SOCIAL CAPITAL AND CLIMATE CHANGE ADAPTATION STRATEGIES: THE CASE OF SMALLHOLDER FARMERS IN THE CENTRAL REGION OF GHANA.

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A mini-thesis submitted to the Faculty of Economic and Management Sciences (EMS), Institute for Social Development (ISD), University of the Western Cape (UWC), in Partial Fulfilment of the Requirement for the Master's Degree in Development Studies.

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DECLARATION

I, Sampson Osei, hereby declare that the work presented in this thesis entitled, '*SOCIAL CAPITAL AND CLIMATE CHANGE ADAPTATION STRATEGIES: THE CASE OF SMALLHOLDER FARMERS IN THE CENTRAL REGION OF GHANA'*, was done by me under supervision in the Institute for Social Development (ISD) from January, 2015 to February, 2016. Apart from references to other works which are duly acknowledged, this work has never been presented either in whole or in part for the award of any degree in this university or elsewhere or for publication.

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This thesis has been presented for examination with my approval as supervisor.

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DEDICATION

I dedicate this work to my lovely mother, Rebecca Abban, A. K. A. “Saawoyem”

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ABSTRACT

Agriculture in Ghana is dominated by smallholder farmers who are faced with unpredictable rainfall and extreme weather events. Climate modelling forecasts that the rate at which precipitation will decrease in the country is far more than the rate at which it will increase during the wet season. It is predicted that rain-fed maize output will decrease below 25 percent in all the ten regions of the country by 2020 if nothing is done. To mitigate the effect of climate change and safeguard food security, the country must undertake measures to adapt to the changing climate. The process of adaptation, therefore, involves the interdependence of agents through their relation with each other. This includes the institution in which the agents reside and the resource based on which they depend. The resource embedded in such relationship has been termed social capital. Empirical studies on social capital and climate change adaptation is lacking, especially in Ghana. Based on this, the study assesses the influence of social capital on climate change adaptation strategies among smallholder farmers in the Central region of Ghana. Both primary and secondary data were used for the study. Primary data was collected using household questionnaires, focus group discussions, and key informant interviews. K-means cluster analysis was used to identify weak and strong ties and four individual social capital variables. Twenty-year maize and rainfall data were analysed using trend analysis. The influence of individual social capital and other controlled variables were analysed using Multinomial logit model. Using 225 sampled households the results of the study showed that all the four identified individual social capital variables differ by sex. The perceptions of climate change among smallholder farmers also differ significantly by location. The four individual social capital variables as well as other controlled variables influence at least one indigenous adaptation strategy and one introduced adaptation strategy. The study recommends, among others, that transfer of climate change adaptation techniques or technology to smallholder farmers should not be solely accomplished through the usual technology transfer network of agricultural researchers and extension agents. Rather, it will be imperative to increased contact with a wide variety of local actors who provide information and resources for agricultural production.

Key Words:

Social Capital, Climate Change and Variability, Adaptation, Smallholder Farmers, Cluster Analysis, Multinomial Logit Model, Ghana

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AEAs	Agriculture Extension Agents
AGR	Africa's Green Revolution
FBOs	Farmer Based Organisations
FGDs	Focus Group Discussions
GAIPs	Agricultural Insurance Pools
GLSS	Ghana Living Standard Survey
GSGDA	Ghana Shared Growth and Development Agenda
IIA	Independent of Irrelevant Alternate
IPCC	Intergovernmental Panel on Climate Change
MEST	Ministry of Employment, Science and Technology
MLM	Multinomial Logit Model
MoFA	Ministry of Food and Agriculture
MPM	Multinomial Probit Model
PSIA	Poverty and Social Impact Analysis
SIOPS	Standard International Occupational Prestige Scale
VIF	Variance Inflation Factor

CHAPTER ONE
INTRODUCTION

1.1 Contextualization and Background to the Research

Climate change is arguably the most persistent threat to global stability in the coming century. Its combat and mitigation has led to international environmental agreements in building legitimacy through a large-scale international scientific effort known as the Intergovernmental Panel on Climate Change (IPCC). According to Hope (2009), climate change is any change occurring in the climate during a period of time which can range from decades to centuries. He further reports that climatic changes are caused by natural and human activities. There is a fundamental difference between climate change and climate variability. While climate change includes long term changes at the global scale, climate variability refers to short-term fluctuations and associated weather conditions of each region (Campos *et al*., 2013:433). Climate vulnerability is defined as the combined measure of threats to a particular system. "It is the degree to which a system is susceptible to or unable to cope with the adverse effects of climate change, including climate variability and extremes" (IPCC, 2007:73). Any anthropogenic intervention to reduce the impact of climate change is called mitigation. It also include actions to reduces the sources or enhance the sinks of greenhouse gases (IPCC, 2001). These terminologies will be used in the way they are understood to avoid confusion. The impact of climate change, especially in Sub-Sahara Africa, has been well established in the literature (see Kurukulasuriya *et al*., 2006; Apata, *et al*., 2010; Agbogidi, 2011). Studies on modelling of climate change in Ghana forecast that the rate at which precipitation will decrease is far more than the rate at which it will increase in all the six climatic zones during the wet season. The Central region is situated between the coastal savannah and deciduous forest zones. In the coastal zone the decrease in precipitation is forecasted to be 52 percent as against 44 percent increase by 2080. In the deciduous zone the decrease is forecasted to be 48 percent as against 45 percent increase by 2080 (Stanturf *et al*. 2011). Agriculture in Ghana is highly rainfall dependent. This is because only 0.2 percent of the total land under cultivation in the country is under irrigation (MoFA, 2013). Africa is forecasted to experience a 10 percent loss in maize yield by 2050 if climate mitigation intervention is not taken up (Jones & Thornton 2003). Thus, a decrease in precipitation and the changes in other climatic elements (e.g. increased temperatures) pose a threat to the food security status of developing countries where farming is rainfall dependent.

Farming in Ghana is dominated by smallholder farmers who mostly cultivate maize and cassava. Though there are large farms in the production of cocoa, rubber, coffee, oil palm and the like, about 90 percent of farm holdings in the country are less than 2 hectares in size (MoFA, 2013). Farmers, particularly smallholder farmers in the country, are vulnerable to shocks such as seasonal variation in rainfall, and a long term increase in temperature (Stanturf *et al*., 2011). The Ghana living standard survey (GLSS) report indicates that maize and cassava are the most frequent crops in the consumption baskets of Ghanaian households (GLSS, 2008). Thus, the national staple food and food security status is under threat by climate change and variability. The challenge that arises is the development of innovation technologies to help mitigate the adverse effect of climate change in agriculture. Vulnerable countries will have to take additional measures to adopt these technological innovations, while ensuring that the most vulnerable smallholder farmers and rural livelihood are protected and the environment conserved.

The state intervention to enhance adaptation capacity in the various sectors of the economy will require, among others, diffusing information on the available mechanisms in the country. The process of adaptation, therefore, involves the interdependence of agents (e.g. extension officers and farmers) through their relation with each other. This includes the institution in which the agents reside and the resource base on which they depend (Adger, 2003:388). The resource embedded in such relationship has been termed social capital. Social capital –understood broadly as the features of social structure that facilitates action – has informed the study of families and youth behavioral problems, schooling and education, community life, democracy and governance, economic development, general problems of collective action and more recently farmer related problems, including climate change (see Putnam, 2000; Bourdieu, 1986; Adger, 2001; Ngigi, *et al*., 2012)

Two major competing constraints facing smallholder farmers' adaptation to climate change have been poor extension service delivery and the lack of information on particular adaptation strategies and weather forecasts (Ozor *et al*., 2010; Conway & Schipper, 2011). Studies by Adger (2001) and Deressa *et al*. (2009) have shown that social capital influences access to agricultural information, loan lending and capacity building to adapt to climate change. The adoption of technology by farmers, according to Casey and Lynne (1999), is more effective if the spread of knowledge is shared through social interaction. Individual farmers who interact with one another exchange ideas and information which enhances their capacity to respond to climate

impact and risk (Fafchamps, 2005). This aspect of interaction is widely discussed in the literature under network social capital which is often termed individual social capital (Lin, 2001).

The focus of this study is to assess the impact of individual social capital on climate change adaptation strategies among smallholder farmers in the central region of Ghana. Using structured questionnaires, focus group discussions and key informants interviews, four key research questions were investigated. The first question seeks to understand the types and the strength of social relations among smallholder farmers. The second question draws on secondary data to investigate rainfall pattern trends over the past 20 years and its association with maize output in three districts in the central region. The third question ascertains farmers' perception of the changing climate. The last question uses econometric models to analyze the impact of individual social capital on climate change adaptation strategies among smallholder farmers. In order to give direction to this study, two theories (i.e. social capital theory and theory of adoption) were combined with an economic theory (i.e. random utility theory) to generate the research hypothesis.

1.2 Problem Statement and Research Questions

The negative impact of climate change is projected to impact all facets of the Ghanaian economy (see section 2.3) and this threatens the development prospect of the country. The impact will be substantial on the poor and smallholder farmers that rely heavily on natural rainfall for farming activities. Adaptation and perhaps mitigation are important avenues through which to reduce the impact of climate change.

Numerous studies have investigated the determinants of climate change adaptation strategies among farmers (see Mandleni & Anim, 2011; Tazeze, *et al*., 2012). However, these studies focused extensively on perceptions of climate change, incentives and ability to adapt, and other environmental factors. The role of social capital as determinant of household decision to adapt to climate change has not been comprehensively investigated. Moreover, previous studies that considered social capital used it in the form of single dimension or aggregate index (Ngigi *et al*., 2012). These studies were unable to show how different components of individual social capital such as bonding, bridging and linking influence the choice of adaptation. Further, most studies on social capital in the climate change arena are qualitative in nature and focus on group and

institutional perspective (Sekine *et al.*, 2009; Pelling, 2003; Pelling & High, 2005; Adger, 2003). This study used a mixed methodology approach to bridge the qualitative and the quantitative realms.

Moreover, gender is a cross cutting issue in this study and is investigated on each level of objective. In view of this, the study does not only provide qualitative findings but empirical evidence on how individual social capital influences the capacity of smallholder farmers to adapt to climate change. Individual social capital is a pool of resources embedded in one's social network. This can facilitate the achievement of one's goal in addition with or instead of personal resources (Lin, 2001).

The research questions that follow are therefore tailored towards assessing the impact of individual social capital on climate change adaptation strategies among smallholder farmers in the central region of Ghana:

1. What types of social relations exist among smallholder farmers and what are the strengths of these relations (ties)?
2. What is the trend of weather patterns (e.g. rainfall) in and its association with maize output over the past 20 years in the Central region of Ghana?
3. What are the perceptions of the smallholder farmers on climate change and their adaptation strategies?
4. Do individual network-based social capital and other factors influence climate change adaptation strategies among smallholder farmers?

1.3 Research Objectives

The main objective of the study is to assess the impact of network-based social capital on the climate change adaptation strategies among smallholder farmers in the Central region of Ghana. The specific objectives of the study are:

1. To identify the types of social relations that exists among smallholder farmers.
2. To analyse the strengths of the social relations among the smallholder farmers.
3. To analyse the trend of weather patterns (e.g. rainfall) over the past 20 years and its association (correlation) with annual maize output in the central region of Ghana.

4. To ascertain the perception of the smallholder farmers on climate change and their coping strategies.
5. To analyse the effect of individual network-based social capital and other factors on the adaptation mechanisms of the smallholder farmers.

1.4 Rationale and Significance of the Study

Climate change is expected to have a negative impact on the food security status of the global economy. Studies show that this will persists for decades even if there is spontaneous introduction of global mitigation strategies (Valenzuela & Anderson, 2011). The changing climate is not only showing up in warmer temperatures but also in altered rainfall patterns, water availability and more frequent and extreme weather events. It is not without merit that climate change may have a short span positive effect for particular farmers within a certain geographical location. For example, changing climate may benefit crop productivity changes for farmers in cooler temperature region in higher altitudes. These changes tend to be catastrophic in the tropics and the global level as whole (Nelson, 2009; Mendelsohn, 2008).

Africa's Green Revolution (AGR) aims at contributing to food security and economic growth on the continent. Studies show that only 6 percent of African crop land is under irrigation (IPCC, 2007). This makes smallholder farmers who depend on agriculture for food security and livelihoods more vulnerable to climate change. Moreover, the realization of the objective of AGR is under threat by climate change.

The development prospects and plans of Ghana to become an upper middle income country by 2020 are under threat by climate change. The Ministry of Employment, Science and Technology (MEST) reports that there is a clear sign of the impact of climate change on the national economy:

> *Evidence abounds in Ghana that temperatures in all the ecological zones are rising whereas rainfall levels and patterns have been generally reducing and increasingly becoming erratic. The national economy stands to suffer from the impacts of climate change because it is dependent on climate sensitive sectors such as agriculture, energy, forestry, etc. Based on a 20-year baseline climate observation, it is forecasted that maize and other cereal crop yields will reduce by 7% by 2050. Available data also shows a sea-*

level rise of 2.1 mm per year over the last 30 years, indicating a rise of 5.8 cm, 16.5 cm and 34.5 cm by 2020, 2050 and 2080 (Agyemang-Bonsu *et al*., 2008 as cited in NCCAS (2011:6); see also MEST, 2010).

Adaptation to climate change will help the nation to cope with these impacts and is a key objective within the Ghana Shared Growth and Development Agenda (GSGDA). Studies conducted by Pinto *et al*., (2012) recommend potential adaptation strategies for Ghana's agricultural sector. Some of these options include, among others, weather and climate information services and early warning, the development of improved seeds and technologies, the raising of awareness and access to information, the use of drought and flood resistant seed varieties, as well as crop diversification and specialization, fertilization and irrigation. These recommendations were a result of constraints identified among smallholder farmers adaptation to climate change. Many scholars have therefore studied some socio-economic factors that influence climate change adaptation strategies in the country (Etwire, *et al*., 2013; Armah, *et al*., 2013; Amikuzuno & Hathie, 2013).

As a new concept with its origin from sociology, recent studies show that social capital influences the capacity to adapt to climate change (see Ngigi *et al*., 2012; Adger, 2001; Adger, *et al*.,2003; Deressa *et al*., 2009; Nam, 2011). The relevance of considering local knowledge and community experience in the development of climate change adaptation strategies and respective policy-making is often stressed in the climate change discourse (IPCC, 2001; UNFCCC, 2007). However, in doing so, it is vital to identify and exploit the right resources that can help communities and individual to self-organize, build their adaptive capacity, enhance resilience and security, and establish partnerships with public authorities and organizations. Individuals who interact with others create a network and benefit from the embedded resource within the network. This network is classified in the literature as bonding, bridging and linking (Lin, 2001; Adger, 2001).

In the climate change asset adaptation framework, Moser and Stein (2010) mentioned the following classes of capital assets of communities, households, and individuals: physical capital, financial capital, human capital, social capital, and natural capital. In studies on climate change adaptation in Ghana, social capital has received little attention. However, network social capital

is not only important in climate change adaptation but also the economic development of Ghana. Networks provide a platform for communication which might prove helpful in the promotion of joint initiatives (Matuschke, 2008). According to Gómez-Limón*etal*., (2013:386) "Social relationships/networks may affect the economic sustainability of farmers by influencing farming practices and their propensity to adopt newer technologies via the supply of information through these networks". More importantly, networks help in building mutual trust and solidarity (Putnam, 2000). This is very important in the study since many smallholders are constrained by lack of information relating to weather forecasts, the availability and accessibility of adaptation strategies, poor extension service delivery, etc.

Inadequate or a lack of knowledge should not be an obstacle to increasing the general resilience of farmers to future environmental threat. It is necessary to investigate the personal networks among smallholder farmers to see how this influences decision making. The study is therefore important because it does not only serve as a useful guide for climate change adaptation policy, programme formulation and design for farmers, it also builds on the knowledge base of the impact of network social capital on climate change adaptation mechanisms in the academic community.

1.5 Organisation of the Study

The study is organized into six chapters. Chapter two entails an extensive literature review relevant to the study. Some of the issues discussed under literature view are social capital and climate change, the effect of social capital on adoption of agricultural innovation-empirical evidence and impact of climate change on smallholder farmers in Ghana. Moreover, the literature also discusses adaptation strategies to climate change and variability in Ghana, definition of smallholder farmers from the perspective of the global and local community and decision of the respondent (i.e. application of the multinomial logit model). The theoretical underpinnings of the study and research hypothesis are discussed in chapter three. Chapter four discusses the research design as well as the methodological approach of the study. The results are presented and discussed in chapter five, while the conclusion, limitations and suggestion for future research and policy recommendations are presented in chapter six.

CHAPTER TWO

LITERATURE REVIEW

This section presents extensive literature review relevant to the study. The literature review establishes the link between the field of study and the research. It details both the theoretical and empirical issues of the topic under study. The relevance of the literature review is not only to provide knowledge of the problem area but also to identify the need for the proposed study and avoid repetition of what has already been done. To this end, the impact of climate change on smallholder farmers in Ghana is presented in section 2.1. Section 2.2 presents adaptation strategies among smallholder farmers. A brief discourse between social capital and climate change is presented in section 2.3 while Section 2.4 highlights the empirical evidence of social capital and climate adaptation. Misconception with regard to smallholder farmers is presented in section 2.6. Finally, the relevance on the use of Multinomial logit model is presented in section 2.5.

2.1 Impact of climate change on smallholder farmers in Ghana

According to the IPCC, climate change will lead to an increase in the frequency and intensity of natural disasters and extreme weather events. These include, among others, floods, rising sea levels, drought, salinization of water supplies and agricultural land, unpredictable rainfall, and a reduction in crop productivity (IPCC, 2007). Thus, changes in climatic elements pose a threat to the food security status of Ghana. The decline in the production and availability of food will not only lead to reduced nominal income and increased food prices but ignition of all other psychological responses (e.g. hunger) associated with food insecurity. This will in turn lead to an increase in poverty, especially among smallholder farmers as they are characterized by low and limited usage of inputs.

Scientific empirical research in Ghana shows the following: rising temperatures (Mcsweeney, *et al*., 2010; MacCarthy, *et al.*, 2013); declining rainfall totals and variability (Mcsweeney, *et al*., 2010, Müller-Kuckelberg, 2012; MacCarthy, *et al.*, 2013); rising sea levels (Addo & Adeyemi, 2013); and a high incidence of extreme weather and disasters such as flooding (Addo & Adeyemi, 2013; Tetteh, *et al.*, 2014). Climate projections indicate that the impact will be disastrous on all facets of the Ghanaian populace now and in the future.

Global studies on the impact of climate change on crop yield predict losses. For instance the fourth Assessment Report of the IPCC predicts that by 2050, yields from rain-fed agriculture in some Sub-Saharan African countries could be reduced by up to 50 percent (IPCC, 2007). In Ghana it is predicted that rain-fed maize output will decrease below 25 percent in all the ten regions of the country by 2020 if nothing is done (Pinto et al. 2012). Overall cereal output (e.g. maize, rice, millet) in the country, according to Fischer, *et al.*,, (2005), will decrease by 2080 even if adaptation measures are implemented. A crop simulation model using 30 year historical data on weather scenarios, crop characteristics and management practices indicated that the yield of a variety of maize crop (locally called *Obaatanpa*), has declined by 19-41 percent in the Guinea savanna and semi-deciduous zone of the country (MacCarthy, *et al.*, 2013) Studies also show that cassava productivity is expected to decrease in 2020, 2050 and 2080 by 3%, 13.5%, and 53%, respectively (Sagoe, 2006).

Policy makers in Ghana admit that climate change has reduced productivity among smallholder farmers and has even caused disease outbreak (Tetteh *et al*., 2014). Farmers from all the regions of Ghana are reported to have lost more crops, livestock, and income as a result of bad weather (Müller-Kuckelberg, 2012).

2.2 Adaptation Strategies to Climate Change and Variability in Ghana

Broadly, adaptation, according to Smit *et al*. (2001), is an adjustment in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. The term encompasses changes in processes, practices, or structures to moderate or offset potential damages or to take advantage of opportunities associated with changes in climate. There are a plethora of adaptation strategies used by farmers as a result of climate change and these can be categorized into different groups. For example, in a review undertaken by Pinto *et al*. (2012) adaptation mechanisms in Ghana were classified into four options: (i) dealing with risk and uncertainty (e.g. indigenous knowledge, weather and climate information services and early warning, crop insurance, raising of awareness and access to information, etc.); (ii) farming practices and technology (e.g. drought resistant varieties, soil conservation and erosion control, crop diversification and specialization, irrigation, etc.); (iii) off-farm practices and strategies (e.g. improve post-harvests, food storage practices, migration, empower communities and females,

etc.); and (iv) national development policy (e.g. agricultural intensification and land use policy, access to and governance of water, institutional reforms, etc.).

Studies show that farmers have developed indigenous adaptation strategies to address changing climate patterns (Pinto *et al*., 2012; Kuwornu,*et al.*, 2013; FAO, 2009). These strategies are perceived to have been accumulated over generations living in a particular environment and the transfer of such knowledge has been embedded in the culture through various rites of passage such as birth, social gathering and the like (Egeru, 2012). In a survey conducted by the FAO (2006), climate change adaptation strategies were classified into traditional strategies, government supported strategies[1], alternative and innovative automatic adaptation strategies, and technology driven strategies. Thus, recognition of local knowledge seems to be one of the means of enhancing awareness and adaptation of climate change. Following the classification of Pinto *et al*. (2012) and FAO (2006), this study classifies adaptation strategies into two, namely, indigenous adaptation strategies and introduced or research-based adaptation strategies[2].

2.2.1 Indigenous Adaptation Strategies

The literature unveils and classifies different indigenous adaptation strategies used by smallholder farmers such as, for example, re-sowing and changing the timing of farm operations, etc. (see Kuwornu *et al*., 2013). The FAO (2010) categorized indigenous adaptation practices into three; namely, income coping strategies, cutback strategies, and agricultural coping strategies. This study categorizes indigenous adaptation practices into five, namely: soil and water conservation strategies, changing planting dates and periods, crop diversification (i.e. multiple cropping), livestock diversification strategies, and diversification to non-farming activities. These are the indigenous adaptation strategies (dependent variables) used in the econometric model (see section 4.5.5).

Soil and water conservation strategies are defined in this context as the mechanisms used to keep the moisture and the organic matter content of the soil during and throughout the planting season.

[1] Government supported strategies are equivalent to the national development policy as identified by Pinto *et al*., (2012).

[2] Strategies such as off farm practices and strategies and national development policy as identified by Pinto et al., (2012) are beyond the scope of this study.

These include mulching, planting of cover crops, planting of leguminous crops, planting of trees, and a combination of these.

Changing planting dates and periods implies that the farmers who are precipitation dependent do not plant at the exact planting month due to delays in precipitation. Thus, planting begins after the first precipitation or upon knowing in advance - through weather forecast - that it will rain in a particular time.

Livestock and crop diversification in this context is defined as a means of rearing more than one type of livestock and or growing more than one crop on the same piece of land, a concept called multiple cropping in the case of crop diversification. The livestock and or crops do not necessarily have to be improved varieties. For example, a farmer can grow maize and interplant with cassava.

Diversification to non-farming activities is a situation whereby farmers resort to other activities to generate income besides farming. The income generated is used to support the households. This does not mean that the farmer has stopped farming activities completely; instead, they allocate time to non-farming activities to support the household.

2.2.2 Introduced Adaptation Strategies

Introduced adaptation strategies have increasingly received more attention over the past decade and are well organized in the literature compared to indigenous adaptation strategies. This study organizes these strategies into five, namely: irrigation, crop insurance, soil and plant related strategies (e.g., pesticides and fertilizer), improved varieties and breeds, and recommended agricultural practices. Once again, these are the introduced adaptation strategies (dependent variables) used in the econometric model (see section 4.5.5).

Irrigation is the artificial application of water to the soil through various systems of tubes, pumps, and sprays (Schultz & De Wrachien, 2002). It is usually used in an environment where rainfall is irregular or where there is persistent drought. Water for irrigation can be from wells, spring, river, lakes, wastewater, ground water and so forth. Depending upon how water is distributed, irrigation systems can be surface irrigation, drip irrigation, sprinkler irrigation, sub-irrigation, or manual irrigation (Schultz & De Wrachien, 2002).

Ghana Agricultural Insurance Pools (GAIPs) aims at providing security to farmers – smallholder, commercial and nucleus farmers - in times of disaster such as drought, fire outbreak, floods and other extreme weather related hazards since 2011. Crop insurance, in this study, means farmers who have insured their crops and or livestock against climate-related hazards. Soil and plant related strategies include the application of inorganic fertilizer such as NPK-15:15:15, NPK - 15:15:20, Sulphate of Ammonium, etc. This strategy also includes the application of pesticides.

Improved varieties and breeds are technologies developed by scientists to improve the inherent genetic characteristics of plants and livestock. Some of the characteristics of these crops include the: ability to resist drought, weed, pest and diseases. A typical example of improved drought-resistant rice variety is NERICA, a product of Inter specific Hybridization Project of the Africa Rice Centre (WARDA) (Below, *et al.,* 2010). Recommended agricultural practices includes any practice that helps to improve the agronomic and husbandry practices, for instance, appropriate planting methods, spacing and plant populations, maintaining clean soil and keeping the farm clean to avoid the spread of pests and diseases.

