more effective.

Monitoring mechanisms such as the installation of tracking devices on vehicles which carry subsidized fertilizer and the use of grass root supervisors should be put in place to prevent smuggling and ensure that subsidized inputs get to the poor rural farmers in order to enhance their adaptive capacity. Also, the Construction of irrigation dams in communities which do not have such facilities could ensure all-year round production which will provide additional income sources and reduce the vulnerability levels of the poor households to droughts and floods which usually destroy crops and other properties reducing the adaptive capacity of the poor rural farmers. Again, subsidized razor wire nets should be supplied to farmers in irrigation projects areas in order to prevent annualized cutting of wood from the bush for gardens in irrigation project areas which could eventually lead to desertification of the area.

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APPENDICES

APPENDICE A

UNIVERSITY OF GHANA, LEGON, ACCRA

DEPARTMENT OF GEOGRAPGHY AND RESOURCE DEVELOPMENT

I am a student of the above mentioned university conducting a research on the theme “**Assessing the Effectiveness of Agricultural Households’ strategies for Sustainable Adaptation to Climate Change**”. This research is for academic purposes and responses will be confidential.

Instruction: A household head or a representative of each household is required to answer on behalf of the household. Tick or write in the spaces provided.

BACKGROUND INFORMATION OF RESPONDENT

1. Name of community.....
2. Sex male [] female []
3. Age.....
4. Position of respondent in the household. 1. Household head [] 2. Wife of household head [] 3. Son/Daughter of household head. 4. Others, specify.....
5. How many years have you been living in this community.....
6. Educational status of respondent. 1. No formal education [] 2. Primary [] 3. JHS/Middle School [] 4. SHS/'O'level/'A' level/ Vocational [] 5. Tertiary []
7. Marital status. 1. Married [] 2. Single [] 3. Widowed 4. Divorced/Separated
8. Size of household (this include those away).....
9. Gender characteristics of household. 1. Number of males..... 2. Number of females.....
10. What is your main source of income? 1. Crop farming [] 2. Livestock farming [] 3. Hunting [] 4. Trading and commerce [] 5. Civil Servant [] 6. Others, specify.....
11. What are your other income sources? List them.....
12. What is your annual income? Estimate.....

13. Do you own a farm land in this community? 1. Yes [] 2. No []
14. How many acres of land do you have permanent use of?
.....
15. Select the items you own from the table below (Tick as many as possible)

Items Owned	Assets owned	
	Yes	No
1. Traction livestock (e.g. mule, horse, oxen)		
2. Car		
3. Plough		
4. Gas/kerosene stove		
5. Television		
6. Radio		
7. Bicycle/moped		
8. Iron roofed house		
9. Refrigerator		
10. Cellphone		

PERCEPTIONS OF CLIMATE CHANGE AND ITS IMPACTS

16. Do you think the temperature (Hotness or coldness of the environment) in this area has changed over the past 30 years? 1. Increased [] 2. Decreased [] 3. Extreme Fluctuations [] 4. No change [] 5. Don't know []
17. Do you think the rainfall pattern in this area has changed over the past 30 years 1? Increased [] 2. Decreased [] 3. Extreme Fluctuations [] 4. No change [] 5. Don't know []
18. Is the Climate Changing? 1. Yes [] 2. No [] 3. Don't know []
19. What do you think is responsible for the changes in rainfall and temperature? (1) Cutting down trees [] (2) Over grazing [] (3) Excessive cultivation [] (4) Others (specify.....)
20. How often does this area get flooded? 1. Every year [] 2. Every other year [] 3. Once in 5 years [] 4. Not common [] 5. Don't know []

21. How often do you experience droughts and dry spells during the farming season?

1. Frequently [] 2. Occasionally [] 3. Not common [] 4. Don't know []

22. How does changes in temperature affect your main economic activities?

.....

23. How does changes in rainfall affect your economic activities?

.....

24. How does flooding affect your economic activities?

.....

ADAPTATION STRATEGIES OF FARMERS AND THEIR ABILITY TO REDUCE IMPACTS OF CLIMATIC HAZARDS

25. What kind of crops do you cultivate? 1. Maize [] 2. Yam [] 3. Groundnut []
4. Millet [] 5. Cotton [] 6. Others,
specify.....

26. What type of livestock do you keep? 1. Cattle [] 2. Goats [] 3. Sheep [] 4.
Donkeys [] 5. Others,
Specify.....

27. 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?

Adaptation Strategy	Strategy adopted?		Did strategy help to reduce the impacts of hazards	Give reasons why strategy was not adopted (<i>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</i>)
	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				
Use of weedicides/pesticides				

OBJECTIVES OF HOUSEHOLDS

28. 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.....