2.3 Social Capital and Climate Change Discourse in a Brief

The IPCC, as part of its mission, has explored potential options for adapting to the negative impact of climate change. One of these avenues is to increase the adaptive capacity of the smallholder farmers, especially in developing countries (IPCC, 2007:39). Research shows that individuals and communities, throughout history, have been able to adapt to climate change and the inherent capacity to adapt is interlinked with the ability to act in a collective way (Adger, 2003). Thus, social relationships, networking, exchange of information as well as 'social learning' have been found to contribute greatly to environmental management and building adaptive capacity (Adger, 2003; Moser *et al*., 2010). This asset, popularly known as social capital, has not reached consensus in terms of definition and measurement[3]. For example, Putnam, (1995:664) defines social capital as "features of social life – networks, norms and trust – that enable participants to act together more effectively to pursue shared objectives". Moreover, social capital, according to Moser *et al*., (2010:7) is an intangible asset and that it is an

3 The different argument with regard to the definition and measurement of social capital are beyond the scope of this study. Thus, the study simply defines social capital as interpersonal network (ties) plus resources. The study therefore assumed that social capital is an individual asset.

embodiment of rules, norms, obligations, reciprocity, and trust which are embedded in social relations, structures and institutional arrangements. The term network has been distinguished from association. For example, Bayat (2015:33) notes that "networks are distributed groups of people that communicate with one another and work together as a unit or system for a joint purpose. Networks are more characteristic of individuals and small groups while associations are broader than networks" Thus, despite the debates around the definition of social capital, there are several elements that have been found to relate to adaptive capacity. These include social trust, reciprocity and interpersonal relationship (Pelling & High, 2005).

Social capital can emerge spontaneously in different ways and contexts. Adger (2003) reports a significant example of social capital coming forward to replace the reduced role of state authority in Vietnam during the period of decentralization and economic liberalization. In the mid-1990s, the local hazard planning and coastal defence systems were centralized under socialist Vietnam. Also, agricultural cooperatives were used to manage the coastal defence system. This trend changed suddenly into decentralization and the agricultural cooperatives dissolved. Management of sea defence was abandoned which deepened the vulnerability of the populace living in coastal areas. Social capital emerged initially in community networks and informal association as a result of economic liberalization. This helped in building credit and insurance schemes for the protection of households in the face of economic crisis and stress. At the same time, these new measures brought about by the social capital also facilitated adaptation strategies as state planning of coastal defence resumed.

In some coastal parts of East Africa such as the cities of Mombasa in Kenya and Dar es Salaam in Tanzania, the potency of social capital to build adaptive capacity has been established. These cities represent national and regional economic development centres and commercial hubs. However, the populace faces high levels of poverty and urbanization and are vulnerable to climate change impacts such as frequent and intense flooding and storms. Kithiia (2010) reports that the urban poor reside in areas of these cities that are subject to the highest level of risk. National and city governments in East Africa, as in many other low-income countries, do not possess sufficient resources to build appropriate infrastructure to mitigate climate change impacts, or to otherwise reduce the vulnerability of its population (Kithiia & Lyth 2011). The collective group actions in Dar es Salaam and Mombasa demonstrate the presence and the

capabilities of social capital to conserve natural resource and in building adaptive capacity. The latter is often termed "soft engineering" methods of building adaptation (Kithiia, 2010). The soft engineering method, according to Kithiia and Lyth (2011) can be achieved through the protection of urban wildscapes, green infrastructure, and provision of spaces (i.e. heterogeneous structures which facilitate the survival of some wild species and or support biodiversity in the urban habitat).

In the realm of risk management, studies have shown that the poor strategise by using networks. According to Bayat (2015), the poor can maximize social and economic outcomes in diverse ways with and even without the government intervention. Poor service delivery has been a common denominator for most developing countries and that poor communities manage and maintain local resources by collaboration and engaging with state institutions to facilitate service provision. She argues that "given the limited capacity of community associations and networks to provide services, they are likely to concentrate on activities that relate to reducing their vulnerability to shocks or minimising the effects of poverty, or improving their safety and security" (Bayat, 2015:84). Thus, from the perspective of the individual, it can be argued that famers would like to maximize production, reduce vulnerability, and minimise the impact of climate change. Where there is a farmer-based organisation (which is a common practice in most farming communities), leadership can engage with state institutions (e.g. District Chief Executive or Extension officer) for assistance (e.g. training, accessed to government fertilizer subsidy and tractor for mechanisation) and thus establish networks. This mechanism does not only lead to flow of information with regards to farming practices but also behavioural change through appropriate climate change adaptation strategy.

2.4 Measurement and Effect of Social Capital on Climate Change Adaptation Strategies – Empirical Evidence

Several empirical studies have been carried out to investigate the influence of social capital on climate change adaptation. Using Mekong River Delta in Vietnam as a case study area, Nam (2011) assessed the role of social capital on private adaptation to climate change. Nam constructed four social capital indicators: formal institutional index, informal institutional index, trust index and cooperativeness index. The formal institutional index was constructed using the degree to which household members participate in non-governmental organisations. Name

generator questions were constructed to determine the size and usefulness of the network to proxy informal institutional index. The trust index was constructed based on a 5-points likert scale. Finally, using experimental design, cooperativeness was defined as the extent to which the respondents voluntary contribute to the provision of public goods. Using a multinomial probit model (MPM), the study revealed that formal institutional index positively influences the adaptation of different varieties or crops. The informal institutional index also turned out to positively influence changing planting dates and periods. The trust and cooperativeness index, however, did not have any meaningful influence on these adaptation measures. One thing which was not clearly defined in Nam's (2011) work was the items in the name generator questions. The degree of participation in organisations will, certainly, determine the network size of an individual. Therefore enlisting the name generator items will clearly define the type of network members of the respondents.

Ngigi, *et al*., (2012) investigated the role of social capital on climate change adaptation in Kenyan Agriculture. Drawing on the new institutional economics, the authors focused on the group dimension of social capital and constructed one index using principal components analysis. Using 707 households the results of the Multinomial logit model (MLM) employed indicate that social capital has a positive effect on the adoption of new agricultural technologies. The study of Ngigi, *et al*., (2012), however, could not tell which type of social capital influence the adoption of new agricultural technology.

In the state of Georgia, 317 households' survey data conducted by National Agricultural Statistics was used to study the effect of social capital in the form of community involvement on the adoption of sustainable agricultural practices. Munasib and Jordan (2011) measured social capital in the form of associational membership. Thus, the authors used the number of association a farmer belongs to construct social capital index. Some of the associations included: sport, religious groups, parent-teacher associations, internet groups, and neighbourhood associations. Using cross sectional regressions, the study revealed that social capital (community involvement) does not only have a positive causative effect on the adoption of pest control practices, grazing practices and soil management practices but also on the extent to which farmers adopt these practices.

In Kirundo province of Northern Burundi, Minani *et al*. (2007) investigated how social capital improves family agriculture and resilience to the changing climate. Social capital indicators were constructed using local institutional network. Thus, three groups of farmers were constructed. The first group of farmers comprised local associations with experience (i.e. in agriculture, livestock rearing, etc.) and who received training from formal institutions. The second group of farmers comprised of different organisations but without experience and support. The last group did not belong to any local association and did not receive any training. The results indicated that about 44 percent of farmers in well-organized local institutions have adapted to climate change. Thus, training and experience play a significant role in the decision of household to choose a particular adaptation strategy. Moreover, members in FBOs who receive good training have a high probability of reducing the negative impact of climate change through appropriate adaptation strategy. Thus, it is not enough to belong to a group or an association. The members must be trained. From social network perspective, relative, friends and acquaintances connected to farmers/households heads that belong to a well-organised and trained group have a high probability of getting relevant information and changing behaviour (i.e. choosing adaptation strategy to reduce the negative impact of climate change).

A study in the Central region of Ghana revealed that social capital has a positive causative effective on the decision of smallholder farmers to adopt soil and plant related strategies such as the application of fertilizers, and pesticides. In his study, Osei, (2015) constructed social capital index using the number of organisations a household head belongs to. Five main organisations considered are farmer based organisations, traders or business association, finance or credit or savings (‘susu’) group, religious or spiritual organisations and other production group.

In sum, the empirical studies show that individual has intangible asset called social capital which influence the choice of adaptation strategies to the changing climate. However, none of the studies was able to show what type of individual social capital (e.g. bonding, bridging, etc.) influences the choice of adaptation strategies.

2.5 Smallholder Farmers from the perspective of the Global Community

Defining a smallholder farmer is a difficult task. Most often, the term has been awarded the epithet “farmers with small land holdings”. A lot of definitions abound in the literature.

Smallholder farmers, according to Dixon, *et al.* (2003), are farmers with less than 2 hectares of cropland and with low asset base. The authors further report that smallholder farmers have limited resource endowments relative to other farmers in the sector. Narayanan and Gulati (2002) also define smallholder farmers as farmers who practice a mix of commercial and subsistence production with a heavy reliance on family labour. This definition is in consonance with Hall (2009:51) who argues that smallholder farmers are distinguished from commercial farmers by the degree of labour-intensity and that smallholding appears to be equated with farming that relies mainly on household labour. Other scholars have used certain criteria such as production of crop and livestock for the market as well as consumption to distinguish smallholder from subsistence farmers (see Hall, 2009; and Andrews, *et al.,* 2009). In South Africa, black smallholder farmers have been labelled with the term 'small-scale farmers'. These farmers, according to Kirsten and van Zyl (1998), are characterized by non-productive, non-commercial, 'backward', and subsistence agriculture. The definitions enumerated above have been used to classify smallholder farmers around the world. However, the one that has received the most criticism is to define smallholder farmers based on the size of land holdings or the number of livestock. The main disadvantage of this definition, according to Von Braum (2005), is that it may not be relevant for all crops and regions. The author continues to argue that: "a small farmer with market access producing a high-value crop and another farmer on the same size farm cultivating a staple crop for home consumption can hardly be compared in a meaningful sense" (Von Braum, 2005:23)

The concept of smallholder has brought about terminologies like "small-scale', 'resource poor', subsistence' fragmented holdings, and 'peasant farmer'. Moreover, there are similar themes in all the definitions and usually concentrate on basic characteristics such as constraints to land, labour, market orientation, limited inputs, and other factors. The definition of smallholder farmers can also be argued to heavily depend on the context, country, and agro-ecological zone.

2.5.2 Small Scale Farmers in the context of Ghanaian Economy

MoFA, in its annual reports, states that farming in Ghana is on a smallholder basis and the majority of the land landings (90 percent) have less than 2 hectares (MoFA, 2013). In Ghana's Poverty and Social Impact Analysis (PSIA), variability of resource and conditions of risk were argued to be a better proxy for smallholder farmers than land holdings (Asuming-Brempong *et*

al., 2004). The definition of smallholder farmers in Ghana is based on several themes which include: the size of land, wealth status, market orientation and level of vulnerability to risk such as the adverse effect of climate change. Based on the wealth status, PSIA outlines five categories of smallholder farmers: Large Scale Commercial Farmers, Small Commercial Farmers, Semi-Commercial Farmers, Non-Poor Complex Diverse Risk Prone Farmers, and Poor Complex Diverse Risk Prone Farmers. The last three are classified as smallholder farmers in Ghana by PSIA. The criterion used in this categorization was the development of several indicators which concluded that non-commercial agriculture population in Ghana constitutes 95 percent. Policies that aim at transforming smallholder farmers in Ghana is largely based on low market oriented farmers or subsistence farmers.

Using 1998/9 and 2005/6 Ghana Living Standard Survey (GLSS4/5) data which comprises of 8687 households, and production data from MoFA, Chamberlin (2007) quantitatively, categorized smallholder farmers in Ghana based on land holdings, crop mix, and level of commercialization and input used. Based on the three main ecological zones, average landholding is 2.3 hectares, 3.1 hectares, 4.0 hectares, respectively, for the coastal, forest and savanna zones.

Comparing to producers with large land holdings, the study also revealed that smaller holdings have portfolios with a smaller number of crops and this cuts across all three major ecological zones. Agricultural households with less or equal to 1 hectare of land have three crops in the portfolio while those with more than five hectares of land have five crops. Households with fewer crops in their portfolio could mean that they are more vulnerable to the risk of crop failure (Chamberlin, 2007) which is likely to be caused by climate change (e.g. erratic rainfall and high temperatures). The two most frequent crops in the portfolio of households are Maize and Cassava.

The study also revealed that the market participation for almost all the crops evaluated in the portfolio of households is in general less for those with small land holdings than those with larger land holdings. Lastly, on economic welfare, Chamberlin showed that there is a significant but weak (0.02) correlation between land holdings and per capital consumption at the national level. Thus, larger holdings are able to take advantage of economies of scale than smaller holdings. The magnitude and the sign of this finding vary across ecological zones. In his

conclusion, Chamberlin is of the view that the anecdotal association between smallholder farmers economic welfare in Ghana is not of significance. Following Chamberlin, small holder farmers in this study are defined as those with small holdings which grow one or more than two crops, are more vulnerable to climate change, have poor resource endowments and commercialize less of their crops.

2.6 Decision of the Household Head: Application of the Multinomial Logit Model

In modelling the influence of individual social capital on climate change adaptation strategies, the decision of the household head was paramount to the study. This is important for the following reasons: (1) living arrangement, even in the rural areas, is independent nuclear family, (ii) decision to adopt any strategy is assumed to be taken by the household, and (iii) the time frame in which the research was conducted could not permit to collect data on all the family members.

The decision of the household head about the choice of adaptation mechanism involves more than two outcomes and this has informed the application of several models in econometrics analysis. Notable among these are Multinomial Logit Model (MLM) and Multinomial Probit Model (MPM). Though contestation around the use of these models abounds in the literature, both are used to investigate multiple responses or choices that involve unordered categories (Gujarati, 2004). The main distinguishing feature between MLM and MPM is the distribution of error term (Greene, 2003:734) which lead to the strengths and weaknesses of both models. As strength, the MPM does not assume the assumption of Independent of Irrelevant Alternate (IIA) (see section 4.5.5). This allows simultaneous modelling of the influence of a set of independent variables on each of the decision outcome (adaptation choices in the case of climate change) while allowing the error terms to be freely correlated (Hausman and McFadden, 1984). The computation of MPM, however, is very complicated and this even becomes more prohibiting as the number of decision outcome (adaptation choices) increases. Despite this challenge several authors have applied MPM in the study of climate change adaptation (Tazeze, *et al*., 2012). This study applies MLM on the ground that it is easy to compute (i.e. it does not involve the computation of sophisticated integral functions. Statistical software can instantaneously maximize the resulting likelihood function even for large adaptation choices (Hausman and

McFadden, 1984). The strengths of MLM have informed many scholars as well to apply the model in climate change adaptation research (Kuwornu *et al*., 2013).

In sum, the decreased in rainfall and increased periods of drought has negatively affected smallholder farmers in Ghana. The declined in the production of maize and tuber crops indicate that smallholder farmers are vulnerable to the changing climate. There is the need to look for effective and efficient avenues that facilitate the choice of adaptation strategies. The literature review showed that there are several econometric models that are used in the choice framework of smallholder farmers. Moreover, the literature review noted that smallholder farmers have embraced several adaptation strategies and the social capital play a significant role in the choice of adaptation strategies made by farmers. Unfortunately, the role of individual social capital on climate change adaptation has not been well investigated in the context of the Ghanaian economy. The next chapter discusses the theoretic underpinnings of this study.

CHAPTER THREE
THEORETICAL FRAMEWORK

This study is underpinned by two main theories: social capital theory and random utility maximization theory. However, to see the relevance of these two theories, the study will highlight the classical theory of adoption, specifically diffusion of innovation theory, developed by sociologist, Everett Mitchell Rogers (2003). Each of these theories is elaborated below:

3.1 Theory of Adoption

There are numerous theoretical frameworks that can be drawn when studying adoption of innovation (Botha & Atkins, 2005) such as climate change adaptation strategies. Notable among these theories of adoption is Rogers' Diffusion of innovation theory. According to Rogers, adoption of innovation such as climate change adaptation strategies is influenced by four factors which include innovation, communication, time and the social structure where the innovation was introduced. This study will not focus on the last two factors.

According to Rogers (2003:12), "An innovation is an idea, practice, or project that is perceived as new by an individual or other unit of adoption." Innovation in this study can be irrigation, drought tolerant variety, improved variety and so forth. An innovation may have been adopted in other parts of the world already but it becomes new and therefore an innovation to an individual who perceives it for the first time. During the innovation decision process, the individuals have to move away from the state of being unaware to the state of being aware. This process, termed the knowledge stage, is where the individual seeks more information concerning the principles behind it and how to put the innovation into use. It is not enough for an individual just to be aware of the innovation since s/he may decide to adopt the innovation. The next phase in the innovation decision is persuasion. Individuals may develop favorable or unfavorable attitudes and the degree of uncertainty is reduced through credible subjective evaluation of the innovation from close friends and peers. Sherry (1997) writes that close friends and colleagues might not be experts of innovation and that they must be well trusted and gives a convincing subjective innovation. The next stage is decision making where an individual decides to adopt or not adopt. An individual may reject the innovation. However, s/he may decide to adopt it again or abandon it for good. Implementation and confirmation are the last stage of the innovation decision process. While the implementation stage is where the innovation is actually put into practice, the

confirmation stage is where the individual seeks support for his or her decision. At the confirmation stage, Rogers reports that the individual stays away from people who gives conflicting messages and turns to people whose message confirm his/her actions (Rogers, 2003:189). From Rogers' argument one can predict that the individual or adopters stay away from people who are not trustworthy during the confirmation stage.

The next element of Roger's diffusion of innovation theory is communication channels. Communication, "is a process in which participants create and share information with one another in order to reach a mutual understanding"(Rogers, 2003:5). The source of the communication can be an individual or an institution that delivers the message and that interpersonal communications has more potency to create a change in the attitude held by an individual.

In the modernization and development of the agricultural sector in Ghana, one means of applying Rogers' innovation of diffusion theory has been the deployment of agriculture extension agents (AEAs) to the door steps of the farmers. However, I am of the view that the probability of achieving the intended objectives of Rogers' theory using AEAs in Ghana is less. Smallholder farmers in Ghana are scattered across the country. It therefore needs large number of extension officers to reliably reach the farmers. Statistics shows that the ratio of AEA to farmers is 1:2500. This situation is worse in some districts in the Northern region where the ratio is estimated to be 1:3000 (Owusu-Baah, 2012; Salifu, *et al*., 2012; Duo & Bruening, 2007). Further, it is reported that only 10 percent of farmers in the country are receiving extension services and smallholder farmers who constitute about 70 percent of the labour force in the country are not receiving adequate AEA services. Due to the embargo on the employment in the public sector, Owusu-Baah (2012), writes that the attempt of MoFA to reduce the ratio to 1:800 has not materialized. The World Bank, in an attempt to bridge this gap, partnered with the government of Ghana and introduced a unified agricultural extension system whereby cocoa, crops, and livestock was fused together so that AEA can deliver information to all sub-groups of farmers at the same time. Evaluation of the unified agricultural extension system on cocoa production indicates that the system has failed (Owusu-Baah, 2012; Asuming-Brempong, *et al*., 2005). Governments in most developing countries have recently promoted the formation of farmer-based organizations (FBOs) to ensure effective service delivery by extension officers. Asante *et al*., (2011) show that

most farmers are not part of these organizations. Based on these existing challenges, the study does not focus on the number of farmer–based organizations the farmer belongs but the people s/he comes into contact with (that is, his/her network members).

Rogers' theory of diffusion of innovation is not without limitations. One of the limitations which has received much attention is that the theory ignores the individual's resource or social support that enables the adoption of innovation (Botha & Atkins, 2005). Some of the individual resource can be income, ownership of land, etc. This limitation is addressed by inclusion of other controlled variables such as income, land, etc. in random utility theory (section 3.3). In sum, based on Rogers' theory of innovation diffusion, one can assume that the information barrier with regard to climate change and adaptation can be broken if a farmer comes into contact with relevant occupational prestige such as extension officer, teachers, fellow experienced farmers, among others.

3.2 Social Capital Theory

The theory of social capital can be viewed from two different levels: group or collective action and individual level. Briefly, authors who write from the perspective of the group level dwell on (i) how certain group develops and more or less maintains social capital as a collective asset, and (ii) how such collective assets enhances members of the group life chances (Lin, 2001:22). Social capital, according to Bourdieu (1986), is made up of social obligations or connections. He defines social capital as the aggregation of potential resources which are linked to a possession of a durable network of institutionalized relationship of mutual acquaintances and recognition (Bourdieu, 1986:248). Thus, Bourdieu sees social capital as the production of the group's members and that it is a collective asset shared by the members of a defined group, with clear boundaries, obligation of exchange, and mutual recognition.

From the individual perspective, Lin (2001) proposes that an individual can gain access and use two types of resources –personal and social resource. Personal resources are resources possessed by an individual (e.g. ownership of a material which included symbolic goods such as certificate). Conversely, social resources are resources accessed through individual's social connections. These resources, according to Lin (2001), can be 'borrowed' for the intention of making a gain (e.g. a Knapsack sprayer borrowed from a friend to spray pesticides on the farm).

Flap (1999) views social capital as mobilized social resources of individuals. He defines social capital based on (i) the number of persons within the social network of individuals and who are ready to assist when the need arises, (ii) the strength of the relationship indicating readiness to help, and (iii) the resources of the personal network members. According to Flap (1999), social capital is resources provided by the network members (alters) who have a strong relationship with ego. Thus, in a social network design, an 'ego' is the focal object of the relationship while the 'alter' is the object to which the focal object is linked. The focal objects are often sampled from a larger population (Flap, 1999). In this study, an 'ego' is the individual (sampled respondent) and the 'alters' are the people s/he is connected with (network members). These terminologies will be used throughout the study. The work of Putnam (1995) on participation in voluntary organisation in democratic societies such as United State puts both group and individual level into one context. The association and participation promote and enhance collective norms and trust, which are central to the production and maintenance of collective wellbeing. The concept of social capital can therefore be placed into three components: (i) moral obligation and norms, (ii) social values (with trust as a principal value), and (iii) social network, especially voluntary association (Putnam, 1995). Thus, trust is a principal component of social capital. Following Putnam (1995), trust is incorporated in the model used in the empirical estimation (section 4.5.2). The study narrowly defines trust as 'trust of familiars', sometimes called particularized or personalized trust, or social trust of familiars. The source of this trust are within established relationships and social networks (Stone, 2001).

The theory of social capital, from the individual level, can therefore be agreed to focus on the resources embedded in one's network. Moreover, it focuses on how access to and use of such resources benefits the individual's actions. The valued good in a society is termed as a resource and the actions taken by individuals for the purpose of gaining access to the valued good is the central theme of the theory. According to Bourdieu (1986), the volume of one's social capital largely depends on the network size (i.e. number of ties an individual has in his/her personal network). Lin (2001) adds that effective utilization of social capital also depends on the heterogeneity of the network members. Thus, farmers can therefore network with people with different socio-economic status such as community members, family members, and government officials, among others. This leads to two concepts of individual social capital-bonding and bridging-as identified by Granovetter (1973). Bonding social capital is the construction of intra

group ties. Social networks are homogenous and can be very informal (e.g. family and friends) or formal (e.g. work, union members). Networks of such nature exhibit distinctive forms of internal trust and is driven by values and voluntary efforts with strong ties (Granovetter, 1985). The cooperative spirit from *bonding* not only provides social safety nets to individuals or group but also protects themselves from external invasion (Fukuyama, 1995). During hard times when the state fails to provide basic services, family relations and kinship come in to help each other.

Bridging Social Capital is the construction of social network with those unlike the farmers (heterogeneous group). It is impersonal and horizontal, and characterised by general trust and volunteering action (Woolcock & Narayan, 2000:230). Gittell & Vidal (1998) define it as weak social ties that enable people get ahead and gain opportunities. With bridging, different groups with diverse interest are able to share and exchange information, ideas and innovation. In Fukuyama's (1995) language, this expands social capital by increasing the 'radius of trust'. When farmers network with experts in the field of climate change, exchange of information is likely to take place (e.g. a farmer who establishes a network with agro-chemical sale personnel). Farmers in most cases also network with people of authority, or power differential and social status (vertical relationship) and this type of network has been termed linking social capital. Szreter and Woolcock (2004:655) define linking as "norms of respect and networks of trusting relationships between people who are interacting across explicit, formal or institutionalized power or authority gradients in society". Linking social capital is created when a farmer, for instance, establishes a network with University professor. This study used occupation prestige of the network members of the farmers to establish linking social capital (see section 4.5.2).

The theory of social capital, however, is not without limitation or criticisms. One main criticism which is levelled against social capital is the multiplicity of its definition. To this, it further criticised that it is impossible to measure (Haynes, 2009). Multiplicity of the definition of social capital poses a problem to comparable conceptualization and measurement. This has a potential of generating misleading results and prediction, especially in the case of quantitative research. As raised in section 2.3, the definition of social capital is context specific and this determines the mode of measurement. This study simply defines social capital as individual asset and this makes it easy to apply name and position generator (see section 4.5.2) to capture the relevant resources embedded in the relationships.

The theoretical integrity of social capital theory has also been challenged. For example, Haynes (2009) argues that social capital cannot be considered as a theory. He explains that the concept does not seem to have to generally accepted elements that constitute a theory which is to provide clarification for specific events. Theory, according to Babbie (2007), is systematic set of interrelated statements intended to explain some aspect of social life. In a general sense, a theory is any more or less formalized conceptualization of the relationship between variables. It is tentative explanations of phenomena observe and representative of the most logical explanation based on currently available evidence. Theory becomes stronger as more supporting evidence is gathered and provides a context for predictions. In his book: Social capital: a theory of social structure and action, see Lin (2001), provided scientific studies and proofed several hypotheses within social capital theory. The study therefore assumes social capital to be a theory of high integrity.

Moreover, the concept of social capital has been criticised to be a misleading metaphor, not a capital as known in classical economic theory. According to Arrow (1999), the term 'capital' has three distinct elements: (i) time extension, (ii) the intended sacrifice for deferred benefit, and (iii) alienability. In his argument, Arrow (1999) concluded that social capital should be abandoned as it does not reflect any of the elements. However, Adler and Kwon (2000:93-95), enumerated instances where social capital depicts many of the features of other forms of capital (i.e. physical, human or financial capital): (i) people can invest in social capital with an expectation of future returns which is not certain, (ii) social capital is appropriable and to some degree "convertible", and (iii) social capital requires maintenance to remain productive. Social capital, I strongly believe, is an asset and a capital within the social system. As shown in section 2.3 and 2.4 communities and individual that possess social capital asset have a comparative advantage (i.e. in terms of information acquisition and changes to farming practices) over those that do not possess.

In sum, Lin (2001:19) gives four explanations as to why embedded resources in social relation augment the outcome of action. For one, the flow of information is facilitated. Second, social ties may exert influence on the decision of an agent. Third, social ties, and their acknowledged relationship to the individual, may be conceived as social credentials that reflects accessibility to resource. Finally, social network are expected to reinforce identity and recognition. This study

therefore investigates key elements of social capital –bonding, bridging and linking – and how they influence the capacity of farmers to cope and adapt to the changing climate.

3.3 Random Utility Theory

Choice, according to Ben-Akiva & Lerman (1985), is a process and that the outcome includes five steps namely: definition of the choice problem; generation of alternatives; evaluation of attributes of the alternatives; choice and implementation. Understanding some elements such as decision makers, alternatives, attributes of alternatives and decision rule will give a good insight about each of the decision process. Decision makers can be any individual, a household or family or organization. In this study individual farmers (respondents) are the decision makers and the different choices that are expected to be made are the alternatives. This is defined in the study as climate change adaptation strategies as enumerated in section 2.4. Each of these alternatives has characteristics which are termed attributes. Since there is more than one alternative a farmer will need a decision rule in order to make a choice. Thus, decision rule is defined as an internal process used by the farmers (decision makers) to process the available information and make a unique choice (Cascetta, 2009).

The literature identifies a lot of rules decision maker can use and one of these is utility maximization rule. This rule assumes that a vector that defines an objective function expressing the attractiveness of the attributes of an alternative expresses the attractiveness of an alternative (Svenson, *et al*.,1990). This attractiveness is referred to as the utility which the decision maker tries to maximize and this is what the study is based upon from an economic perspective. Ben-Akiva and Lerman (1985) classified utility into constant and random utility which is not distinct from cardinal and ordinal utility in micro economics. Cardinal utility, in economics, is considered outdated so as constant utility. Manski (1977) formalizes random utility theory and assumed that the decision maker (farmers/respondents) maximize their utility which is in alignment with consumer behaviour theory. The utility of the decision maker is expressed in modelling as a function. The randomness is due to the fact that the researcher does not know with certainty the utility of the decision maker and hence treated as random variable. Thus, in this study, modelling of utility comprises of decision makers (individual farmers), a set of alternatives, and some utility function that describe how the farmers choose the most preferable alternative through some decision process as described by their utility function.

McFadden (1973), under random utility framework, condensed the five steps in choice modelling identified by Ben-Alkin and Lerman into three. Choice behaviour of consumers are described by (i) the object of choice (i.e. *X*) and sets of alternatives available to decision makers (ii) the observed attributes of decision-makers (i.e. *Z*), and (iii) the model of individual choice and behaviour and attributes of behaviour patterns in the population (McFadden, 1973: 106-107). These fall under the random utility framework. In this study, climate change adaptation options are the objects of choice and alternative at the farmers' disposal while individual network-based social capital and other controlled variables are the attributes of the farmers. The utility derived from any adaptation option is made of deterministic and an error components which cannot be determined but follows a predetermined distribution. This implies that one cannot determine with certainty the alternative adaptation option that the farmers will select. It is, however, possible to apply probability theory by showing that the perceived utility associated with a particular adaptation option is greater than the other adaptation option (Cascetta, 2009).

Let U represents the utility an individual obtains from consumption of good J, V as deterministic component (Utility function) and ε as the error component. The utility of such consumer can be defined as:

$$U_{ij} = V_{ij} + \varepsilon_{ij} \qquad \text{…….. (3.1)}$$

The utility of such consumer depends on the choice made among other available options (Cascetta 2009). The utility function of the individual is assumed to be:

$$U_{ij} = V(X_j Z_i) \qquad \text{…….. (3.2)}$$

The fundamental axiom of random utility maximization theory is that a rational farmer will choose an adaptation option that will maximize the present value of production over a specified period of time. Moreover, the farmer ***i*** will use ***j*** adaptation option if the perceived benefit from that option is greater than the utility from other option k if $U_j > U_k$. It is possible that a farmer may not choose what seems - from the population perspective - to be preferred adaptation option and this is accounted for by an inclusion of a random element. Thus, equation 3.2 can be re-written as:

$$U_{ij} = V(X_j Z_i) + \varepsilon(X_j + Z_i) \qquad \text{…… (3.3)}$$

The probability that farmer selected randomly from the population will choose adaptation option among the set of adaptation options could be defined as follows:

$$P[i|CS] = P\left[U_j > U_k\right], \forall J \in CS \qquad \text{.....} (3.4)$$

$$= P\left[\left(V_j > \varepsilon_j\right)\right](V_k > \varepsilon_k)$$

$$= P\left[\left(V_j > V_k\right) > \xi\right]$$

Where *CS* denotes complete choice set of adaptation option. Typical assumption made in the distribution of the error term is that it is Gumbel-distributed and independently and identically distributed (McFadden, 1973). Choosing an adaptation option to maximize present value of production over a specified period of time, however, is subject to constraints such as relevance and volume of network one accumulate, income, and experience, among others.

In sum, these observed attributes (independent variables) of decision makers (farmers) are expected to influence the maximization of utility from a set of climate change adaptation options.

3.4 Research Hypotheses

According to Bourdieu (1986) the size of the network an individual is able to mobilize effectively determines the volume of his/her social capital. The strength of weak tie hypothesis by Granovetter (1973) indicates that tie strength of smallholder farmers will differ. The study, therefore, hypothesized:

Hypothesis 1: Smallholder farmers in the central region of Ghana have networked and that the strength of the network differs among them.

The theory of individual social capital implicitly assumed that individuals with more network members and connected with resource have high probability of getting access to resources. Moreover, it is also assumed that the stronger the tie to a network member, the greater the willingness of giving access to resources, and thus the better available these resources will be to the individual (ego). Thus, the study hypothesized:

Hypothesis 2: Smallholder farmers with more network members connected with resource have a greater chance of receiving resource (information) and this influences adaptation to climate change.

In sum, according to Babbie (2007), theories are incommensurable. This presupposes that one theory cannot be held as more valid than another and thus, it is possible to attribute a particular study with more than one theory which is the pathway of this study. In the economic discipline, the main theory that has been used in studying climate change adaptation is random utility

theory. In the field of social sciences, prominent theories have been the theory of adoption, specifically, innovation diffusion theory and more recently, social capital theory. Scholars of climate change adaptation studies usually combine economic theory with either the theory of adoption (Kuwornu *et al*., 2013; Etwire, *et al.*, 2013) or with social capital theory (Ngigi, *et al.*, 2012; Deressa, *et al.*, 2009). This study seeks to combine these three theories to help overcome some of the limitations raised and help better understand the social and economic interaction that influence a farmer's decision on climate change adaptation options.

CHAPTER FOUR

RESEARCH DESIGN AND METHODOLOGY

This chapter presents the research design of the study. Delineation of the case study area is presented in section 4.1. Research methodology is presented in section 4.2. The sampling procedure and sample size determination is presented in section 4.3. Section 4.4 presents the type and source of data and data collection. Method of data analysis and ethical consideration are respectively presented in section 4.5 and section 4.6.

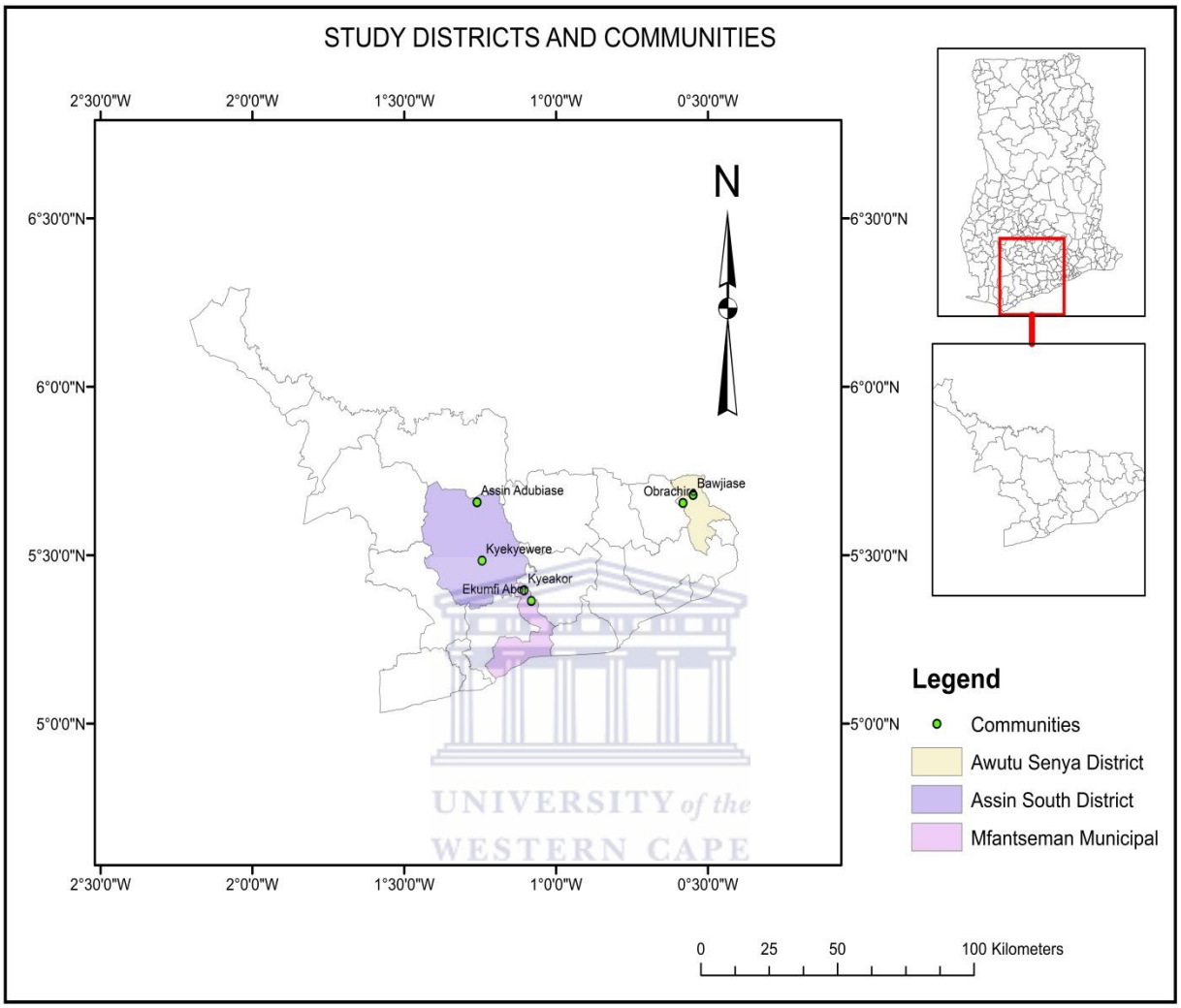
Deciding on a specific research design rests primarily on the objectives of the proposed research. Research design refers to a framework or plan that stipulates how a researcher intends to conduct a research project (Babbie, 2007). Research design gives the researcher the necessary tools that help determine what observations s/he is going to use to test the formulated hypotheses (Babbie, 2007). Contestation surrounding what research design to use in a particular study exists in the literature. In the sections that follow, the designs for reaching the study objectives are highlighted.

4.1 The Study Area

Ghana is a country located in Western Africa along the Gulf of Guinea at Latitude 4° 44' N and 11°11'N and Longitude 3° 11 W and 1°11'E. The population and average per capita annual income are, respectively, 24 million and US$ 879 (GSS, 2012). The country has ten administrative regions. Central region, Capital Cape Coast, is the third smallest region and occupies 4.1 percent (9,826 square kilometres) of Ghana's land area (GSS, 2012). It is bounded to the west by the Western region, east by Eastern region, North by Greater Accra and the south by Gulf of Guinea (Figure 4.1). The population of the region, according to the 2010 population census, stood at 2,201 863 and 47.1 percent reside in the urban areas. The region is made up of 20 districts[4] (GSS, 2012). The classification of these districts according to their geographical location by Ministry of Food and Agriculture (MoFA) is presented in Table 4.1.

[4] New districts have been created from the existing districts in figure 4.1 amounting to 20. Thus, some of the districts have been split into two and these were not taken into account during the study because MoFA has not classified them based on the agro-ecological zone.

Figure 4.1: Map showing the Sampled Communities and Districts in the Central Region of Ghana



The rainfall distribution is bi modal with annual rainfall of 1000mm along the coast and 2000mm in the inland. Average monthly temperature can peak at 24 degrees in the wet season and 30 degrees in the dry/hottest season (MoFA, 2013). Agriculture remains the predominant occupation employing about two-third of the work force in most districts. Some of the major cash crops produced in the semi-deciduous forest zone are cocoa and oil palm. Cereals (e.g. maize), tubers (e.g. cassava), pineapple, are other staple crops grown in region. Fishing activity is concentrated mainly in the six coastal districts.

Table 4.1: Classification of Districts in the Central Region of Ghana based on the Agro-ecological Zone

NO.	Municipal/District/Metropolis	Capital
	Coastal Savanna	
1	Cape Coast	Cape Coast
2	Komenda/Edina/Eguafo/Abrem	Elimina
3	Effutu	Winneba
4	Awutu Senya	Awutu Breku
	Transitional Zone	
5	Mfantseman	Saltpond
6	Gomoa West	Apam
7	Gomoa East	Afransi
	Forest Zone	
8	Ajumako-Enyan-Esiam (AEE)	Ajumako
9	Abura-Asebu-Kwamankese (AAK)	Abura Dunkwa
10	Asikuma-Odoben-Brakwa(AOB)	Bremen Esikuma
11	Agona West	Agona Swedru
12	Agona East	Nsaba
13	Assin North	AssinFosu
14	Assin South	Nsuaem–Kyekyewere
15	Twifo-Hemang-Lower Denkyira (THLD)	Twifo Praso
16	Upper Denkyira East	Dunkwa-On-Offin
17	Upper Denkyira West	Diaso

Source: (MoFA, 2015)

4.2 Research Methodology

There are two major traditions of research methodology in the field of social sciences, i.e. quantitative and qualitative methodologies. Qualitative research focuses on generating data that are stated in prose or textual forms whereas quantitative research focuses on the usage of numerical data. Moreover, qualitative research helps build synergy among respondents. This is because, participants can build on the comments and ideas of other participants (Garbarino & Holland, 2009). Moreover, qualitative research is primarily defined as describing and understanding rather than explaining human behaviour. It offers opportunity to probe and this helps the researcher to reach beyond the initial response and rationale. The use of qualitative research helps to capture non-verbal communications (Babbie, 2007). Quantitative surveys generate quantifiable data that can be analysed statistically, with the purpose of aggregating, measuring, modelling and predicting behaviour and relations (Garbarino & Holland, 2009.). For

example, adaptation of a particular coping mechanism can be compared based on gender, location and so forth. Moreover, generalization and objectivity of findings are the two primary strengths of quantitative research in social science (Neuman, 2003). This study used a mixed methods approach; that is, the combination of the quantitative and qualitative methodology to guide the research process. This will not only help address a problem at different levels but also complement the strengths of the two methods.

The qualitative components of the study includes focus group discussions (FGDs) and key informant interviews. The techniques were used to help gain a detailed understanding on some of the issues raised in the questionnaires and as well serve as a way of verifying the patterns of information provided in the questionnaires (Babbie, 2007). For example, the FGDs were used to verify the coping mechanisms familiar in the community and how the entire community perceives changing climate patterns. Thus, these methods afforded the researcher the opportunity to gain more understanding on issues that are not easily quantifiable.

4.3 Sampling procedure and Sample Size Determination

A sample size of 225 smallholder farmers from six different communities in three districts was used for this study. The universe defined for assessing climate change adaptation mechanisms among smallholder farmers in the central region was the farming population living in the six communities in the three districts. To ensure that all the districts and every farmer have equal chances of inclusion in this research random sampling procedure was used. Thus, three stages of sampling were employed.

The first stage of the sampling procedure entails the selection of three districts from each of the agro-ecological zone in Table 4.1 and this was done using a simple random sampling procedure (lottery method). For example, from the coastal zone, the districts were represented by numbers (1 to 4) written on small pieces of paper. These small pieces of paper were then folded and tossed in a small container for one minute and emptied onto a table for picking. The district that was selected by chance process was Awutu Senya district. The other two districts that were selected from the transitional and the forest zone using the same procedure were Mfantseman and Assin South, respectively. The three sampled districts are shown in Figure 4.1.

The second stage was the sampling of two communities from each district and this was done using the same (lottery) sampling procedure. Table 4.2 present the districts and communities selected. The MoFA offices in each of the sampled districts were contacted two weeks prior to the survey for a list of farmers particularly into staple food production.

Table 4.2: Distribution of households sampled per district

Agro-ecological Zone	Sampled Districts	Sampled Communities	Number of household Interviewed
Coastal Zone	Awutu Senya	Bawjiase and Obrachire	73
Transitional Zone	Mfantseman	Kyeakor and Abor	73
Forest Zone	Assin South	Nsuam/Kyekyewere and Adubiase	79
Total			**225**

Source: Field Survey, 2015

The formula for calculating the sample size for the survey, according to NEA, (1960) is depicted in equation (4.1). This was employed in order to measure a given proportion with a degree of accuracy and above all at a given statistical significance.

$$s=\frac{\chi^2 NP(1-P)}{d^2(N-1)}+\chi^2(1-P) \qquad \text{..... (4.1)}$$

Where:

s = required sample size

χ^2 = Chi squared value (table) for 1 degree of freedom at the desired confidence level (3.841)

N=the population size

P = the proportion of the population (this was assumed to be 0.5 so as to provide the maximum sample size)

d = the degree of accuracy expressed as a proportion (0.05)

Applying this formula on a population of 1200 households will yield sample size of 384 households. However, due to the time frame within which the research was to be carried out coupled with a lack of resources, 225 households were randomly sampled for the study. This accounts for about 60 percent of the required sample.

Two instruments, FGDs and key informant interviews were used to collect qualitative data to complement the quantitative findings. In total three FGDs were held, one in each district. In Awutu Senya district, the FGD was held in Obrachire. In Assin South and Mfantseman district the FGD was held, respectively, at Adubiase and Abor. A non-probability sampling was used to select participants for the FGDs and the key informant interviews. On this note, purposive sampling which is mostly used in qualitative studies (see Babbie, 2007) was employed to select 12 farmers for every FGD held and 2 best farmers for the key informant interviews. The rationale behind the use of purposive sampling was to get the maximum variations of respondents. Thus, this was done to ensure that farmers with different socio-economic profiles (e.g. age, sex, land size, plant cultivated, etc.) are represented.

Three key informant interviews (semi-structured) were planned to be carried out, one in each districts. However, only two of them were successfully carried out. Moreover, semi-structured interviews beside allowing informants to freely express their views in their own terms provides reliable and comparable qualitative data (Babbie, 2007). Strenuous effort was made to purposively select two best farmers (i.e. farmers who have received national awards for their outstanding contribution to agricultural output) for the interview. In a meeting with the directors of MoFA in the sample districts, a list of best farmers were obtained and contacted prior to the research. Empirical research has shown that experience and knowledge on environmental factors play a significant role in climate change adaptation adoption (Kuwornu *et al*., 2013). The researcher therefore assumed that these farmers have more experience, divergent opinions and perspective of the topic under study.

4.4 Type and Source of Data and Data Collection Method

The study combined both primary and secondary data to collect relevant information needed for the study. A well-structured questionnaire was administered through face-to-face interviews with the farmers. Prior to the main survey, the structured questionnaire was pre-tested where 15 farmers were interviewed. All shortfalls such as wrong wording of sentences, ambiguous questions, omission of relevant variables, etc. were factored into the final questionnaire. The structured questionnaire captured four main classes of information which include: demographic characteristics; personal network of the respondents; farm and other characteristics; and climate

change information (i.e. perception and adaptation strategies). The structured questionnaire for the households is attached at appendix B3.

A checklist was developed for the FGDs conducted in each of the sampled districts (see appendix B1). Each FGD lasted for about 45 minutes to 1 hour. The checklist has four main themes: demographic information; concept and perception of climate change; impact and adaptation to climate change; and individual social capital (networking activities).

The interview guide for the key informants is attached in appendix B2. It covers two main themes: perception, impact and adaptation to climate change and individual social capital (networking among farmers). About one hour interview was carried out in the residence of those key informants who honoured the appointment made.

Secondary data on the other hand were obtained from Ghana Meteorological Agency and MoFA. To this end, time series data on the amount of rainfall (on daily basis) in the Central region of Ghana from 1994 to 2014, reflecting participating districts and communities were sourced from Ghana Meteorological Agency. Annual Output of Maize in the central region over the same time frame was sourced from Ministry of Food and Agriculture.

4.5 Method of Data Analysis and Presentation

The administered household questionnaire for the quantitative survey was coded and captured using Statistical Package for Social Science (SPSS) software for windows version 23.0. Data verification and cleaning was done to identify and correct or eliminate outliers, mismatches and omissions. But for the cluster analysis and empirical econometric model estimation, SPSS was used to analyse all the outlined objectives. Using the outputs of the SPSS, all graphs were developed using Microsoft Excel. The cluster analysis and the estimation of the empirical econometric model were achieved using Stata software version 13.

Analysis of the qualitative data (both FGDs and key informant interviews) was based on content analysis (Bryman, 2008). Responses undertaken with regards to concept and perception of climatic change, impact and adaptation and individual social capital (networking) were summarized according to emerging themes and presented as counts. Qualitative analysis of information from FGDs and the interviews is a continuous process. This starts during data

collection on the field with identification of major themes and ends with an in-depth description of the results. Following Newing (2011), data from the FGDs and key informants was summarized according to key themes. These were illustrated by direct quotes, recounting particularly relevant experiences and views of smallholder farmers, all of which were essential for the authenticity of findings. The sub-sections that follow describe, quantitatively, how each of the objectives was analysed.

4.5.1 Identifying the kind of personal social relation (network) that exist among smallholder farmers

Two modes of instruments were used to identify the personal social network of the respondents. Following Lin (2001), these instruments are name and position generator.

Name Generator

The name generator instrument asks questions about the personal network of the ego (respondent). For instance, 'whom will you seek for advice/information if you encounter a problem in your farm?' The name(s) generated from this question were recorded and served as the basis for the subsequent questions. Questions about each network member such as the age, sex, occupation, relation with the ego and the like were taken and recorded as well. This process is called name interpreter (Flap *et al.,* 2000). To fully capture the individual social capital that may enhance the flow the information on climate change adaptation strategies and to avoid bias toward single form of social capital, ten name generator questions were employed in the questionnaire. These questions vary in terms of skills, knowledge and resource that can potentially be exchanged among farmers and other relevant actors. To minimize the burden on the ego, the number of alters to be named were restricted to two. Exclusion of weak tie has often been one of the main weaknesses of name generator and this is reported to cause structural distortion in ego-centered network data (Van Der Gaag, 2005). This problem is minimized by the inclusion of the second instrument, position generator, in the study.