29. What has been the state of your family food security over the last 30 years 1. Increasing [] 2. Decreasing [] 3. Has remained the same [].

30. What about the output of your major crops? 1. Increasing [] 2. Decreasing [] 3. Has remained the same []

31. 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 [].

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

33. Where do you get your inputs to buy? 1. In my community [] 2. At the district centre [] 3. In the regional capital []

34. If you get inputs for your farm, are you able to pay for the cost of the inputs? 1. Yes [] 2. No []

INSTITUTIONAL SUPPORT

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

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

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

38. 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

APPENDICE B**INDIVIDUAL INTERVIEW GUIDE**

1. Have you experienced any changes in climate in this community? Changes in rainfall and temperature.
2. How has climate change affected your farming activities? Positive and negative effects.
3. Apart from farming, what are your other sources of income?
4. What strategies have you put in place to adapt your farming activities to climate change?
5. How do these strategies help you to achieve food security for your household?
6. What will you say about the effects of these strategies that you have mentioned on the output of your major crops?
7. How has the strategies affected your household income over time?
8. It has been argued that due to social change processes, some of the adaptation strategies of households have lost their ability to continue to produce desired results. What do you think are some of these social change processes?
9. How have these social change processes affected your adaptation strategies over time?
10. Has your household received any form of assistance from any agency/organization during periods of climate –related hazards? If yes, state name of organization and explain nature of assistance.
11. What do you think are the effects of your adaptation strategies on the environment? E.g water bodies, soil, biodiversity.

Positive effects.....

Negative effects.....

12. How do you manage your land so that it can continue to support crop production?

APPENDICE C

FOCUS GROUP GUIDE

Before we start, I would like to remind you that there are no right or wrong answers in this discussion. I am interested in knowing what each of you think, so feel free to be frank and to share your point of view, regardless of whether you agree or disagree with what you hear. It is very important that I hear all your opinions. You probably prefer that your comments not be repeated to people outside of this group. Please treat others in the group as you want to be treated by not telling anyone about what you hear in this discussion today. Let us start by each of us introducing ourselves.

1. What are the effects of climate change on farming activities?

Negative and positive effects at the individual level.....

Negative and positive effects at the community level.....

2. How do community members adapt their farming activities to climate change?
Droughts and floods

3. What are the objectives that you intend to achieve with your adaptation?

4. Do you achieve these objectives and How?

5. What are some of the factors which enable you to be successful with your adaptation?

At the individual level...

At the community level.....

6. What factors prevent you from achieving the objectives of your adaptation?

At the individual level.....

At the community level.....

7. In which ways do you think your adaptation strategies affect the environment?

Positive effects.....

Negative effects.....

8. How do you manage your farmland in order to maintain its fertility?
9. What are some of the things that you think can be done to make your adaptation to climate change successful?

Individual level.....

Community level.....

APPENDICE D (BINARY LOGISTIC REGRESSION OUTPUT)**Table A**

Variables	Odds Ratio	Std. Err.	P>z
Community			
Wellembelle	1.000000		
Sakai	1.194701	0.647506	0.743
Sex of respondent			
Female	1.000000		
Male	0.807877	0.419738	0.681
Household size			
1-10 members	1.000000		
11-20 members	0.937252	0.372551	0.87
More than 20	0.918362	0.600131	0.896
Education			
No formal education	1.000000		
Formal education	0.890086	0.315512	0.743
Other income sources			
No other income source	1.000000		
Has other income source	2.265653	1.075718	0.085*
Ownership of television			
No television	1.000000		
Television	1.579944	0.670396	0.281
Ownership of radio			
No radio	1.000000		
Radio	1.333142	0.664518	0.564
Ownership of phone			
No phone	1.000000		
phone	0.278922	0.183005	0.052*
Adaptation of strategy			
Not adopted	1.000000		
Intensification of irrigation	2.573668	1.244825	0.051*
Water-harvesting	1.6423	0.664784	0.22
Change planting date	0.949655	0.677102	0.942
Chemical fertilizer	2.402263	2.82531	0.456
Application of compost / manure	1.006191	0.381398	0.987
Tillage practices	0.492972	0.225786	0.123
Cover-cropping / mulching	2.069609	1.043483	0.149
Land rotation	0.301309	0.181773	0.047**
Seasonal migration to urban areas	0.465754	0.164176	0.03**
Change consumption	0.553368	0.209879	0.119
P-value = 0.0003	Pseudo R² = 0.1707		N = 209