Position Generator

The position generator instrument utilizes a limited list of occupations in order to map the occupational positions of network members (Van Der Gaag, *et al.,* 2008). It usually used to measure the weak tie of individuals. Generally, these occupational positions are considered good

indicators of the resources embedded in a social network. The theoretical framework embodied in the construction of position generator is built from the assumptions on the usefulness of the presence of alters, the availability of resources, and the presence of resources owned by alters (Van Der Gaag 2005). In its pure form, position generator, does not create names neither does it have name interpreter. The respondents are made to answer 'yes' or 'no' as a response to whether or not they know someone from a sample of occupations. For example, do you know any agronomy and forestry technicians? Responding to just 'yes' or 'no', however, do not suffice for the intended social capital to be measured. To get a meaningful result from this response, the name interpreter is applied to each of the names generated. The kind of relationship through which the occupation is accessed – friend, family or acquaintance – is also examined to understand the availability of social resources. Meeting the theoretical goal of position generator requires that sample occupations range widely in prestige and covers different sectors of the economy (Dinh *et al.*, 2012). The study uses ten different set of occupations, based on the international occupational prestige developed by (Ganzeboom & Treiman, 1996). These occupations are also found in all Ghana living standards surveys (GLSS) and labour force module, 2012/2013. Descriptive statistics was used to compute the response of the position generator items in the questionnaire.

4.5.2 Analytical Method for Identifying tie strength and social distances

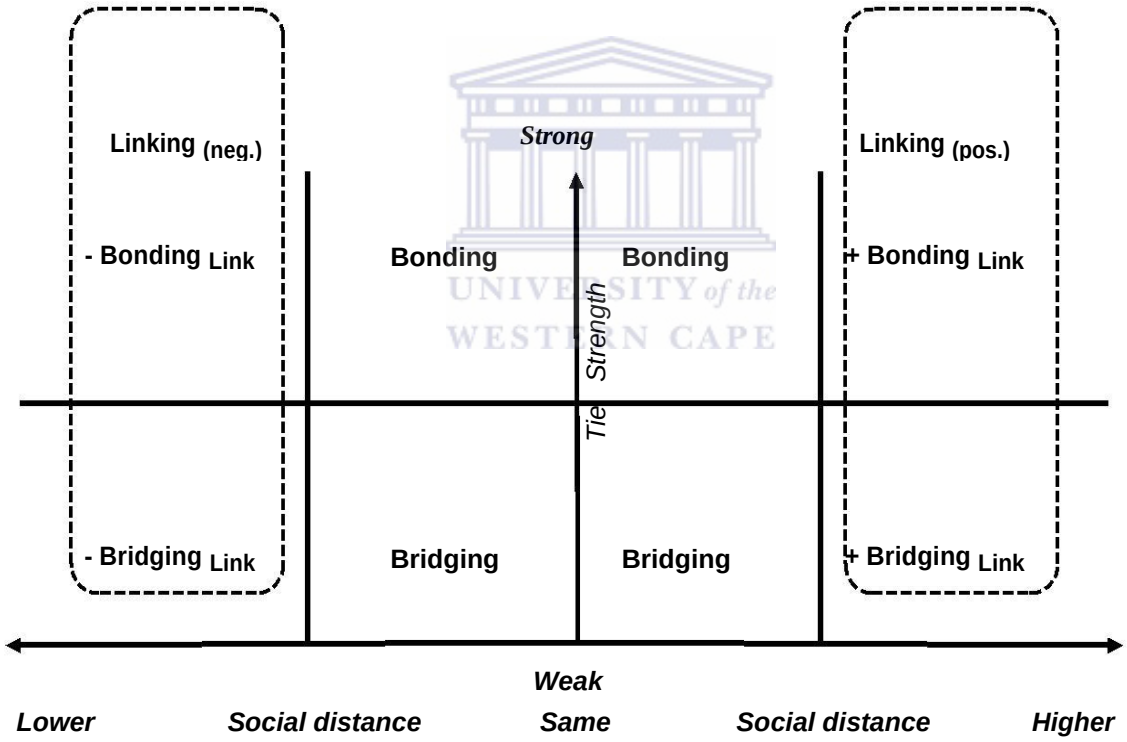
Network social capital resides in relationships (Coleman, 1988). In operationalizing individual network social capital, personal network in this study is defined as the summation of all the relationships the individual possessed. To be able to identify the resource network of the respondents, only relationships that are connected to resource (e.g. someone who can give you GHs 100, an extension Agent) were measured. The personal network variables captured by the SPSS were transposed (using SPSS) and the network members (from both position and name generator) of each respondent were marched. A k-means cluster analysis was employed to distinguish strong and weak ties. Following Zhao (2002), five indicators were used to estimate the tie strength between respondents and their network members. These indicators include the type of relationship (core family, extended family, friends and acquaintance), frequency of contact per month/year, duration of relation in years, degree of closeness and the level of trust.

A k-means cluster analysis was employed to distinguish bonding, bridging and linking social capital. This study distinguishes linking social capital by using social distances defined as the

occupational prestige of the household head and his/her network members. This is measured by the usage of Standard International Occupational Prestige Scale (SIOPS) developed by Ganzeboom and Treiman (1996). Social distance, is precisely, computed as the difference between the household head SIOPS and the SIOPS of network members.

Social distance can be lower (negative) or higher (positive) or even neutral (see figure 4.2). Thus, bonding and bridging social capital can be connected to linking social capital. This interaction therefore generates four variables (clusters) in the econometrics analysis: *bonding*, *bridging*, *bonding_link*, and *bridging_link*. The aggregation (number of ties) of these four variables (clusters) is done for each person in the social capital categories.

Figure 4.2: Different Form of Individual Social Capital



Source: Dufhues *et al.*, (2011) and Dinh *et al*., (2012)

4.5.3 Analytical Methods for the Trend of Weather Pattern (Rainfall) and its Association with Maize Output over the past 20 years

The trends of rainfall pattern and maize output (from 1994 to 2014) were analysed graphically using trend analysis in Microsoft Excel. The number of days with dry spell over the 20 year

period was also analysed using the same statistical tool. Pearson correlation coefficient was used to test the association between the two variables (rainfall pattern and maize output).

4.5.4 Analytical Methods for Ascertaining Farmers' Perception of Climate Change and their Adaptation Strategies

Smallholder farmers were asked to express their opinion on statement related to climate change. Some of these statements were nominal, categorical and others on a five point likert-type scale: Strongly Disagree [1] to Strongly Agree [5]. Descriptive statistics was used to analyse the responses of these statements. In order to show which of the perception indicators is most pressing (rating), the responses of the five points liker-scale were computed as follow: The cut off mean for each indicator on the likert scale was **3.0** [i.e. [(5+4+3+2+1)/5=3)]. The total score of each statement was then divided by the number of respondents (225). For instance, the statement: Precipitation has been unpredictable over the past 20 years had the following responses; Strongly Disagree (*f=5*); Disagree (*f=6*); Neutral (*f=33)*; Agree (*f=85*]; Strongly Agree (*f=99*]. These were worked out as: 5*1=5; 3*2=6; 33*3=99; 85*4=340; and 99*5=495. The product of the responses were then summed and computed the average as [(5+6+99+340+495)/225 = **4.2].** Thus, the mean score of the statement is **4.2** which is greater than the cut off mean (**3.0**).

Mann-Whitney U test and Kruskal-Wallis test were used to test if the perceptions of smallholder farmers on climate change differ across sex and the location (sample districts), respectively.

4.5.5 Analytical Method for the effect of individual network social capital and other factors on the adaptation strategies

To see the effect of individual social capital and other controlled factors on the farmers' choice of adaptation strategy of climate change, a MLM is employed. The farmer is faced with more than one adaptation strategy and a decision must be made to adopt one or more to mitigate the effect of climate change. Thus, the model assumes that farmer *i* will maximize his/her perceived utility from using a particular adaptation strategy subject to given factors of constraints. The farmers' choice of adaptation is therefore modelled in a random utility framework. The utility function attached to each adaptation methods (j = 0, 1, 2 …J) is partially observed and following Cameron and Trivedi (2005) these can be expressed for farmer *i* as:

$$U_0 = \epsilon_0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(4.2a)}$$

$$U_1 = X\beta_1 + \epsilon_1 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(4.2b)}$$

$$U_2 = X\beta_2 + \epsilon_2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(4.2c)}$$

$$\ldots\ldots$$

$$U_J = X\beta_J + \epsilon_J \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(4.2d)}$$

Where $j = 0$ represent a farmer who chooses not to adapt and $j = 1,2 \ldots, J$ represents the available suite of adaptation strategies from which farmers can choose; X represent a vector of farmer characteristics and other factors that may influence the choice of a particular adaptation strategy. βs are unknown parameters to be estimated while ε are idiosyncratic factors that are independent from each other. With the assumption of rationality, a farmer will choose adaptation strategy that gives the highest utility, that is, the farmer will choose option four is and only if,

$$U_4 > U_j \qquad \forall\, j = 4$$

The probability for the choice of option four above can therefore be defined as:

$$P(Y = 4|X) = P\left(\mu_4 > \mu_j\right) \quad \forall\, j \neq 4$$

$$P(Y = 4|X) = P\left(X\beta_4 + \varepsilon_4 > X\beta_j + \varepsilon_j\right) \quad \forall\, j \neq 4$$

$$P(Y = 4|X) = P\left(\varepsilon_j - \varepsilon_4 < X\beta_j + \beta_4\right) \quad \forall\, j \neq 4 \qquad \ldots\ldots\ldots\ldots\ldots \text{(4.3)}$$

The model that explains the mechanism of such choice decision is called MLM. The model implicitly assumes that the choice preference of a given adaptation strategy is unaffected by the presence of the other adaptation choices. This assumption is termed Independence of Irrelevant Alternative (IIA)[5] and follows that disturbances are independent and homoscedastic (Greene, 2003).

The MLM for climate change adaptation choice is specified as:

$$Prob(Y_i = j) = \frac{exp(X_i\beta_j')}{\sum_{j=1}^{J} exp\left(X_i\beta_j'\right)}, \qquad j = 0, 1, \ldots \ldots J \qquad \ldots\ldots \text{(4.4)}$$

5 If a farmer begins with one or two adaptation method(s) and later decides to add additional adaptation strategy, the IIA assumption implies that the additional choice should not alter the probability of the existing method.

Inherent in equation (4.4) is the problem of Indeterminacy. A convenience normalization that solve the problem is by assuming that $\beta_0 = 0$. The probabilities are estimated as:

$$Prob(Y_i = j|X_i) = \frac{exp(X_i\beta_j')}{1+\sum_{j=1}^{J} exp\left(X_i\beta_j'\right)}, \qquad j = 0, 1, \dots \dots J, \beta_0 = 0. \qquad \dots\dots (4.5)$$

The Maximum Likelihood estimation yield the odd ratio as presented in equation (4.6)

$$\ln\left[\frac{P_{ij}}{P_{ij}}\right] = X_I'(\beta_j - \beta_j) = X_j^i\beta_j \qquad if\ k = 0 \qquad \dots\dots (4.6a)$$

From equation (4.6a), the model specified for the estimation of choice of adaptation mechanisms can be specified as:

$$\begin{aligned} CS = \ln\left[\frac{P_{ij}}{P_{ij}}\right] &= \beta_0 + \beta_1 BONDING + \beta_2 BOND_{link} + \beta_3 BRIDGING + \beta_4 BRIDG_{link} \\ &+ \beta_5 AGE + \beta_6 SEX + \beta_7 SIOPS + \beta_8 FINCOME + \beta_9 FEXPERIENCE \\ &+ \beta_{10} LANDSIZE + \beta_{11} LEADROLE + \beta_{12} MARKETDIST + \beta_{13} LOCATION \\ &+ \varepsilon \end{aligned} \qquad \dots\dots\dots (4.6b)$$

Following equation (4.6), the choice of any adaptation strategy is interpreted as the log-odd in relation to the base category. The coefficient in this model is difficult to interpret (Greene, 2003) There is high possibility of associating Bj with jth outcome which is misleading. Estimation of the marginal effect helps to explain the effect of the independent variables on the dependent variables in terms of probabilities. Thus, differentiating equation (4.6a) yields the marginal effect as in equation (4.7).

$$\frac{\partial P_j}{\partial X_i} P_j\left[\beta_j - \sum_{k=0}^{J} P_K\beta_k\right] = P_j\left[\beta_j - \bar{\beta}\right] \qquad \dots\dots\dots (4.7)$$

The marginal effect therefore measures the expected change in the choice of a particular adaptation strategy as a result of a unit change in the exogenous variable (Greene, 2003).

The independent (exogenous) variables used in the econometric model are operationalized and defined in table 4.3

Table 4.3: Operationalization and Description of variable used in the Econometric Model

Variables	Description	Measurement	A priori Expectation
Individual Social Capital Variables			
BONDING	Bonding Social Capital	Continuous unit	+
BOND_link	Bonding_link Social Capital	Continuous unit	+
BRIDGING	Bridging Social Capital	Continuous unit	+
BRIDGE_link	Bridging_link Social Capital	Continuous unit	+
Other Control Variables			
AGE	Age of the household head	Years	+/-
SEX	Sex of household head	Dummy: 1=Male; 0=Female	+/-
SIOPS	Occupational prestige	Continuous	+
FINCOME	Farm Income	Amount in GHs	+
FEXPERIENCE	Farming experience	Years	+
LANDSIZE	Total farm size cultivated	Hectares	+/-
MARKETDIST	Distance to the nearest market	Kilometres	-
LEADROLE	Leadership status of household head	Dummy: 1=Yes; 0=No	+
LOCATION	Districts/Climatic Zone	1=Awutu- Senya; 2=Assin South and 3=Mfantseman	+/-

4.6 Ethical Consideration

This research only commenced after it has been approved by University of the Western Cape Senate, the Economic and Management Sciences Higher Degrees Committee and the Institute for Social Development. The research held in high esteem all the ethical considerations and made known the aim to all the participants. Publicity and awareness drive of the research was carried out in the sample communities with the local people such as opinion leaders, representative of producers and association such as clan leaders, and chiefs prior to the commencement of the research. Participation in this research was voluntary and participants were given the freedom to drop out in the course of the interview if the need arises. This research did not impose harm to

any participant and confidentiality of information given by the participant was fully assured. Participants made to consent not to divulge any information discussed in the focus group and the interviews (key informants). Also, respondents were informed that the report about the findings of the research will be disseminated to all relevant people and institution and copies of the main findings will be given to those participant interested. This report has been written to avoid identification of any participant in the study. Copies of this research have been made available to the information bank of the University of the Western Cape.

CHAPTER FIVE
RESULTS AND DISCUSSION

Climate change has many negative implications especially on the growth of developing countries. Smallholder farmers who are vulnerable to climate change suffer most of the implications. Adaptation to the changing climate is the best way to mitigate the negative effect of climate change. Ascertaining the perception of smallholder farmers helps in configuring the problem as this can shape the plethora of adaptation actions taken. A number of factors influence adaptive capacity of smallholder farmers to the changing climate and one of these is social network which is embedded in the theory of social capital. Farmers with no or little knowledge on agricultural practices and technology are likely to rely on others for information. This study basically argues that government extension officers do not reach most of the smallholder farmers. Smallholder farmers acquire knowledge from their network members which aid in the choice of adaptation strategy to climate change.

This chapter presents and discusses the results of the study. Section one presents and discusses the socio-economic description of the respondents. The types of social relations and the strength of these ties are presented and discussed in section two. Section three presents the trend of weather pattern (rainfall) over the past 20 years and its association (correlation) with maize output in the study area. The perceptions of smallholder farmers on climate change and their coping strategies are presented in section four. Lastly, section five presents the empirical econometric results of the effect of the individual social capital and other factors on the climate change adaptation strategies. The results of the focus group discussions and key informant interviews are discussed alongside the quantitative findings of the study in these sections. It must be noted that the study used Pseudo names in the analysis of the qualitative findings. This was done to ensure that participants are protected.

5.1 Socio-Economic Description of Respondents

The survey sampled 225 households and the proportion of male and female in each of the three case study Districts is presented in table 5.1. About 61.6 percent of the household heads were female in Awutu-Senya compared to 41.8 percent in Assin South district. Only 11 percent of the household head were female in Mfantseman district. Overall, the proportions of female and male headed households sampled are respectively, 38.5 and 61.5 percent. In rural Africa, men usually

represent the household head. Women, however, assume the role of household head upon divorce or the death of the husband. This is reflected in the marital status of the respondents.

The gender diversity in Ghana is a socio-cultural phenomenon and this may have significant implications on welfare and ownership of resources. These implications are highlighted along the individual social capital, perceptions and adaptation strategies later in this chapter.

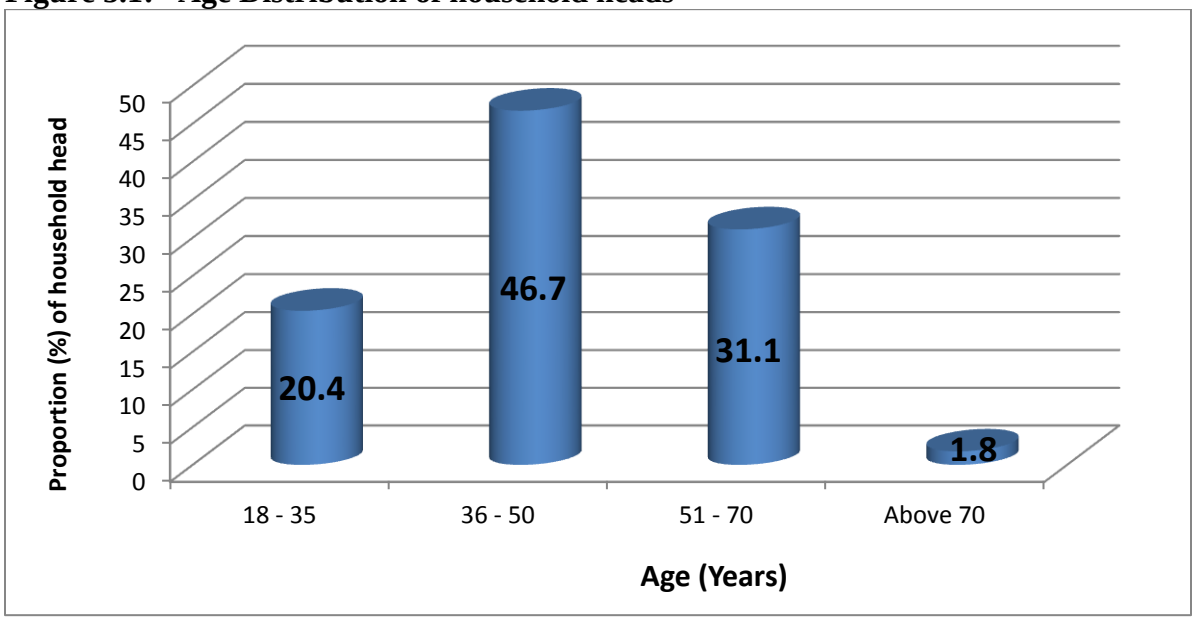
Table 5.1: Distribution of household heads sampled by sex

Variable		Districts						
		Awutu-Senya (*n* = 73)		Assin South (*n*= 79)		Mfantseman (*n*= 73)		Overall
		Freq.	%	Freq.	%	Freq.	%	%
Sex	Female	45	61.6	33	41.8	8	11	38.5
	Male	28	38.4	46	58.2	65	89	61.5

Field Survey, 2015

The majority of the respondents (46.7 percent) are within the age group of 36 to 50 years (figure 5.1). While 31.1 percent are within the age group of 51 to 70; only 1.8 of the respondents are above 70 years. Young farmers (those between 18 and 35) who form the future producers constitute 20.4 percent.

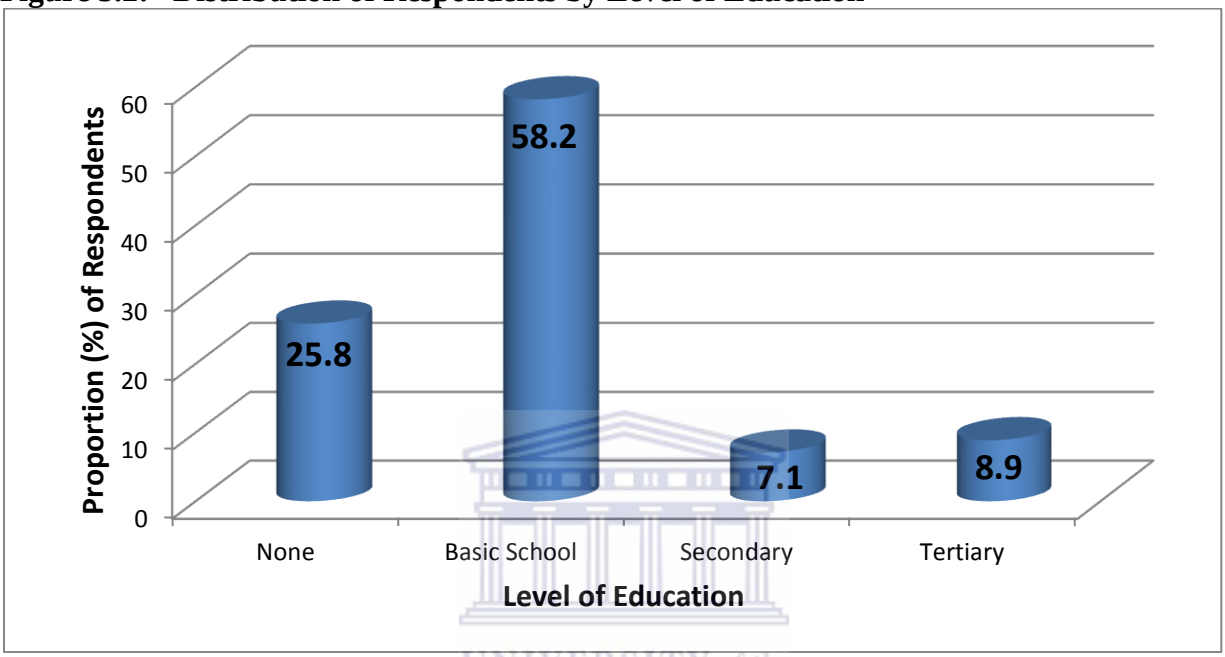
Figure 5.1: Age Distribution of household heads



Source: Field Survey, 2015.

The education of household heads is presented in figure 5.2. Most of the household heads (58.2 percent) had basic education. While 8.9 percent had tertiary education only 7.1 percent had secondary education. The proportion of household heads with no formal education constitutes 25.8 percent.

Figure 5.2: Distribution of Respondents by Level of Education



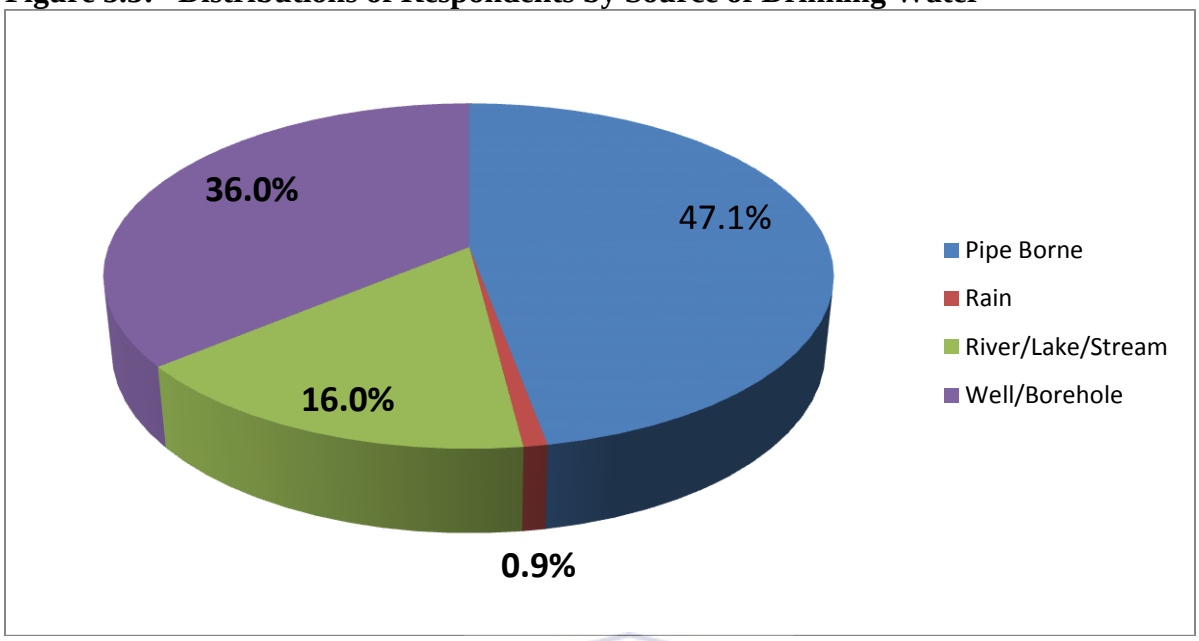
Source: Field Survey, 2015.

Married household head constitutes 71.6 percent. While 14.2 percent have divorced/separated only 6.7 percent are widow/widower. Single household heads are 7.6 percent.