Table B

Variables	Odds Ratio	Std. Err.	P>z
Community			
Wellembelle	1.000000		
Sakai	1.996213	1.246178	0.268
Sex of respondent			
Female	1.000000		
Male	1.126488	0.746634	0.857
Household size			
1-10 members	1.000000		
11-20 members	0.479331	0.237939	0.139
More than 20	2.343015	2.742941	0.467
Education			
No formal education	1.000000		
Formal education	0.445491	0.206505	0.081*
Ownership of television			
No television	1.000000		
Television	2.238302	1.14675	0.116
Ownership of phone			
No phone	1.000000		
phone	0.80703	0.562336	0.758
Ownership of plough			
No plough	1.000000		
Plough	2.44852	1.248211	0.079*
Other income sources			
No other income source	1.000000		
Has other income source	2.067938	1.120782	0.18
Change in rainfall pattern			
No change / increase in rainfall	1.000000		
Decrease in rainfall	1.024501	0.589754	0.966
Adaptation of strategy			
Not adopted	1.000000		
Intensification of irrigation	2.451614	1.525596	0.15
Water-harvesting	3.537633	1.838461	0.015**
Change planting date	0.582175	0.585184	0.59
Chemical fertilizer	0.694841	1.078889	0.815
Application of compost / manure	0.846415	0.420975	0.737
Tillage practices	1.595701	0.953506	0.434
Cover-cropping / mulching	1.202538	0.690057	0.748
Land rotation	0.669728	0.519223	0.605
Seasonal migration to urban areas	2.862397	1.347792	0.026**
Change consumption	1.770223	0.850237	0.234
P-value = 0.0085	Pseudo R2 = 0.2020		N = 209

Table C- Intensification of irrigation

Variables	Odds Ratio	Std. Err.	P>z
Community			
Wellembelle	1.000		
Sakai	0.003111	0.003816	0.000***
Sex of respondent			
Female	1.000		
Male	0.986953	0.537727	0.981
Age of respondent			
20-30	1.000		
31-40	0.896782	0.461128	0.832
41-50	1.701934	1.038101	0.383
51-60	0.551309	0.568569	0.564
61+	0.427159	0.446847	0.416
Household size			
1-10 members	1.000		
11-20 members	2.145466	1.309351	0.211
More than 20	4.647047	6.281786	0.256
Income			
has been increasing	1.000		
has been decreasing	1.226144	0.799388	0.754
has remained the same	0.52235	0.462566	0.463
Objectives			
Food security	1.60528	1.623135	0.64
Increased family income	2.62714	1.596291	0.112
Increased crop output	0.43293	0.189815	0.056*
P-value = 0.0000	Pseudo R2 = 0.4705	N = 210	

Table D- Water harvesting

Variables	Odds Ratio	Std. Err.	P>z
Community			
Wellembelle	1.000		
Sakai	0.551932	0.191536	0.087*
Sex of respondent			
Female	1.000		
Male	1.206232	0.628549	0.719
Age of respondent			
20-30	1.000		
31-40	0.718303	0.283876	0.402
41-50	1.165966	0.55126	0.745
51-60	1.609407	1.098728	0.486
61+	8.966428	9.178181	0.032**
Household size			
1-10 members	1.000		

11-20 members	0.654411	0.262126	0.29
More than 20	0.211953	0.130294	0.012**
Income			
has been increasing	1.000		
has been decreasing	0.278034	0.115902	0.002***
has remained the same	0.481225	0.328545	0.284
Objectives			
Food security	0.319808	0.259131	0.159
Increased family income	4.320827	1.941361	0.001***
Increased crop output	0.315274	0.116322	0.002***
P-value = 0.0000	Pseudo R2 = 0.1996	N = 210	

Table E- Change Planting Date

Variables	Odds Ratio	Std. Err.	P>z
Community			
Wellembelle	1.000		
Sakai	4.624372	3.358145	0.035**
Sex of respondent			
Female	1.000		
Male	1.795799	1.28911	0.415
Age of respondent			
20-30	1.000		
31-40	1.031341	0.698433	0.964
41-50	1.630298	1.333018	0.55
51-60	0.342263	0.354832	0.301
61+	1.545445	2.078218	0.746
Household size			
1-10 members	1.000		
11-20 members	0.592739	0.397464	0.435
Income			
has been increasing	1.000		
has been decreasing	0.224215	0.14167	0.018**
has remained the same	0.221404	0.241312	0.167
Objectives			
Increased family income	1.112471	0.837506	0.887
Increased crop output	4.689182	2.75986	0.009***
P-value = 0.0165	Pseudo R2 = 0.1924	N = 177	