5.1.2 Environmental and Institutional Characteristics

The source of drinking water and the distance to the nearest market are the two characteristics presented in this section. The proportion of households who drink from pipe born water and well/borehole are, respectively, 47.1 and 36.0 percent (figure 5.3). About 16 percent of the households get drinking water from the river or lake or stream. Those reported to get drinking water from rainwater harvesting form only 0.9 percent.

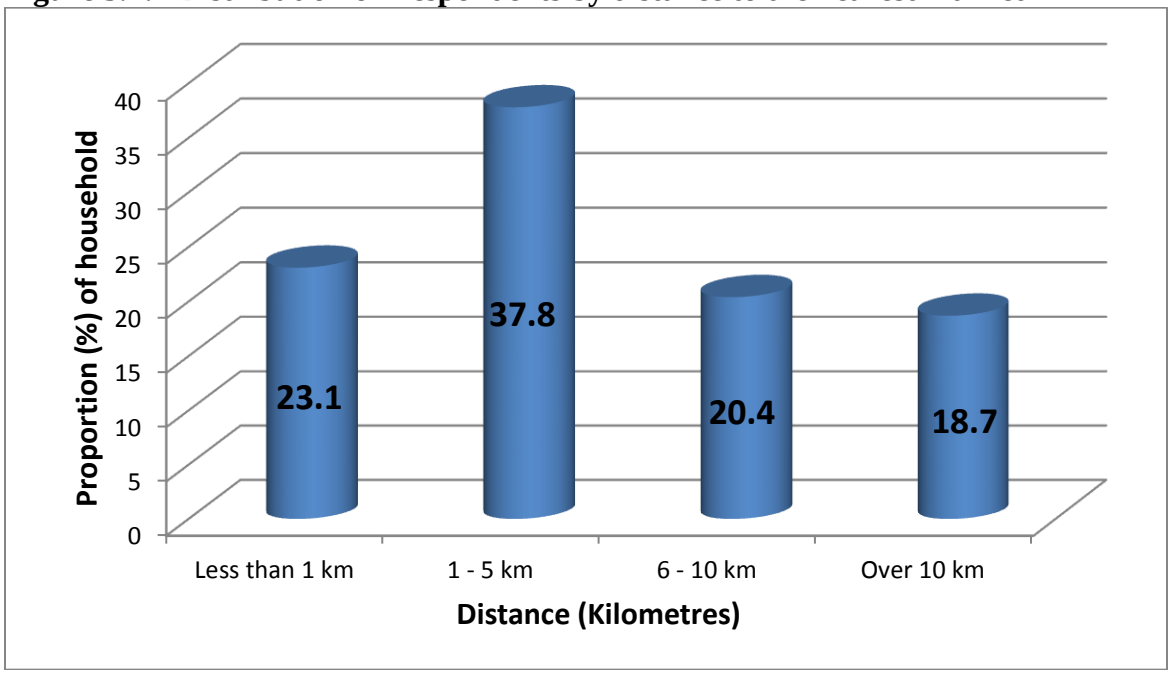
Figure 5.3: Distributions of Respondents by Source of Drinking Water



Source: Field Survey, 2015

Majority of the respondents (37.8 percent) live 1-5 km to the nearest market (figure 5.4). Those who are less than 1 km and between 6-10 km from the nearest market form about 23.1 and 20.4 percent, respectively. Respondents who are far away from market centres (above 10 km) constitute about 18.7 percent.

Figure 5.4: Distribution of Respondents by distance to the nearest market



Source: Field Survey, 2015

5.1.2 Other Socio-Economic Characteristics of the Respondents

Household size was measured as the number of people eating from the same pot. The mean household size of the 225 respondents is about 6 with a standard deviation of 2.759 (see table 5.2). The minimum and maximum household sizes are respectively 11 and 18. The mean annual farm income from the previous season is GHs 2963.76 with a standard deviation of GHs 3703.23.

Table 5.2: Further Description of Socio-Economic Respondents

Variable	Mean	Standard Deviation	Minimum	Maximum
Household Characteristics				
Household size	5.8	2.759	1	18
Household Farm Income*	2963.76	3703.23	0.00	29000.00
Farm Characteristics				
Size of land Cultivated in hectares	1.450	1.326	0.081	6.475
Farming Experience	16.02	10.56	2	50

Source: Field Survey, 2015; *GHs 1.00 = R4.02 = US$ 0.25 = €0.23 as of 11th December, 2015.

GHs 0.00 and GHs 29000.00 are the minimum and maximum annual farm income of the sampled households. The average of the size of land cultivated in the previous season is 1.450 hectares with a standard deviation of 1.326 hectares. The minimum and the maximum land cultivated are respectively 0.081 and 6.475 hectares. Lastly, the average number of years with farming experience is about 16 with a standard deviation of about 11 years. The minimum and the maximum years with farming experience are 2 and 50, respectively.

5.2 Types of social relations and the strength of ties between respondents (egos) and network members (alters)

The name and position generator unveiled that egos have networked with different people of different occupational prestige. Some of the respondents (egos) relate to network members (alters) as core family members, extended family members, friends and acquaintances. The response of the items used in the position generator questions is presented in table 5.3. The majority of the respondents (80 percent) have not networked with people in higher education profession.

Table 5.3: Responses to the items in the position generator question

Is anyone in your family or among your friends or acquaintance a/an:	Percentage (%)				
	Nobody	**Core Family**	**Extended Family**	**Friend**	**Acquai-ntance**
National government official including minister	51.1	1.3	2.2	5.3	40
National local government official	45.3	4.9	7.6	18.2	24.0
Radio, television & other announcers	23.1	9.3	9.8	24.0	33.8
Meteorologists	53.8	0.4	0.4	15.1	30.2
Agricultural veterinary officer	43.6	0.4	1.8	14.2	40.0
Agricultural extension officer	55.1	0.9	1.8	20.4	21.8
Machinery renter	12.0	13.8	21.3	36.4	16.4
Shop sales person (agro chemical shop)	4.4	8.0	9.8	40.4	37.3
Higher education Professionals (University professor, lecturer)	80.0	2.2	3.6	7.1	7.1
Secondary education teacher (SHS, JHS, etc.)	44.0	16.9	10.2	22.2	6.7
Authors, journalists & other writers	59.1	0.9	2.2	6.2	31.6
Farmer (crop production)	0.2	44.0	22.7	28.0	4.4
Animal producer (farmers into livestock and poultry production)	12.0	11.1	23.1	40.0	13.8

Source: Field Survey, 2015.

Most of the respondents (about 95.6 percent) have networked with shop sales personnel (agro-chemical shop) and about 40 percent relates to the respondents as friends. But for farmer (crop production) alters who relate to egos as friend and acquaintance are more than those who relate as core family and extended family. According to Lin's theory of social capital (2001), social resource (i.e. occupational prestige) in a society has a structure in the form of pyramid which depicts control and accessibility of such resources. The peak of the pyramid (higher position) is occupied by fewer people with significant influence (in term of wealth, status and power). The pyramidal structure offers advantages and disadvantages to occupants who are, respectively, close to the peak and at the bottom of the structure. To this end, those closer to the peak can reach up (contact) those at the peak to exert influence as compared to those at the bottom of the peak. The responses of the position generator items in this study show this phenomenon. More than half of the respondents do not have network members in each of the following occupation: higher education, Author or Journalist, Extension Officer, Meteorologists, National government

official. This is likely to reduce the amount of social resources possessed by such individuals thereby making them more vulnerable to the risk associated with climate change. Studies have shown that the type and the extent of social network are key determinants of risk management strategies of the poor. Using the case of Mexicans in San Diego and Haitians in Miami, it was revealed that the populace are denied some economic resources benefits and social opportunities due to their social low level of capital and internal cohesiveness (Rao and Woolcock, 2001 as cited in Bayat, 2015). Like human, physical or financial capital, lack of social capital limits one of many opportunities (e.g. access to public services). It will be relevant to facilitate the reaching-up process (e.g. farmers establishing contacts with personnel at the peak of the pyramid) by involving such personnel in farmers' training programmes.

The strength of ties between egos and alters is presented in table 5.4. The standardized variables were clustered into two: weak ties and strong ties. For instance, the mean value and the standard deviation of the duration of relationship of the weak ties are 10.38 and 7.396, respectively. The minimum and the maximum years of relationship are 1 and 45, respectively. On the other hand, the duration of relation for strong ties has a mean value and standard deviation of 18.82 and 13.57, respectively. The minimum and the maximum duration of relationship are 1 and 71 years, respectively. Interestingly, the minimum score of closeness of relationship and trust level for strong ties is 2 in both cases and 1 in the case of weak ties.

Table 5.4: K--Means Cluster Analysis of Tie Strength

Variable	Mean	Std. Dev.	Minimum	Maximum
Cluster 1, Weak Ties; N = 1093				
Role relation	2.111	1.080	1	4
Frequency of contact	3.274	1.206	0	4
Duration of relationship (years)	10.38	7.396	1	45
Closeness of relationship	3.122	0.983	1	5
Level of trust	3.573	1.154	1	5
Cluster 2, Strong Ties; N = 1490				
Role relation	2.462	1.057	1	4
Frequency of contact	3.483	0.994	0	4
Duration of relationship (years)	18.82	13.57	1	71
Closeness of relationship	4.863	0.418	2	5
Level of trust	4.717	0.569	2	5

Source: Field Survey, 2015

According to Granovetter (1985), strong ties are established among relatives (coded as 4=core family, 3=extended family) while weak ties are usually found among friends (coded with 2) and acquaintances (coded with 1). Moreover, strong ties are characterised by trustworthiness, long lasting contacts and closeness between ego and alter. Frequency of contact determines the dormancy or the activeness of the tie relationship.

The implications of strong and weak ties on the probability of information flow and behavioural changes have been established. Weak ties have been revealed to diffuse information about new ideas as result of differences in the social circle of actors (Rogers, 2003; Granovetter, 1985). In this study, improved varieties and breeds, certain type of pesticides and fertilizers, recommended agricultural practices are some of the new ideas (innovations) that are likely to be conveyed to smallholder farmers when connected with relevant occupational prestige. Lack of weak ties, according to Rogers (2003), can serve as a barrier to diffusion. The positive effect of strong ties, according to Friedkin (1982), is that it is a more efficient contributor to the probability of information flow than weak ties. In assessing probability of information flow in intra-organisational social network, Friedkin (1982) established that it requires twice as many weak ties to obtain the equivalent effect of a given number of strong ties. Thus, the relative number of strong and weak ties contributes greatly to the diffusion of knowledge and behavioural change. I argue that both strong ties and weak ties are needed to spread climate change adaptation practices among smallholder farmers.

Lin's theory of social resource indicates that the ability of network members to provide help and other resource is directly proportional to their social status. Sociologists have therefore established that occupational prestige in modern industrial society is the most relevant indicator for social status (Zhao, 2002). The occupational prestige that emerged from the survey (both position and name generator) is attached in appendix A9. It must be stressed that the computation of strong and weak tie characteristics was based on the respondent's connectedness with alters within a defined occupational prestige. Each respondent had an option of generating at most 23 network members from both position and name generator items used in the study. After elimination of 'nobody' ties (i.e. respondents who do not know anyone from a particular occupation or do not have anyone to consult for help) the 225 respondents came out with 2583 network members (both position and name generator). Table 5.5 presents the four clusters of the

network members based on the differences in SIOPS as explained in section 4.5.2. The least among the clusters is cluster one (12.7 percent) which shows a very high negative SIOPS difference between the ego and the alter. The smaller the mean value in absolute terms the more similar the ego and alter are in terms of socio-economic status. This lends credence to strong tie arguments which stipulate that the stronger the ties between actors the more similar they are in diverse ways (Granovetter, 1985). The following clusters (i.e. cluster 1, 2 and 3) are grouped into no linking ties category.

Table 5.5: K-Means Cluster Analysis of the Social Distance of personal network members of the household head

Variable	Mean	Std. Deviation	Minimum	Maximum	
Cluster 1, N=392					**No linking Ties Category**
Cluster Difference of SIOPS	-27.04	5.660	-47	-21	
Cluster 2, N=526					
Cluster Difference of SIOPS	-14.34	4.080	-20	-8	
Cluster 3, N=983					
Cluster Difference of SIOPS	-0.166	1.242	-7	4	
Cluster 4, N=682					**Linking ties**
Cluster Difference of SIOPS	12.07	6.235	6	28	

Source: Field Survey, 2015

Linking social capital has two points of connection. The first is through bridging social capital where the connection is through a weak tie ($Bridging_{link}$). The second is bonding social capital where connection is through a strong tie ($Bondingl_{ink}$). The aggregation of the number of ties for each of the linkages (connections) yield four individual social capital variables as presented in table 5.6. The mean value and the standard deviation of bonding social capital is 4.369 and 2.034 respectively. The minimum and the maximum number of ties for bonding social capital is 1 and 10, respectively. Bridging social capital has a mean value of 3.031 and the standard deviation of 2.215 with a minimum tie of 0 and the maximum of 11.

Table 5.6: Descriptive Statistics of Individual Social Capital Variables

Variable	Mean	Std Deviation	Minimum	Maximum
Bonding Social Capital	4.369	2.034	1	10
$\text{Bonding}_{\text{link}}$ Social Capital	1.742	1.720	0	8
Bridging Social Capital	3.031	2.215	0	11
$\text{Bridging}_{\text{link}}$ Social Capital	2.338	1.380	0	8

Source: Field Survey, 2015

An independent sample **t test** was carried out to find out if the mean number of ties for each level of social capital differs across sex of the respondents. The result of the test statistics is presented in table 5.7. Taking bonding social capital for instance, there is a significant difference in the number of ties of network members between females (mean=3.686, standard deviation=1.849) and males (mean=4.791, standard deviation=2.034) conditions; t(223)=(-4.0991), p=0.0001.

Table 5.7: Independent sample t test of individual social capital across sex

Variable	Sex	N	Mean	Std. Dev.	Std. Error	t value*	Ha: diff !=0 Pr |T| > |t|
Bonding Social Capital	Female	86	3.686	0.199	1.849	-4.0991	**0.0001**
	Male	139	4.791	0.173	2.034		
$\text{Bonding}_{\text{link}}$ Social Capital	Female	86	1.407	0.156	1.450	-2.3215	**0.0212**
	Mae	139	1.949	0.156	1.843		
Bridging Social Capital	Female	86	2.395	0.173	1.604	-3.4693	**0.0006**
	Male	139	3.424	0.207	2.444		
$\text{Bridging}_{\text{link}}$ Social Capital	Female	86	1.965	0.120	1.111	-3.2547	**0.0013**
	Male	139	2.568	0.125	1.480		

Source: Field Survey, 2015; *Degree of freedom = 223

Thus, male-headed households possess more individual social capital than female-headed households. The result gives credence to recent finding by Szreter and Woolcock (2004) which shows that the network of men tends to be more formal with less relatives as compared to women. Moreover, women tend to delineate themselves from relationships that transcend the power differential in a society. Kabeer (1996:19) explains the rationale behind the poor

individual social capital of women stating that "women are generally poorer than men because they lack the range of endowments and exchange entitlements which male members of their households tend to enjoy."

Recent findings in Ghana indicate that women in rural part of Ghana have less access to formal channels that provides entrepreneurship skills and other training programmes. In part, this is because they are not aware of the existing of such training programmes (Amu, 2005). There is a high intra-household gender power relation in part of rural Ghana. In rural Ghana, women traditionally look after the homestead. Moreover, aside childbearing, women are burdened with high amount of work such as tendering family, gathering of firewood, and other household chores. Hence, they end up relying on informal exchange network to reduce risk such as climate change, and share resources. One major implication of this is the tendency of women to be locked out of relevant information which may help mitigate the negative effect of climate change through appropriate adaptation strategy. From the perspective of women empowerment, this has the tendency of causing structural inequality that work against women in the rural communities. Strenuous effort should be made by relevant stakeholders to involve women at all levels in training programmes not only to enhance their intellectual capacity but also to widen their network size.

In sum, the study unveils that smallholder farmers in the study area have networked as hypothesized. The strength of these networks differs in terms of the role relationship, years of relationship, frequency of contact, closeness and level of trust. In terms of gender, the kinds of the social relations significantly differ between men and women. Thus, the first research hypothesis is supported.

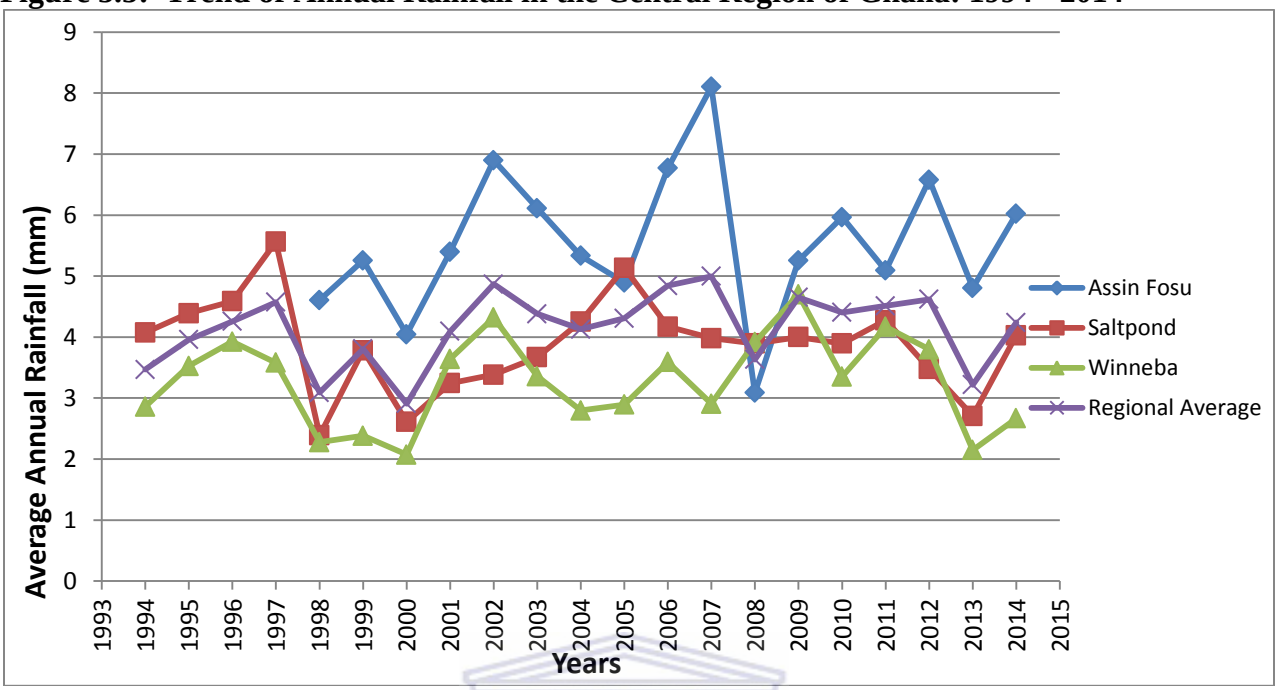
5.3 Trend of Weather pattern (Rainfall) and its Association with Maize Output in the Central Region of Ghana

This section brings out the relationship between rainfall pattern and annual maize output over the past 20 years in the central ion of Ghana. The general trend of these variables in the region is presented first followed by the trend in each of the case study Districts. The number of days it does not rain (dry spell days) and is unveiled in this section.

Daily rainfall patterns from three synoptic stations in the Central region of Ghana from 1994 to 2014 were used in the trend analysis. There are two main planting seasons in the Central region of Ghana: the major season which start from April to July and the minor season which start from September to November. Based on this, daily rainfall in April, May, June, July, September, October and November was used to compute an average annual rainfall. Three synoptic stations in the region used in the analysis include Assin Fosu (Forest Zone), Saltpond (Transitional Zone) and Winneba (Coastal Zone). Figure 5.8 present the trend in the rainfall over the 20 year period. There is a vast inter and intra annual variability of rainfall pattern over the period. The computed mean rainfall for Assin Fosu, Saltpond and Awutu-Senya districts is 5.54 mm, 3.88 mm and 3.28 mm, respectively. Among the three zones the rainfall pattern in Winneba shows a decreasing trend. There was significant decrease in rainfall (about 62 percent) from 2007 (8.10 mm) to 2008 (3.09 mm) in Assin Fosu. The highest rainfall in Saltpond was recorded in 1997 (5.56 mm) and this reduced by 57 percent in 1998 (2.39 mm). The pattern, since 2005, has been decreasing steadily until 2014. In the coastal zone (Winneba) the highest average rainfall was recorded in 2009 (4.70 mm). The decrease in rainfall in this zone is reflected from 1996 (3.93 mm) to 2000 (2.07 mm), and from 2009 (4.70 mm) to 2013 (2.15 mm). Generally, the average rainfall in the Central region has been decreasing since 2007.

These findings are consistent to the trend rainfall in other part of Africa and the world. According to United State Geological Survey, the amount of rainfall in Ethiopia during the Belg (September to November) and the Kiremet (June to August) season has decreased by 15-20 percent between the mid-1970s and late 2000s (USGS, 2012). In South Africa, MacKellar *et al*. (2014), report that rainfall and the number of rain days have decreased in some climatic zone from 1960-2010. Among these zones are KwaZulu-Natal and some parts of southern Mpumalanga, Limpopo and some parts of northern Mpumalanga. This has serious implications for smallholder farmers who are rainfall dependents. Among these implications is the potential of increasing the number of poor harvest that can be expected from smallholder farmer making their households more food insecure. This calls for an urgent need for smallholder farmers to adapt to the changing climate.

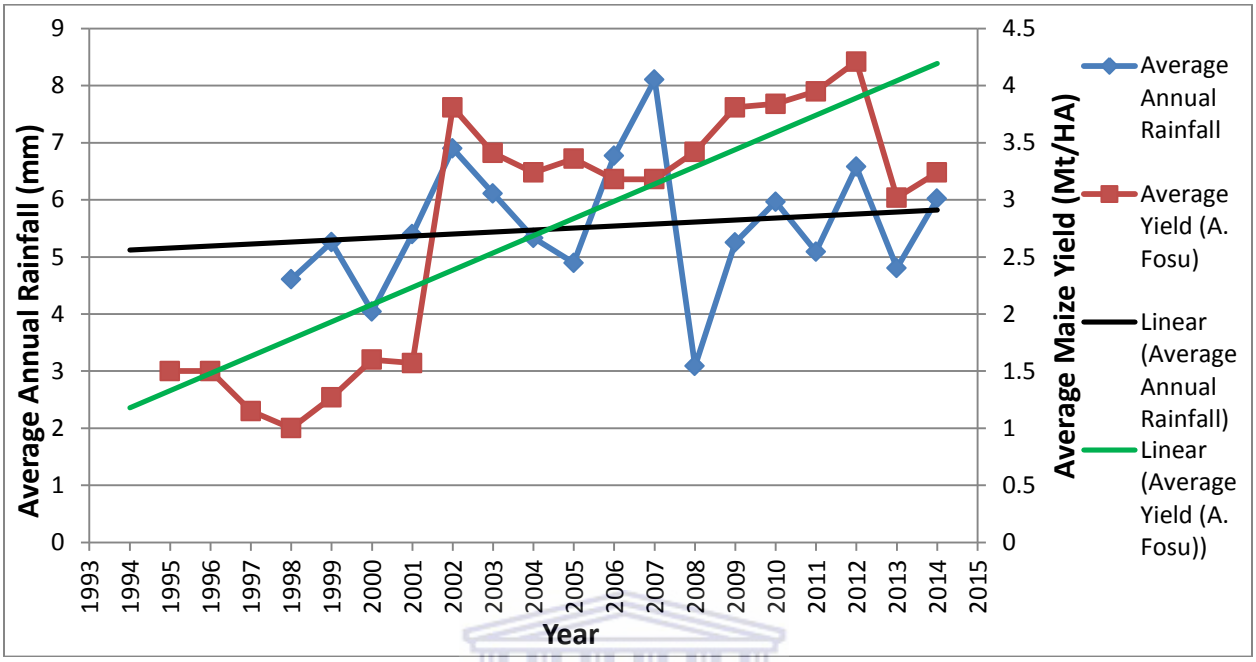
Figure 5.5: Trend of Annual Rainfall in the Central Region of Ghana: 1994 - 2014



Source: Author Computation, 2015.

Figure 5.6 present the association between the rainfall pattern and maize output in Assin Fosu over the past 20 years. There is a positive but weak (0.33) correlation between maize output and average annual rainfall in this district (see appendix A1). Thus, an increase in rainfall goes hand in hand with an increase in maize output. It can be inferred that the trend of these variables follow an interesting particular pattern. For instance, both rainfall and maize output decreased from 2002 to 2005, 2007 to 2007, and finally from 2012 to 2013. The opposite is reflected in the other years. In assessing the relationship between rainfall and rice yield in Bida, Nigeria, Dangana and Muhammed (2013) showed that the mean annual rainfall decreased from 104.3mm in 2003 to 86.5mm in 2004. This led to a decrease in rice yield from 85.3 percent to 56 percent in the same period. In Kasara province of Eastern Sudan, Larsson (1996) also revealed that a decrease in rainfall has led to a decrease in the yield of sorghum from 1960 to 1990 with a Pearson correlation coefficient of 67 percent. It can be argued that rainfall plays a significant role in the yield and production of crops. Plants need water to survive even if all other things (e.g. fertilizer) are met. Higher rainfall implies higher soil moisture, until soil saturation level is attained. Soil moisture enhances the activities of plant metabolisms for good yield and large production. Therefore, in the absence of rainfall (soil moisture) there will reduction in quality and quantity of maize production.

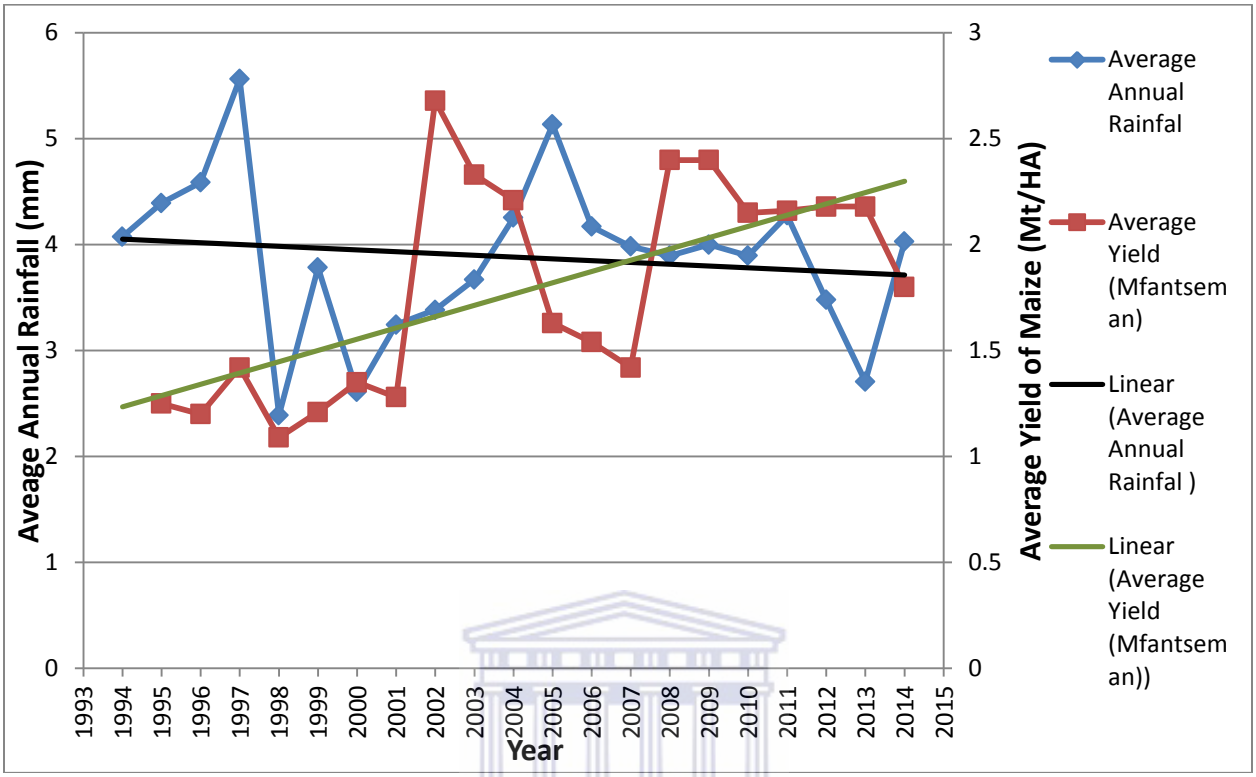
Figure 5.6: Association between annual maize outputs and rainfall in Assin Fosu District: 1994 - 2014



Source: Author computation, 2015.

The association between maize output and rainfall in Mfantseman district is presented in figure 5.7. Similar to the rainfall pattern, the output of maize over the past years in the district has not been stable. There is high annual inter-variability over the period. The annual maize output in 2002 peaked at 2.68 Mt/Ha. The trend of maize output since this year has been decreasing. The correlation coefficient is negative and very weak (-0.0557). Larsson (1996) revealed similar trend with rainfall and production of Sesame crop (r = -0.01) from 1960-1989. The trend line indicates that rainfall pattern in Mfantseman District is decreasing almost every year. The increase in maize output could be attributed to the other adaptation strategies the farmers in this district have put in place (see section 5.5).

Figure 5.7: Association between annual maize outputs and rainfall in Mfantseman District: 1994 - 2014

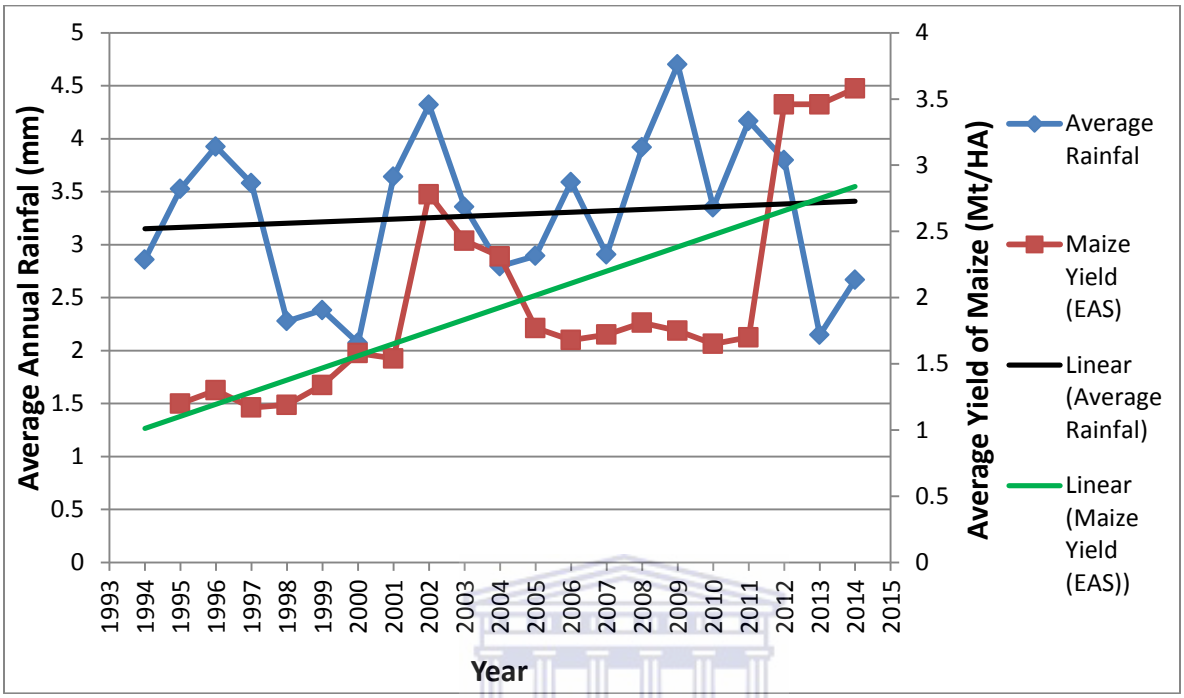


Source: Author computation, 2015.

Figure 5.8 present the association between annual maize output and rainfall in the Awutu-Senya district. The correlation coefficient is negative and very weak as obtained in Mfantseman District (r = -0.0882). There was significant increase in the output of maize and the amount of rainfall in the year 2000 and both declined drastically thereafter.

Generally, there is a moderate correlation (0.43) between annual maize output and amount of rainfall in the Central regional of Ghana (see appendix A1). Thus, a unit increase in annual rainfall goes hand in hand with increase in maize output.

Figure 5.8: Association between annual maize outputs and rainfall in Awutu-Senya District: 1994 - 2014

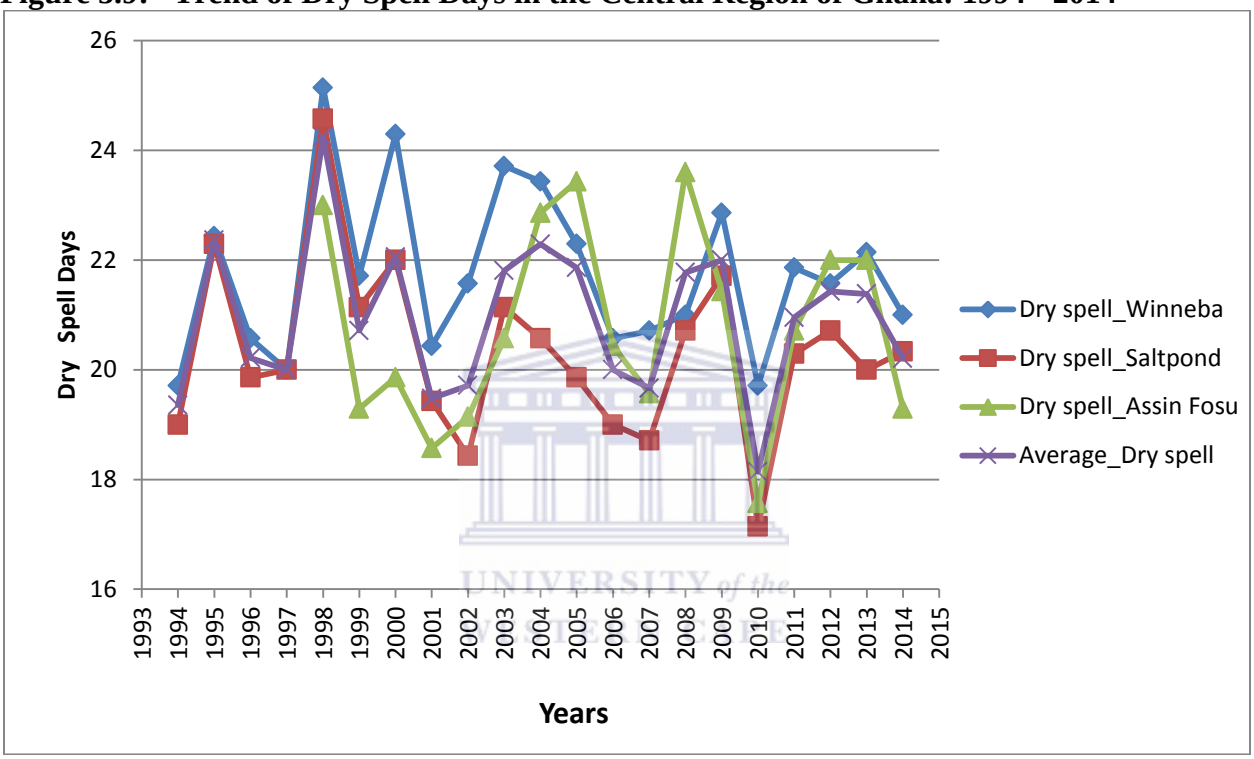


Source: Authors computation, 2015.

The periods of drought greatly influence productivity and the farming practices of farmers. Due to this, the number of days without rainfall (i.e. dry spell days) were computed from the daily rainfall data. Figure 5.8 present the dry spell days over the same period. There is high intra and inter annual variability in the number of dry spell days. In 1998 there was no rain for about 24 days in a month. However in 2010, the maximum number of days without rainfall in a month was 12 days. There is a negative correlation, though weak (-0.22), between the average dry spell days and the maize output in the region. This means an increase in the dry spell days goes hand in hand with a decrease in the output of maize in the region. Reflections in the recent incidence in Southern Africa attest to these findings. On 26th January, 2016, Eyewitness News reported that long period of dry spell days (drought) in the maize belt of South Africa has caused food and water shortage in many households in the region. In the report the Word Food Programme stipulated that the drought has caused crops failure rate of about 50 percent. Compared to the previous year, The World Food Programme estimated that maize production in South Africa declined by a third and this incidence is expected to hit other Southern Africa countries (EWN, 2016). Moreover, similar incidence of drought was witnessed in the Eastern Africa in 2011. The

report of the United Nation's Children Fund indicated that drought coupled with increase in fuel and food prices worsen the nutritional status of children, most especially in the northern and eastern Kenya, southern and eastern Ethiopia, central and southern Somalia, Djibouti, and some part of Uganda. The drought brought about acute food and livelihood crises in the face of millions of households in the affected regions (UNICEF, 2011)

Figure 5.9: Trend of Dry Spell Days in the Central Region of Ghana: 1994 - 2014



Source: Authors computation, 2015

In sum, there is some degree of association with rainfall pattern (and dry spell days) and maize output in the Central region of Ghana. The association is not only at the district level but also at the regional level.

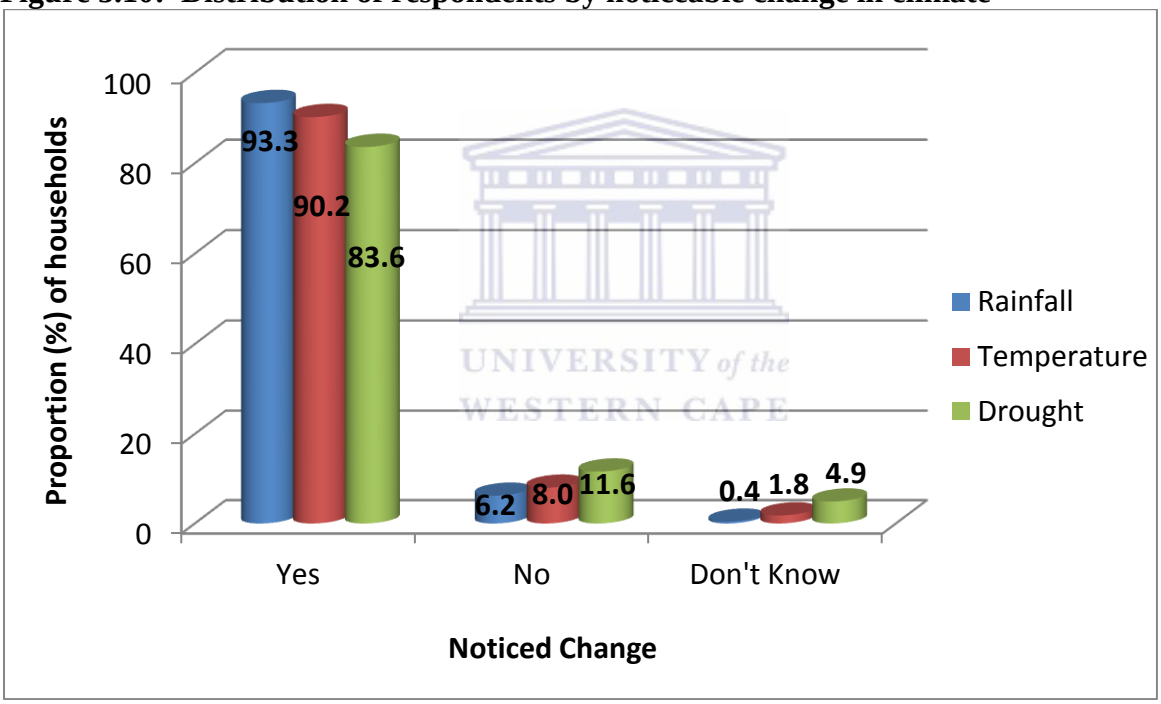
5.3 Perception of Climate Change among Smallholder Farmers

In ascertaining the perception of climate change, respondents were asked if they have noticed a change in the climate between the years 1990s and the 2000s. This section of the study relies heavily on recall of changing climate patterns and weather by smallholder farmers. It is not without doubt that this imposes a limitation on the study as farmers are likely to find it difficult to recall past events. Fortunately, the use of multiple methods of data collection, local name of

months and seasons, local timeframe (e.g. teenagehood), climatic events (e.g. floods, droughts) due to their severe impact on livelihood and food security, helped in curbing such limitation.

The majority have noticed a change in the pattern of rainfall, temperature and the period of drought (figure 5.6). These respectively account for 93.3 percent, 90.2 percent and 83.6 percent. Those who could not tell if there has been any change in these elements of the weather are in general less compared to those who responded to have noticed no change. These results lend credence to recent findings of Falaki *et al*. (2013) in North Central part of Nigeria. The scholars they revealed that out of 411 respondents 71.9 percent noticed an increased in the air temperature over the past 30 years and 2.4 percent could not tell the direction of this change.

Figure 5.10: Distribution of respondents by noticeable change in climate

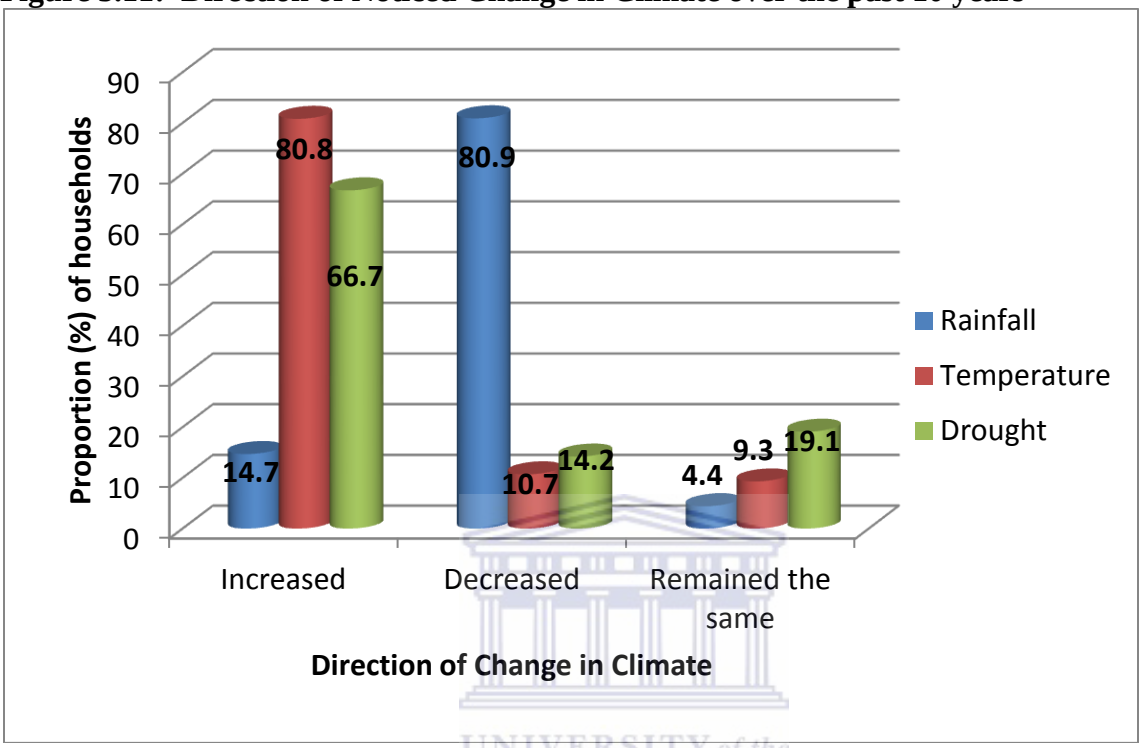


Source: Field Survey, 2015

Respondents were asked to specify the direction of changing climate pattern over the past 10 years. The proportion of respondents who said rainfall has decreased comprised 81 percent compared to about 15 percent who reported an increased in rainfall over this period (figure 5.7). This is an interesting result because it lends credence to the decreased rainfall in the region as unveiled in section 5.3. Respondents who reported an increase in temperature and drought are about 81 and 67 percent, respectively. Some of the respondents reported that the pattern and the

intensity of rainfall, temperature, and the drought have remained the same. Proportion of respondents in these categories is respectively 4.4 percent, 9.3 percent and 19.1 percent.

Figure 5.11: Direction of Noticed Change in Climate over the past 10 years



Source: Field Survey, 2015

The findings on increase or decrease rainfall, temperature or drought are consistent to the Falaki *et al*. (2013) in Nigeria, and Acquah (2011) in Ghana.

Six statements on a five-point likert scale and each describing specific direction of the climatic element were applied to ascertain further about the perception of climate change. About 44 percent of the respondents strongly agree that precipitation has been unpredictable during the past 20 years (table 5.8). Those who agree to this statement are about 38 percent as oppose to about 3.5 percent who are not in favour (strongly disagree and disagree) of this statement. Those who remained neutral constitute about 15 percent. About 47 percent of the respondents agree that there has been delay in the onset of the wet season over the past 20 years. Those who strongly agree with this statement are about 39 percent. While 12 percent remained neutral only about 3 percent are not in favour of this statement. A large proportion of respondents (about 62 percent) do not see (disagree and strongly disagree) the incidence of flood to have increased in the past 20 years as oppose to those (about 21 percent) who see this change (agree and strongly agree).

About 16 percent remained neutral to the statement that incidence of flood has increased in the past 20 years. Respondents who agree and strongly agree with the statement that temperature has been hot over the past 20 years are, respectively, 32 percent and 43.6 percent. On the other hand, those who disagree and strongly disagree are about 4 percent and 5 percent, respectively. About 17 percent remained neutral to this indicator.

Responses with regard to period of drought show that about 57 percent of the respondents perceive that there has been prolonged drought in the past 20 years. About 21 percent remained neutral to this statement. Finally, about 6 percent and 15 percent, respectively, strongly disagree and agree with the statement.

Table 5.8: Distribution of Respondents by perception of Climate Change

Perception indicators	Frequency (Percentage - %)				
	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Precipitation has been unpredictable during the past 20 years	5(2.2)	3(1.3)	33(14.7)	85(**37.8**)	99(**44.0**)
there has been delay in the onset of the wet season over the past 20 years	1(0.4)	5(2.2)	27(12.0)	105(**46.7**)	87(**38.7**)
incidence of flood has increased in the past 20 years	79(**35.1**)	61(**27.1**)	37(16.4)	21(9.3)	27(12.0)
temperature has been hot over the past 20 years	9(4.0)	11(4.9)	35(15.6)	72(**32.0**)	98(**43.6**)
there has been prolonged drought in the past 20 years	14(6.2)	33(14.7)	49(21.8)	85(**37.8**)	44(**19.6**)
bush burning has been rampant over the past 20 years	133(**59.1**)	48(**21.3**)	15(6.7)	17(7.6)	12(5.3)

Source: Field Survey, 2015

Human induced bush burning was also investigated in the case study communities. According to Stanturf *et al*. (2011), bush and forest fires become common in some part of Ghana during long period of drought. This indicator was therefore included to see the trend. The majority of the respondents (about 59 percent) strongly disagree with the statement on bush burning. Human

induced bush burning seems to have gone down in the study area as only about 13 percent supported the statement that *bush burning has been rampant over the past 20 years.* Only few (about 7 percent) remained neutral to the statement.

The computed mean scores of the six climatic perception indicators show that the most perceived indicator among smallholder farmers in the study area is the delay in the onset of the wet season (raining season) with a mean score of 4.2 (see table 5.9). This is followed by unpredictable rainfall, high temperature and prolong drought. Incidence of flood and bush burning do not seem to be significant in the study area.

Table 5.9: Ranked Perception Indicators of Climate Change by Smallholder Farmers

Perception Indicators	Computed Mean Score
There has been delay in the onset of the wet season over the past 20 years	**4.21**
Precipitation has been unpredictable during the past 20 years	**4.20**
Temperature has been hot over the past 20 years	**4.06**
There has been prolong drought in the past 20 years	**3.50**
Incidence of flood has increased in the past 20 years	2.36
Bush burning has been rampant over the past 20 years	1.79

Source: Field Survey, 2015. *Cut of Mean: **3.0**

Thus, rainfall has not just decreased in the Central region of Ghana but delayed and unpredictable. The number of dry spell days also reflects in the period of drought as smallholder attached great significant to the index. The decreased and delayed in rainfall is likely to result in high temperature in the region and this is reflected in the findings. Smallholder farmers attached great significant to the hot temperatures over the past 20 years.

5.3.2 Understanding the Perception of Climate Change Using Qualitative Approach

The qualitative findings obtained from the FGDs and the Key Informant interviews highly complement the quantitative findings. Smallholder farmers have perceived a vast change in the climate. Mr. Ebo from Assin South district explained why he has noticed a change in the climate during the FGD:

The climate has changed. From my experience the month of June was notably known to be a raining season. This trend has changed totally as one cannot predict the rains even in June…oh!

The major raining season in Ghana usually peaks in the month of June. As unveiled in the trend of the number of dry spell days, it can rain, regardless of the intensity, for about 24 days out of the 30 days in Central region of Ghana. The gradual disappearance of this trend has been noticed by smallholder farmers. Some of the respondents noticed a change in climate not only from a farming perspective but also on health grounds. To this, Bra [brother] Kweku from Awutu Senya District explained:

I met my grandparents even up to school going age. I remember how the climate used to be. In June/July, those of us with chronic Rheumatism used not to come out during these months. I used to be clothed with blankets and stayed indoor for days and weeks due to the heavy downpour couple with cold weather. This trend changed long time ago and since then I could walk out and roam even on bear chested in these months.