Table F- Tillage practice

Variables	Odds Ratio	Std. Err.	P>z
Community			
Wellembelle	1.000		
Sakai	2.66531	1.274934	0.04**
Sex of respondent			
Female	1.000		
Male	1.208602	0.69256	0.741
Age of respondent			
20-30	1.000		
31-40	0.854754	0.399716	0.737
41-50	1.698102	1.036857	0.386
61+	2.354339	2.832068	0.477
Household size			
1-10 members	1.000		
11-20 members	0.677613	0.334195	0.43
More than 20	2.558891	2.856723	0.4
Income			
has been increasing	1.000		
has been decreasing	0.224215	0.14167	0.018**
has remained that same	0.221404	0.241312	0.167
Objectives			
Food security	4.140456	3.684794	0.11
Increased family income	1.080638	0.582542	0.886
Increased crop output	2.92703	1.207745	0.009***
P-value = 0.0395	Pseudo R2 = 0.1151		N = 181

Table G-Cover cropping / mulching

Variables	Odds Ratio	Std. Err.	P>z
Community			
Wellembelle	1.000		
Sakai	4.481716	2.118244	0.002***
Sex of respondent			
Female	1.000		
Male	1.863305	0.978994	0.236
Age of respondent			
20-30	1.000		
31-40	0.815968	0.382232	0.664
41-50	1.055513	0.575876	0.921
51-60	3.343304	3.959004	0.308
61+	2.354563	2.730566	0.46
Household size			
1-10 members	1.000		
11-20 members	0.478545	0.222159	0.112

Income			
has been increasing	1.000		
has been decreasing	0.519904	0.262686	0.195
has remained the same	1.256271	1.031341	0.781
Objectives			
Food security	1.593691	1.417648	0.6
Increased family income	2.080106	1.095439	0.164
Increased crop output	0.285945	0.126906	0.005***
P-value = 0.0102	Pseudo R2 = 0.1332	N = 186	

Table H- Land rotation

Variables	Odds Ratio	Std. Err.	P>z
Community			
Wellembelle	1.000		
Sakai	1.203406	0.911465	0.807
Sex of respondent			
Female	1.000		
Male	10.44607	7.864583	0.002***
Age of respondent			
20-30	1.000		
31-40	1.258203	0.956063	0.762
41-50	1.904278	1.919016	0.523
61+	0.526202	0.818028	0.68
Household size			
1-10 members	1.000		
11-20 members	0.610744	0.498307	0.546
Objectives			
Food security	4.266382	5.531063	0.263
Increased family income	3.092888	2.440113	0.152
Increased crop output	2.418629	1.593167	0.18
P-value = 0.0907	Pseudo R2 = 0.1797	N = 164	

Table I- Seasonal migration

Variables	Odds Ratio	Std. Err.	P>z
Community			
Wellembelle	1.000		
Sakai	5.548332	2.058424	0.000***
Sex of respondent			
Female	1.000		
Male	1.132848	0.579785	0.807
Age of respondent			
20-30	1.000		
31-40	0.778786	0.316263	0.538
41-50	0.40854	0.196566	0.063
51-60	0.228777	0.157112	0.032**
61+	0.142449	0.128423	0.031**
Household size			
1-10 members	1.000		
11-20 members	0.899072	0.374267	0.798
More than 20	1.496054	0.90188	0.504
Income			
has been increasing	1.000		
has been decreasing	1.068233	0.462011	0.879
has remained the same	0.348183	0.257646	0.154
Objectives			
Food security	2.530969	2.202659	0.286
Increased family income	1.956965	0.879086	0.135
Increased crop output	3.676568	1.328275	0.000***
P-value = 0.0000	Pseudo R2 = 0.2220		N = 210

Table J- Changed consumption

Variables	Odds Ratio	Std. Err.	P>z
Community			
Wellembelle	1.000		
Sakai	0.418397	0.154049	0.018**
Sex of respondent			
Female	1.000		
Male	0.416266	0.285794	0.202
Age of respondent			
20-30	1.000		
31-40	1.712427	0.712385	0.196
41-50	2.837681	1.470172	0.044**
51-60	0.720968	0.484119	0.626
61+	1.147747	0.944053	0.867
Household size			
1-10 members	1.000		
11-20 members	0.590034	0.234838	0.185
More than 20	3.407608	2.472806	0.091*
Income			
has been increasing	1.000		
has been decreasing	1.428903	0.60058	0.396
has remained the same	0.949434	0.655591	0.94
Objectives			
Food security	1.032011	0.793445	0.967
Increased family income	2.108803	0.93634	0.093*
Increased crop output	2.065103	0.750648	0.046**
P-value = 0.0039	Pseudo R2 = 0.1235		N = 210