Rheumatism according to Schuh and Senn (1992) has stages or processes. Among these are lumbal prolapse of disc, increased of pain, arthritis, and arthrosis. Experimental studies revealed rheumatism has a strong correlation with temperature decrease, increased in humidity, advection of cold air (high pressure area with cold air) and cold (Schuh & Senn, 1992). Climate data in Ghana indicates that the frequency of hot days and night has increased from 1961 to 2003 (Stanturf *et al*., 2011). The scholars defined hot day or night as temperature in excess of 10 percent in the current climate. They further reported that within the same time frame rainfall has decreased. Thus, the gradual disappearance of high humidity (which, perhaps, could be as a result of increase in temperatures) has minimized (if not eradicated) rheumatism from this community.

Production of maize needs an ideal environmental condition such as temperature, moisture and solar radiation beside management practices. For example, it can tolerate a pH range of 5.6-7.5, evenly distributed rainfall of 500-800 mm and will have a detrimental effect if temperature exceeds 32°C. Inadequate or excess of these will affect the growth and the yield of maize. To

this, Maame Esi from Mfantseman District relates the changing climate to production stages of maize crop: She explained:

> *Currently, we are in the month of July and my maize crop has tasselled [tuft of Stamen at the tip of Maize inflorescent]. This is the month farmers need showers of rainfall to help in silking [process whereby style and stigmas appear as a silky tuft at the tips of an ear of corn] and blistering [the process whereby whitish kernels are developed usually 10-14 days after silking] development. Due to the lack of rainfall, my crops are now stunted.*

According to Maame Esi, a rain-dependent farmer, lack of rainfall has caused stunted growth to her maize crop. Prolonged delay in rainfall is likely to caused wilting and deterioration of entire crops leaving her absolutely no yield. Boissière *et al*. (2013), in the tropical forest of Papua, Indonesia, reported that prolonged drought has affected sago, annual plant, fishes and wild pigs.

Besides rainfall pattern, the changing climate can easily be detected in some southern part of Africa. The month of May and June used to be cold in Zambia with formation of ice in some part of the country. A study by Nyanga *et al*. (2011) indicated that smallholders have perceived that the formation of ice has stopped for a very long time due to the rising temperature. This means, smallholder farmers can track monthly incidence for a number of years to see the changing climate. Nana Kwame, a leader of a vibrant farmer based organisation and a teacher from Mfantseman district unveiled the rationale behind the local names of the months by the Fante tribe of Ghana. He explained:

> *Comparing present climate to the time past during my teanagehood, the climate has changed. From my experience January is sunny and same for February. Drizzling is experience in March and April. Due to this our forefathers named May as 'Asusow Aketseaba' which literally means "small rainfall"; June as 'Obirade' which literally means "suffer to eat"; July as 'Ayewoho' which literally means "you have regretted" and August as 'Difuu' which literally means "eat plentifully". In all these months the rains come periodically so that by August food will be in abundance. The names of the months these days do not represent the true meaning. Everything is unpredictable these days…*

The rains do not come on its season and that everything has become unpredictable. The unpredictability of rains has been reported by smallholder across the continent (see Falaki *et al*. 2013).

As revealed in the quantitative findings the farmers perceive a change in rainfall and temperature more than any other perception indicator. This picture came out clearly in the findings as almost every participant explained the change in climate using rainfall and temperature as a reference point. Most of the participants have realized that the rain used to fall at its season so as the sun and these have completely twisted. The sunshine, according to the participants has replaced the raining season. Nana Owusuwaa, from Awutu Senya Disrict has this to say:

> *The amount of rainfall has reduced drastically ….in the past, it rains in its season. In our present times it can rain for the whole week and destroy all our crops. The rains can cut for days, weeks and even sometimes months. All my crops are burnt as the temperature become too hot during these periods. Our water bodies dry up and all your efforts at the end of the season become futile.*

Heavy downpour seems to be a challenge among smallholder farmers. Though rainfall is unpredictable, one downpour causes a lot of damage to smallholder farmers. Boissière *et al*. (2013) reported that heavy downpour have caused crops to rot in the tropical forest of Papua in Indonesia. During the Key Informant Interview, it came out clearly how local knowledge influences perceptions. Mr. Bentsil, a 66 year old farmer explained:

> *The period of drought is in our present time is worst. In the olden days, if you cast your eyes into the forest behind us during the dry season, you only see white clouds hovering over the forest. This sign, which is an indicator of moisture, has stopped for a long time…..*

The incidences of bush burning and flooding are not on the rise in the sampled communities. According to the participant from the FGDs and the key informant interviews farmers as well as game hunters have been educated on reckless bush burning. Mr. Mohammed, a secondary school teacher, explained this:

Farmers have been educated on the consequence of bush burning especially during the dry season. During the farming season, farmers are advised to burn their farms early in the morning or late in the evening.

The participants in all the three FGDs stressed heavily on the impact of climate change on productivity. Jones and Thornton (2003) estimated that the productivity of maize will decrease by 2050 if farmers continue to grow the same variety of crops in the same way and on the same land. To this, it is projected that maize productivity in some Africa countries such as Ethiopia, Ghana, Kenya and South Africa will decrease by 91,350 kg, 100,800 kg, 90,000 kg and 871,500 kg, respectively. In Latin America, productivity decrease was 4,422,558 kg, 883,200 kg and 569,563 kg for Brazil, Mexico and Venezuela, respectively. Though the probability of the decrease in production in each of these countries differs the consequence will be famine in the households of poor resource farmers in the globe. This is exactly the reflection of the incidence of maize belt of South Africa and East Africa highlighted. Impacts unveiled during the FGDs were not only limited to crop failure and famine but poverty, pest and diseases outbreak, urban migration, among others. Mama Esther, from Awutu Senya District put forward her lamentation:

My households are starving at the moment. The community experienced one heavy downpour last month and this destroyed all my cassava crops. My only hope is in the minor season but if the rains and the temperature continue the same way then I don't know how my household can survive …

As environmental conditions become more unfavourable for plant cultivation some are forced to move to other geographical locations or the cities for better livelihood activity. Migrants in the new location or cities ensure that they improve their standard of living by diversifying their portfolio of economic activities. Internal migration due to climate change has therefore become a phenomenon in most developing countries. Unfortunately, the poorest and the most vulnerable are trapped (unable to migrate) due to lack of resource (Waldinger, 2015). Internal migration can be seasonal: where migrants return home after a short period of time (six months or less) or permanent: where migrants move to a new location with their work and residence for good. In Vietnam, it is reported that household improved their standard of living through seasonal migration (Waldinger, 2015). Mr. Kofi Mensah, a 32 year old farmer who received the 2015

national award for an outstanding contribution to Ruminant production in Mfantseman District has this to say:

> *Due to inconsistency in rainfall pattern, coupled with high temperatures, I left the farming for my wife and migrated to the city [Accra]. I worked for someone for almost a year.... I returned back home to continue my farming due to persistent load shedding in the city…..*

A recent study by Osei, (2015) in the Central region of Ghana indicated that climate change has forced some of the household members to migrate to the city. Thus, some of the households manage risk posed by climate change through internal migration. This calls for relevant policy intervention to curb the negative implications posed by urbanization.

Mann-Whitney U test and Kruskal-Wallis test were carried out to find out if the perception of climate change among smallholder farmers differs across sex and location. The result indicated that perceptions do not differ across sex but location (see appendix A2). Thus, almost all the perception indicators differ across location. This possibly could be due to the differences in climatic elements such as rainfall (as depicted in section 5.3), temperature, etc. This confirms the findings of Boissière *et al*. (2013) who report that perception of events on climate change do not show clear gender-specific differences. The results also lend credence to the statement of Nyanga *et al*. (2011) who posits that perceptions are not only context but location specific due to heterogeneity in factors that influence them.

In sum, smallholder farmers have perceived a change in the climate especially in the case of rainfall and temperature and this differ across location.

5.5 Influence of Individual Social Capital on Climate Change Adaptation Strategies among Smallholder Farmers

This section presents all the identified climate change adaptation strategies used by smallholder farmers in the Case Study Communities. Moreover, it also presents the influence of individual social capital on the adaptation of the identified strategies.

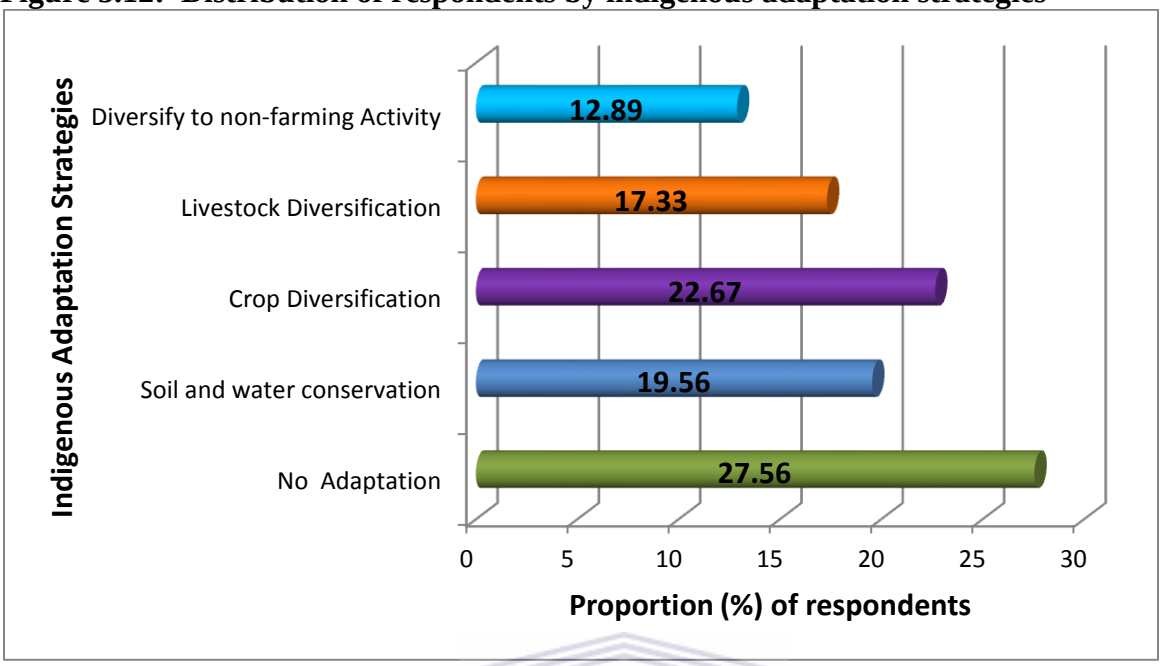
5.5.1 Identified Climate Change Adaptation Strategies

Prior to the analysis of the influence of the individual social capital on climate change adaptation strategies, FGDs were used to identify the adaptation strategy familiar to the farmers in the community. In the case of indigenous adaptation strategies, changing planting dates and periods was not a common practice among the communities where the study was conducted. Pastor Moses posited the rationale behind this result.

> *I do not change the date or period of planting. I start clearing the farm once we enter into the month of April and all other farming activities continue. I do not wait for the rains but plant to wait for the rains*.

One of the non-verbal communications retrieved during the FGDs was that smallholder farmers do not keep a record of the specific date of carrying out farming activities (e.g. planting/sowing, weeding, and fertilizer application). Nevertheless, they are certain of the month when an activity was carried out. It was discovered that some group of farmers (possibly the rich) have more than one plot of land which enabled them to undertake land or seasonal rotation. Thus, due to scarcity of land in the Southern Ghana coupled with the inability of farmers to provide specific date, changing planting date and period was taken out of the econometric estimation. The proportion of farmers who have embraced indigenous adaptation strategies is presented in figure 5.12. About 23 percent diversified their cropping system. The proportion of respondents who practiced soil and water conservation and livestock diversification were about 20 percent and 17 percent, respectively. About 13 percent of the households have diversified to other livelihood strategy (i.e. non-farming activities) such as petty trading, 'gari' processing, etc. Those who do adapt any strategy constitute about 28 percent. In the study conducted by Acquah (2011) in the Northern Ghana (Bawku), however, changing of planting dates was prominent. One possible explanation to this finding could be easy access to land coupled with irrigation facilities in the Northern part of Ghana. As evidence, about 60 percent of the sampled households (95 households) practiced irrigation.

Figure 5.12: Distribution of respondents by indigenous adaptation strategies



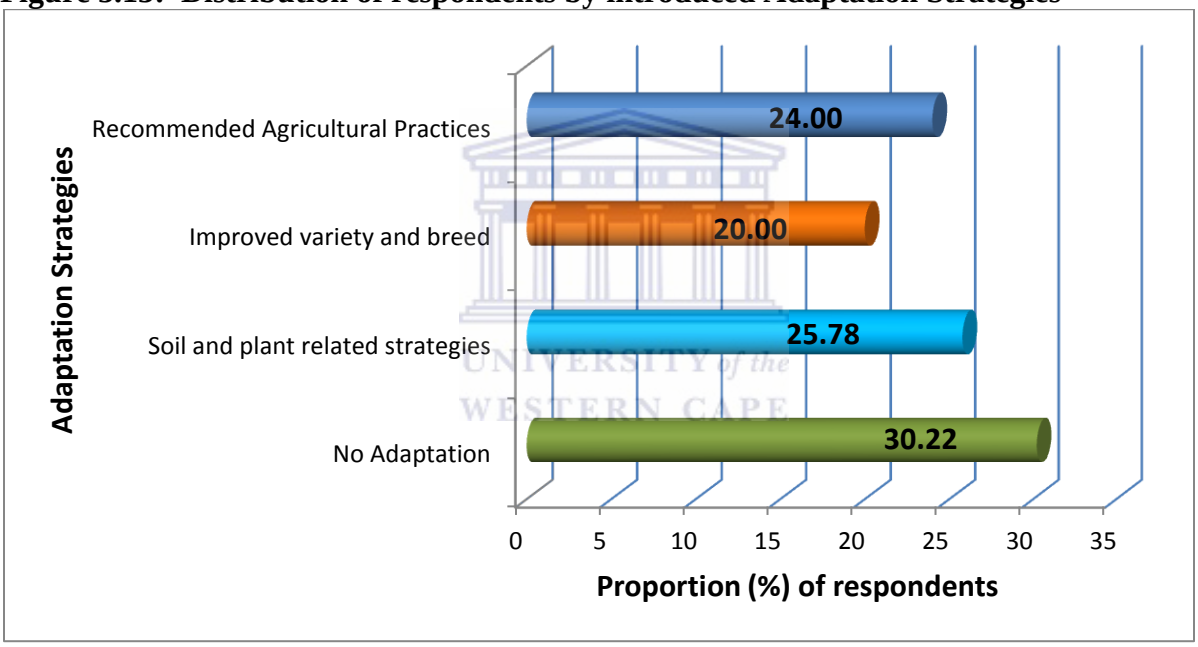
Source: Field Survey, 2015.

In the case of introduced adaptation strategies, irrigation and insurance were found not to be a common practice in the communities where the study was conducted. In the case of crop insurance the participants revealed that they have not even heard that it exists. Thus, it is highly impossible for the sample communities to mitigate the effect of climate change through crop insurance. This is because knowledge and the awareness stage of Rogers' theory of innovation diffusion (which basically state that individual needs to be aware and know the principles behind the innovation before s/he can be persuaded and adopt the innovation) have not been met. This calls for the urgency of intensifying the education on crop insurance by policy makers in the country. The participants also revealed that there is no reliable source of water for them to carry out irrigation. Moreover, farmers cannot afford the facilities needed to carry out this practice. Mr. Godwin, a teacher and a farmer from Awutu-Senya District put it in this context:

> *It is difficult to do farming these days without irrigation. I would love to have my crops irrigated but the cost of irrigation facilities is too much. I cannot afford so I rely on the natural rainfall.*

Thus, smallholder farmers are constrained by a number of factors and these make them more vulnerable to the changing climate. In Southern Nigeria, Ozor *et al*. (2010, also reported that farmers are faced with high cost of irrigation facilities. Strenuous effort need to be put in place to ensure that poor resource farmers mitigate the negative impact of climate change through appropriate adaptation strategy. The proportion of respondents who practiced the identified introduced strategies such as improved varieties and breeds, soil and plants related strategies, etc. is presented in figure 5.13. About 26 percent practices soil and plant related strategies. Those who practice recommended agricultural practice constitute about 24 percent. While only 20 percent adapt improved varieties and breeds about 30 percent do not adapt any strategy.

Figure 5.13: Distribution of respondents by introduced Adaptation Strategies



Source: Field Survey, 2015.

5.5.2 Influence of Individual Social Capital on the Identified Strategies

The last section in this chapter provides not only quantitative (empirical econometric results) but qualitative evidence on the influence of individual social capital on the adaptation of both indigenous and introduced strategies. During the FGDs, participants pointed out that they obtained information on climate change through radio, friends, television, and so forth. Moreover, in Awutu Senya district, some of the farmers pointed out that they are no more interested in joining Farmer Based Oganisations (FBOs). Mr. Opoku, an agro-chemical shop dealer and a farmer explained the rationale behind his decision not to join FBOs:

A lot of FBOs have come to the community and gone. The forerunners of most these associations are the extension officers. During the first few months, they will teach us how to plants in lines and other farming practices. We are made to pay weekly/monthly contribution and at the end of the day the people run away. I have lost interest in group activities…..I will rather learn from my friends…..i can trust them than the personnel who come and make us pay contribution for nothing…..

This is an interesting finding because the relevance of FBOs has been well established in the literature. For instance, it serves as an avenue for institutions to reach the mass of the farmers. It also serves as mechanisms whereby farmer can gain market power and access information (Asante *et al*., 2011). However, in the case of Central region Ghana, some of the farmers, especially in Assin South and Awutu-Senya District, are losing the interest of joining the FBOs. Many scholars have studied the factors that determine the membership to such groups (Asante *et al*., 2011; Adong *et al*., 2013). One factor that is overlooked by the literature is the issue of general trust. The fore runners of some of the FBOs make a lot of promises to the farmers in terms of access to inputs and loans without laying more emphasizes on the acquisition of knowledge. They end up disappointing the farmers when the planting season is due. Individual in a group with high propensity to trust one another have high probability of achieving common goals than a group without trust (Gómez-Limón*etal*., 2013). This is because an actor who is trustworthy (one who can be trusted by other actors) has the possibility of gaining the support of other actors. Actors will certainly relent when kept disappointed. Thus, projects officers and other relevant stakeholders must be cautious of the approach used during the formation of such organisations. An interview with Mr. Bentsil revealed some of the rationales behind why farmers join organisations. He explained that farmers join FBOs with the aim of getting help not acquisition of knowledge.

If you call a farmer to come for education, s/he thinks you are wasting his/her time. This problem can be traced to the low level of education among the farmers…… farmers get discouraged if after three months and they do not receive any help in the form of inputs like fertilizer, boot, etc.

Government of Ghana, NGOs, and other institutions have been advocating for the formation of FBOs. In 2008 for instance, the government of Ghana re-initiated fertilizer subsidy programme where farmers (in associations) are supplied with subsidized fertilizers. According to the report of the Public Agenda, the budget of the Ministry of Finance and Economic Planning promised the supply of 180,000 Mt of subsidized fertilizer to farmers in 2014. However, at the end of the year the ministry has not submitted even half of the promised figure to the targeted farmers. Farmers, according to the report, are contemplating if the programme is still in operation or has been cancelled groups (Public Agenda, 2014). According to Fearon and Adraki (2015), the fertilizer subsidy programme, since 2007-2012, has not been effective as it does reflect productivity and output. The programme does not benefit the target farmers but end up benefitting wrong people (i.e. possibly government officials with large acres of farm land). It is not surprising that some of the farmers (perhaps, neglected ones) are not interesting in joining FBOs.

Nevertheless, most of the farmers in Mfantseman District belong to FBOs and they learn from each other. The participants of the FGDs in the district unveiled that there are more than eight FBOs in the community and each comprises of 30 members. Two of the leaders have a strong network with MoFA and the member of parliament of the district. These leaders occasionally get training from MoFA and they come back and teach their farmers in the community. Nana Kwame explained some of the activities taught during the training.

> *In some of these training we are thought the exact time to plant and harvest. We are cautioned not to plant earlier or delay. So in April the farming activities start…….the community has been given rain gauge used to monitor the pattern of rainfall in our community*.

Nana Kwame is a leader of three associations in Mfantseman Districts. According to him, a new association is formed if the membership reach it limit (30). Though the political domain was not the focus of the study, Nana Kwame has a strong network with political figures and other institutions in the district. Thus, he is able to pool more resources (e.g. training, government subsidy fertilizers, etc.) for the benefit of the association. Besides helping smallholder farmers to reduce the impact caused by climate change, this has many implications on the development of

the districts. It has the potential of facilitating civic engagement and participation. In her work, Social Capital and Developmental Outcomes, Bayat (2015) found out that community leadership is a key determinants of civic engagement which translate into positive developmental outcomes.

Mr. Mohammed Sunday, a farmer and former local government representative, explained how he learns from friends during the FGD in Mfantseman. He explained:

> *I learned a lot from my friends especially during the season of pepper production. I learned how to nurse the seedlings and the techniques used to transplant to the field from Mr Kofi Mensah. This stage is important because there are some soil conservation measures that need to be put in place. The high temperature can kill almost all your seedling if you fail in this regard.*

This finding is supported by Dinh *et al*. (2012) who report that in Vietnam, most farmers receive indirect information from friends. This is because extension officer only speaks to the village headman who also relays the information to other farmers. In establishing the relevance of individual social capital, scholars found out that farmers who do not have contact (network) with relevant occupational prestige are excluded from certain services such as formal credit, government supplied agricultural extension services, health care, among others. Thus, farmers who are excluded from public services such as extension services rely on their friends, who could be trusted family, close friend or acquaintances for knowledge. In the case of Mr. Mohammed Sunday, his bonding relationship with Mr. Kofi Mensah enables him to overcome information barrier with regards to agricultural practices.

Mr. Kwame Odei from Assin South District shared his experience, during the interview, of how personal network has helped him adapt to climate change. The 52 years old farmer explained:

> *As friends, we talk about farming activities anytime we meet at the durbar ground and other places… my personal experience with regards to climate change adaptation is that of soil and water conservation practice. In a conversation with a friend, he told me that he is not using fertilizer but cocoa husk and palm front. I went to his farm and observed it myself…. According to him, he learnt his from the extension officers. He convinced me about the relevance of organic fertilizer to the soil and the yield. I am currently doing the same on my farm…*

In Awutu-Senya District, Mr. Benstil explained how personal network has helped him. According to him, personal network has shaped his vison and he is determined to win another best farmer award in the coming years. The retired general and a farmer explained:

> *I am well known when it comes to oil palm tree (Elaeis guineensis) production in the districts. I have a friend who is into pineapple production. He tells new and improved variety of pineapple in most of the times we meet. Fortunately, I share a boundary with him. The way he goes about his farming practices, application of chemicals and fertilizers made me learn a lot from him. He developed my interest and now I have two acres of pineapple farm….*

Mr. Benstil has added pineapple production to oil palm and staple crop production due to his personal network. According to him, the climate has changed and one must strategise his/her farming practice. He also explained how he goes into Coconut (*Cocos nucifera* L.) production:

> *I have a friend who a soil scientist in one of the research institute. He told me there is new variety of coconut which takes 3 years to mature as compare to mine which take 8 years to mature. He has asked me to do the nursery and he will come and do the budding for me.*

In Granovetter's (1985) language, both strong and weak ties have influences the decision of Mr. Bentsil to adapt to the changing climate through crop diversification and improved varieties. It is difficult to predict the kind of social relation (be it bonding, bridging or linking) between Mr. Bentsil and his friends on qualitative basis. However, the findings indicate that his connections have not only aided the flow of information but changed his behaviour by taking the decision to adopt those practices. The relational concept of social capital has many positive implications on the development of a given society. In the rural areas of Northern India, poor villagers utilize social relations and groups for risk management, protection and solidarity functions (action (Woolcock & Narayan, 2000:230). I still argue that in the phase of harsh climatic conditions, inadequate extension personnel and the quest to increase productivity and ensure food security in rural households, smallholder farmers rely on their personal networks. To this, those who are connected with relevant occupational prestige will take advantage of the resource that is embedded in their network to help overcome such barriers. One interesting future study that

could be investigated is to look at individual social capital and productivity at the household level. Productivity, I believe, is likely to be higher with those who are connected with more relevant occupational prestige, all things being equal.

In sum, individual social capital may affect economic sustainability of farmers. As revealed in this section, the networks of individual have the potential of influencing adoption decision. Farmers who are well connected have a high propensity to adopt improved varieties and breeds, diversify their cropping system, and other farming practice to reduce the adverse effect caused by climate change.

5.5.2.2 Empirical Econometrics Results

Respondents were asked if they receive or give information with regard to farming practice and/or climate change. Most of them indicated yes to some of the network members. It must be stressed that network members were not contacted to verify the information provided by the respondents. This is of two reasons: (i) there was no enough resources (time and money) to contact alters who are scattered in the country other than the location of the ego; and (ii) the occupational prestige used assumed to be relevant enough to aid in climate change adaptation strategies. It must also be stressed that ties that are less than two years were excluded from the model estimation (about 1.4 percent). This reason is that the study referred adaptation practice of the previous planting season (not the current season). Thus, relationships less than two years were assumed not to have any significant impact on the decision and behaviour of respondents.

Estimation of each of the two models was preceded by the normalization of one of the adaptation category. This is often called the reference category. In both models estimation, no adaptation was used as reference category since it is the dominant among all the adaptation categories. Prior to the running of the model, the problem of multicollinearity among the explanatory variables were tested. By this, Pearson correlation among the continuous independent variables was run. The result is attached in appendix A3. Furthermore, the ordinary least square (OLS) model was run with all the independent variables following Variance Inflation Factor (VIF). The result (see appendix A4) shows that multicollinearity is not a serious problem in the model estimation as all the values for the VIF were less than 10 (1.09 – 2.11). The test for IIA shows that the assumption has not been violated (see appendix A5 and A7).

It must be noted that the MLM does not share the monotonic behaviour of the probability of binomial logit model. Thus, the literature usually focuses on the coefficient or parameter estimates rather than marginal effects. The marginal effect estimate depends on the point of evaluation and due to the non-monotonic nature, the sign depends on the value of the dependent variable (Cramer, 1991:46-47; Greene, 1993:667). Thus, the application of MLM results in potential confusion as the coefficient of the marginal effect need not to have the same sign as the model or parameter coefficients. This is reflected in the study as the coefficients of the marginal effect are different from the parameter estimates coefficient. Nevertheless, both the parameter estimates and the marginal effects are presented in this section.

The parameter estimate or coefficient of both indigenous and introduced adaptation strategies as well as their level of significance are presented in table 5.9 and 5.10 respectively. The marginal effects of both models are attached, respectively, in appendix A6 and A8. The marginal effects predict the probability of a choice of a particular adaptation mechanism with respect to a unit change an explanatory variable. The Wald statistics for both indigenous adaptation (Wald chi (42) = 98.48) and introduced adaptation strategies (Wald chi (42) = 90.05) is highly significant ($p < 0.0004$) and ($p < 0.0000$) respectively. This means that the models as whole have a strong explanatory power.

Bonding Social Capital

The estimated coefficient of bonding social is significant and positive related to crop diversification strategy and soil and plant related strategies. The significant level is 5 percent for both crop diversification (table 5.10) and soil and plant related strategies (table 5.11). Taking crop diversification (indigenous adaptation strategy), the coefficient of 0.328 means that one unit increase in the number of ties with bonding social capital (similar social status) is associated with 0.328 increase in the relative log of odds of adapting crop diversification versus no adaptation, holding all variables in the model constant. The marginal effect of crop diversification means that one percentage point increase in the number of ties with bonding social capital increases the predicted probability of adapting crop diversification strategy by 0.0296 ceteris paribus (see appendix A6).

Bonding$_{link}$ Social Capital

Bonding link social capital represents respondents connected with network members of similar social status but through a strong tie. Surprisingly, bonding$_{link}$ social capital has a positive and significant effect on all the indigenous adaptation strategies but none of the introduced adaptation strategies. The level of significant is 1 percent for both soil and water conservation and crop diversification, and 10 percent for both livestock diversification and diversification to non-farming activities. It can be argued that indigenous adaptation strategies within a particular geographical location (or community) easily diffuse among smallholder farmers in that location.

The marginal effect of 0.0326 means that one percentage point increase in the number of ties with bonding$_{link}$ social capital increases the predicted probability of crop diversification adaptation by 0.0326, all variables in the model being held constant.

Bridging Social Capital

Bridging social capital depicts egos with alters of different (lower social status). For instance, a farmer connected with a network member who owns agro-chemical shop. Though such alters have low social status their role in innovation diffusion cannot be looked down. Such occupational prestige can be argued to have the relevant information on agricultural innovations, especially with regard to introduced adaptation strategies such as improved seeds, new pesticides and fertilizers among others. Delineating from one's social circle aids in the acquisition of necessary information needed to adapt to the changing climate.

In the case of introduced adaptation strategies, bridging social capital has a positive effect of soil and plant related strategies and improved variety and breed at a significant of 10 and 5 percent respectively. The marginal effect of 0.0265 means that one percentage point increase in the number of ties with bridging social capital increases the predicted probability of adapting improved variety and breeds by 0.0256 (see appendix A8).

Bridging$_{link}$ Social Capital

Bridging$_{link}$ social capital has no significant effect on any of the indigenous adaptation strategies (see table 5.10). In the case of introduced adaptation strategies, the estimated coefficient of bridging$_{link}$ social capital has a positive effect on improved variety and breed and recommended agricultural practice. The significant level is at 5 percent for both strategies (table 5.11). The marginal effect of 0.0351 indicates that one percentage point increase in the number of ties with

bridging$_{link}$ social capital (egos connected with alters of higher social status but through weak tie) increases the predicted probability of adapting improved variety and breed by 0.0351, ceteris paribus.

Table 5.10: Parameter Estimate of the Multinomial Logit Model _ Indigenous Adaptation Strategies

VARIABLES	Soil and Water Conservation	Crop Diversification	Livestock Diversification	Diversify to non-farming activities
Bonding SC	0.201	0.328**	0.161	0.00512
	(0.144)	(0.137)	(0.160)	(0.159)
Bonding$_{link}$ SC	0.505***	0.556***	0.331*	0.335*
	(0.192)	(0.168)	(0.173)	(0.182)
Bridging SC	0.337*	0.587***	0.136	0.353*
	(0.205)	(0.189)	(0.226)	(0.213)
Bridging$_{link}$ SC	0.346	0.301	0.335	0.0693
	(0.230)	(0.229)	(0.225)	(0.237)
Age	0.00428	0.00453	-0.0547*	0.0314
	(0.0240)	(0.0232)	(0.0323)	(0.0305)
Sex	-0.866	-1.551**	0.374	-0.313
	(0.613)	(0.666)	(0.679)	(0.565)
SIOPS	-0.0184	-0.134*	0.00623	-0.126
	(0.0704)	(0.0698)	(0.0802)	(0.0887)
Farming Experience	0.0655**	0.0353	0.135***	0.0525
	(0.0318)	(0.0343)	(0.0409)	(0.0413)
Land Size	-0.00930	0.0599	0.337	-0.583**
	(0.205)	(0.214)	(0.212)	(0.251)
Farm Income	0.000245**	0.000261**	0.000196	0.000311***
	(0.000123)	(0.000123)	(0.000129)	(0.000121)
Leadership role	1.027*	1.072*	0.397	0.540
	(0.538)	(0.562)	(0.564)	(0.646)
Market Distance	-0.0767	-0.287	0.218	0.270
	(0.237)	(0.262)	(0.249)	(0.272)
Assin South	0.536	0.0960	-0.355	0.566
	(0.758)	(0.771)	(0.759)	(0.651)
Mfantseman	0.204	1.349*	-1.016	-0.325
	(0.758)	(0.811)	(0.801)	(0.800)
Constant	-4.476	-0.126	-4.133	-0.112
	(3.107)	(2.995)	(3.423)	(3.938)

Base category:	No Adaptation	Wald Chi2 (42):	98.48
Number of observations:	225	Prob > Chi2:	0.0004
Log pseudolikelihood:	-278.89194	Pseudo Chi2:	0.2148

Source: Field Survey, 2015.
NB: Values in parenthesis are the robust standard errors
*; ** and *** implies significant at 10; 5 and 1 percent respectively

In the case of indigenous adaptation strategies, bridging social capital has a positive and significant effect on crop diversification (10 percent) and soil and water conservation strategy (1 percent).

Age of the household head

The result of the effect of age on climate change adaptation strategy does not conform to expectation. This finding is not strange as the literature identified mixed effect of age on the decision of household head to adapt to climate change. On one hand, age could be attributed to the experience of the household head with regard to climate change over time. Thus, an increase in age has been found to increases the probability of adapting to climate change (see Tazeze, *et al*., 2012; Osei, 2015). While some studies did not find age to be significant in adaptation decision (Hassan and Nhemachena, 2006) others found out to be negatively related to adaptation decision (Anley, *et al.,* 2007; Nyangena, 2008). The latter assumed young farmers to take up long term adaptation strategies. The result in this study shows that age is significant and negatively related to livestock diversification. Thus, young farmers are more likely to diversify livestock versus no adaptation compared to old farmers.

Sex of the household head

Once again, the literature identifies mixed effect of sex of the household head on climate change adaptation decision. According to Ajao and Ogunniyi (2011) most of the farming activities are undertaken by males while females are more into post-harvesting activities. This trend puts males in a better position to get experience and relevant information on various management practices that help them to cope and adapt to the instability in climate. The result in this study shows that sex is significant (10 percent) and negatively related to crop diversification. Thus, female-headed household are more likely to practice crop diversification compared to male-headed household. To this, the marginal effect of 0.1748 means that the predicted probability of male-headed household to adapt crop diversification decreases by 17.48 percent point compared to female-headed household.

The study shows opposite trend in the case of introduced adaptation strategies. The parameter estimate indicates that sex is significant and positively related to soil and plant related strategies and improved variety and breed. The significant level is 1 percent for both strategies. Thus,

male-headed household are more likely to adapt soil and plant related strategies and improved variety and breeds than female-headed household. The marginal of 0.2302 means that the predicted probability of male-headed households to adapt improved variety and breed increases by 23.02 percent point compared to female-headed households, ceteris paribus (see appendix A8). This result is consistent with Mulwa *et al*. (2015), who found out that male smallholder farmers in Malawi have high probability of adopting improved (diseases/pest resistant variety) than female.

SIOPS of the household head

One common issue with regard to social capital construction is the problem of unobserved correlation. For instance, the social status of an ego can influences the ability to access information and the network size. Following Dinh *et al*. (2012), social status is controlled by inclusion of the SIOP of the respondent. The SIOPS of a respondent is likely to be associated with higher education which can lead to higher income. The Pearson correlation coefficient between SOIPS and education is about 40 percent (see appendix A3). The coefficient of SIOPS turns out to be negatively related to crop diversification at a significant level of 10 percent.

Farming Experience of the household head

Generally, farmers who are more experienced in agriculture can be assumed to be more familiar with the environment and can even anticipate some events such as time of raining, time of planting, among others. Based on this many scholars are of the view that the more experienced a farmer is the higher the probability of responding to the climate change adaptation mechanisms (Kebede, *et al.*,1990; Gbetibouo, 2009). The parameter estimate of this study indicates that farming experience is positively related to soil and water conservation and livestock diversification. This is significant at 5 percent for soil and water conservation strategy and 1percent for livestock diversification. In the case of introduced adaptation strategies, farming experience is significant and positively related to all adaptation strategies. This is significant at 10 percent for soil and plants related strategy and 5 percent for both improved variety and breed and recommended agricultural practice. Thus, farming experience increases the predicted probability of adapting to the change in climate.

Table 5.11: Parameter Estimates of the Multinomial Logit Model: Introduced Adaptation Strategies

VARIABLES	Soil and Plant Related Strategies	Improved Varieties and Breeds	Recommended Agricultural Practices
Bonding SC	0.326**	0.230	0.202
	(0.135)	(0.145)	(0.142)
$Bonding_{link}$ SC	0.303	0.312	0.00968
	(0.189)	(0.195)	(0.177)
Bridging SC	0.282*	0.375**	0.153
	(0.169)	(0.179)	(0.183)
$Bridging_{link}$ SC	0.360	0.618**	0.487**
	(0.247)	(0.275)	(0.227)
Age	-0.00348	-0.0207	-0.0332
	(0.0230)	(0.0228)	(0.0211)
Sex	1.973***	2.822***	-0.102
	(0.662)	(0.783)	(0.615)
SIOPS	0.0785	0.105	0.0711
	(0.0793)	(0.0841)	(0.0743)
Farming Experience	0.0587*	0.0874**	0.0781**
	(0.0354)	(0.0356)	(0.0325)
Land Size	-0.235	-0.513**	-0.122
	(0.228)	(0.253)	(0.256)
Farm Income	0.000197**	0.000244**	0.000192**
	(9.47e-05)	(9.89e-05)	(9.48e-05)
Leadership role	1.448**	0.660	1.502**
	(0.632)	(0.700)	(0.632)
Market Distance	0.243	0.310	0.257
	(0.294)	(0.296)	(0.282)
Assin South	0.350	0.237	-0.309
	(0.710)	(0.750)	(0.624)
Mfantseman	0.159	-0.0776	1.410*
	(0.839)	(0.876)	(0.720)
Constant	-9.846***	-11.69***	-6.477*
	(3.765)	(4.072)	(3.422)
Base category:	No Adaptation	Wald Chi2 (42):	90.35
Number of observation:	225	Prob > Chi2:	0.0000
Log pseudolikelihood:	-220.44689	Pseudo Chi2:	0.2877

Source: Field Survey, 2015.
NB: Values in parenthesis are the robust standard errors
*; ** and *** implies significant at 10; 5 and 1 percent respectively

Size of the land Cultivated

According to Gbetibouo (2009), large scale farmers have a broad capital base and resources and therefore easy for such farmers to invest in strategies that demand a high investment cost and

such are climate change adaptation mechanisms. The parameter estimate indicate that size of land cultivated is significant (5 percent) and negatively to diversification to non-farming activities. Thus, an additional hectare of land cultivated decreases the predicted probability of diversifying to non-farming activities, ceteris paribus. Among the introduced adaptation strategies, size of land cultivated turned out to be negatively related to improved variety and breed which is off expectation.

Farm Income

According to Shiferaw and Holden (1998), wealth is believed to reflect past achievement of households and their ability to bear risks. Thus, one can argue that respondents with less social capital (network size) are not able to access relevant information needed to adapt to climate change. Respondents in this arena, according to Dinh *et al*. (2012), are more vulnerable to climate change and therefore income can create simultaneity bias. In an attempt to reduce this bias only farm income (not household income) was used. Thus, households with higher income and greater assets are in a better position to adopt new farming technologies. The results of this study showed that farm income is positively related to all adaptation strategies except livestock diversification. This result is credence to the report of Deressa*et al*., (2009) and Tazeze, *et al*., (2012). Thus, wealthy farmers are able to invest in productivity smoothening option such as crop soil and water conservation, diversification, soil and plant related strategies, improved varieties and breeds and recommended agricultural practice.

Leadership position of the household head

Leadership position of the household head was incorporated to deal with the issues of correlation arising among unobserved variables. In the construction of social capital indicators, it is possible that household heads with a leadership role in an organization may have stronger social capital and better access to relevant information to aid adaptation of a particular strategy. In this regard, a dummy variable was use to proxy leadership role in an organization. Surprisingly, leadership role has a positive effect on the adaptation of soil and water conservation strategy (significant at 10 percent) and crop diversification (significant at 10 percent).

In the case of introduced adaptation strategies, leadership role has a positive effect on the adaptation of soil and plants related strategies (5 percent significant level) and recommended agricultural practice (5 percent significant level). The marginal effect of 0.1031 implies that the

predicted probability of a household head with a leadership role in an organisation to adapt soil and plants related strategy increases by 10.31 percent point more than those who do not hold any leadership position, all things being equal.

As revealed in the FGD in Mfantseman Districts, community leaders and leaders in other associations have strong connection with local government officials, institutions and Member of Parliament. Thus, such leaders establish strong network with the state and local communities or organisation (Purdue, 2016). The potential effect is that leaders will have higher probability of unlocking the benefits manifested in network.

Market Distance

According to Maddison (2006) proximity to market enhances the likelihood of adapting to climate change, presumably because farmers tend to meets at the market centres and exchange information. Better access to markets is also assumed to reduce transport and other market related transaction costs which translate to uptake of climate change adaptation strategy. Unfortunately, the parameter estimate of this study shows that closeness to market does not significantly influence climate change adaptation strategy.

Location

The introduction of the districts or location in the model is expected to capture elements such as temperature, rainfall, and other environmental factors which cannot be explicitly included in the model. Since the magnitude of such factors differs, different authors obtain different results. For instance, in Babilie District of Ethiopia, Tazeze, *et al*. (2012) revealed that farming in the arid areas increases the probability of changing planting date. The result of this study indicates that when one farms at Mfantseman District, the relative log odds of adapting crop diversification and recommended agricultural practice versus no adaptation increases when moving from Awutu-Senya District (Location==1) to Mfansteman District (Location==3) and both are significant at 10 percent. This result confirms the reason why maize output in Mfantseman district is increasing, though rainfall pattern is decreasing over time. Thus, farmers in this district take up adaptation measures to ensure that an increase in output.

In sum, this study basically shows that social capital at the individual level plays a significant role in the choice made by household head to adapt to the changing climate. Thus, among the

strong determinants of climate change adaptation strategies, this study argues that individual social capital cannot be ignored. Recent studies have presented plethora of evidence that economic performance and welfare of households have a strong positive correlation with social capital (Narayan & Pritchett 2000). Adding these discussions to the results of this studies show that individual farmers make use of their personal netowrk, gain relevant information and mitgate the effect of climate change through approprate adaptation strategy. The results of the study support research hypothesis two which states that individual social capital affluences climate change adaptation strategies.

CHAPTER SIX

CONCLUSION, LIMITATIONS AND RECOMMENDATIONS

6.1 Conclusion

This thesis set out to investigate social capital as a relational concept and its influence on climate change adaptation strategies among smallholder farmers in the Central region of Ghana. It puts into a single framework-social network analysis and econometric estimation techniques. Moreover, it distinctly shows how the individual farmers make use of the opportunities of embedded social relations, both in qualitative and quantitative realm, to adapt to the changing climate. Thus, social relations do not only facilitate the flow of information but behavioural change to manage risk. The results of the study show that smallholder farmers in the study areas have networked with different people of different socio-economic status. Using position generator, the study unveiled that most of the network members relate to ego as friends and acquaintances. On the contrary, the name generator shows the opposite as almost all alters relate to ego as family members with very few as friends. This support Van Der Gaag's (2005) view that the first name that comes into mind when asking name generator questions is that of family members or close friends. According to Granovetter (1973), strong ties are established among family members while weak ties are found among friends and acquaintance. Moreover, strong ties are characterised by high level of trust than weak ties. As strength, the study computed weak ties and strong ties not only on the basis of role relation (i.e. family member or friend, etc.) but with other relevant indicators. Thus, weak ties and strong ties between ego and alter differ in terms of role relationship, years of relationship, frequency of contact, closeness of alter to ego, and level of trust.

Using relevant climate related occupational prestige (SIOPS), social distance between respondents and network members was constructed. Four clusters were generated using K-means cluster analysis. These clusters unveiled egos who relate to alters of the same socio-economic status (bonding social capital), egos who relate to alters of the same social status but through a strong tie ($\text{bonding}_{\text{link}}$ social capital), egos who relate to alters of different socio-economic status (bridging social capital) and finally, egos who relate to alters of different socio-economic status but through a weak tie ($\text{bridging}_{\text{link}}$ social capital). The number of ties of each individual social capitals was aggregated and an independent *t* tested was computed to determine if the mean difference differ across sex of the respondents. The results indicate that men possess large

individual social capital as compared to women. This was significant across all the four individual social capital identified in the study.

Using 20 year period of rainfall data and output of maize the study shows that there is intra and inter annual variation in the pattern of both rainfall and maize outputs. The rainfall pattern in Mfantseman district, which represent transitional zone, shows a decreasing trend over the 20 year period. Maize output in the district, however, tends out to show an increasing trend. The empirical econometric model offers strong evidence to this dynamics. Thus, farmers in the district have high probability of taking up adaptation measures such as crop diversification and recommended agricultural practice. The rainfall pattern and maize output in Assin South district (Forest zone) shows an increasing trend over the period. The association between maize and rainfall in Awutu-Senya district (Coastal zone) is not distinct as there is high inter annual variability over the period. Overall, there is a moderate positive association between rainfall pattern and maize output the in Central region of Ghana. Moreover, there is a negative association between dry spell (in days) and maize output in the region.

The variability of rainfall and other climatic elements is confirmed by the perception of smallholder farmers in the study area. The majority of the respondents have noticed a decreased in rainfall patterns, and increased periods of drought. To most of the respondents (about 80 percent), precipitation has been unpredictable. About 85 percent perceive that there has been delay in the onset of the wet season. Moreover, about 75 percent perceive that the temperature has been hot over the past 20 years. Thus, smallholder farmers perceive a sharp change in rainfall and temperature than any other elements of the weather. Incidence of flood and bush burning has not been on the rise on the study area over the 20 year period. Non-parametric tests indicate that perception indicators used in the study do not differ across sex of the respondents but location. Thus, almost all the perception indicators differ across the study districts. This result is in line with recent findings of Osei, (2015). The FGDs and the Key Informant Interviews carried out show that the variability of climatic condition has negatively impacted the households of smallholder farmers. Most farmers have experienced crop failure and famine, an outbreak of diseases to livestock, an increase in poverty, and rural to urban migration of youth. These results show that smallholder farmers in the study area are more vulnerable to the changing climate.

There is the need to identify coping strategies used by smallholder farmers and the factors that influence that adaptation of the identified strategies.

The study found out that smallholder farmers have embraced both indigenous and introduced adaptation strategies. Indigenous adaptation strategies, according to FAO (2009) are perceived to have accumulated over generations living in a particular environment. Thus, farmers developed their own indigenous adaptation strategies due to their experience in the changing climate. Introduced adaptation strategies are those developed through scientific research. The majority of smallholder farmers have embraced indigenous adaptation strategies compared to introduced adaptation strategies to cope with the impacts of changing climate. The identified indigenous adaptation practice include soil and water conservation (about 20 percent), crop diversification (about 23 percent), livestock diversification (about 17 percent) and diversification to non-farming activities (about 13 percent). The introduced adaptation practices identified include soil and plants related strategies (about 26 percent), improved varieties (20 percent) and recommended agricultural practices (24 percent). The proportion of farmers who did not embrace any indigenous adaptation strategies (27.56 percent) is less than those who did not embrace any introduced adaptation strategies (30.22 percent). This could possibly mean smallholder farmers in the study area have not heard of or do not have the technical know-how of some of introduced adaptation strategies.

The findings from the empirical econometric estimation and the FGDs and key informant interviews are consistent with theory regarding climate change adaptation practices. Social capital and other controlled variable influence climate change adaptation strategies. Individual social capital such as bonding, $bonding_{link}$, bridging and $bridging_{link}$ have a significant positive influence on the adaptation of both indigenous and introduced adaptation strategies. The sex of the respondents has significant negative influence on the crop diversification strategy and a positive influence on the adaption of introduced strategies. Age, SIOPS, and land size of the land respondents has a negative influence on climate change adaptation strategies in the model. Other variables such as farming experience, farm income, leadership position and location positively influence climate change adaptation strategies. Thus, aside the individual social capital variables the controlled variables play a significant role in shaping the choice of adaptation strategies among households of smallholder farmers.

6.2 Limitations and Suggestions for future research

This study is not without limitations. First of all, the study is likely to overlook some occupational prestige relevant to climate change adaptation strategies. For example, in the domain of agriculture, there could be soil scientist, plant breeder, entomologist, pathologist, and others. These occupational prestigious jobs, however, are not included in the study as they do reflect on the standard international occupational prestige as developed by Ganzeboom & Treiman (1996). Thus, future research should find the possibility of widening the scope of the position generator items used in study.

Secondly, there was a potential confusion in the use of name generator techniques. In most Ghanaian societies each individual has two distinct names: local name (i.e. individuals are named after a relative and on the day s/he was born) and an English name. Depending on the kind of friendship and location, an individual can be called by different names by different network members. Though this was not the focus of the study, it would be more appealing to map respondents and network members generated within a particular location. This can even be linked against the adaptation practices. This is because, the study unveiled that some names (network members and respondents) in a particular district were found very common as most respondents came out with those names during the name and position generator question. The issue of different names was discovered during the latter part of the study in one of the districts. Some local leaders and extension officers were found out to be called by different names by different people. Future research can stick to either local or English name or should probe further if the respondent knows alter by another name.

Lastly, it is not without doubt that income variable is likely to create simultaneity bias. As explained earlier several attempts were made to minimize this bias. Future research can include secondary data (income) of the respondents if it is obtainable.

Social capital was also found to be very poor among women and this gives a direction of new research into gender and social capital and its implication with regards to climate change adaptation.

6.3 Policy Recommendations

Social capital and climate change adaptation assessment study comes with a challenging policy recommendation especially to government. This is because such policies have the potential of creating unintended side effects that will threaten the development process of a developing country. The study shows that individual social capital influences both indigenous and introduced adaptation strategies. Base on this finding it would be interesting, on one hand, to call for the promotion of social capital such as bonding, linking, and bridging by government and other relevant institutions and organisations.

The econometric estimation shows that leadership role in an organization or a community positively influences adaptation practices. Based on the result obtained from both position and the name generator technique, it can be argued that relay of climate change adaptation techniques or technology to smallholder farmers need not only be accomplished through the usual technology transfer network of agricultural researchers and extension agents. Rather, it will be imperative to increased contact with a wide variety of local actors who provide information and resources for agricultural production. These could be teachers, religious leaders, owners of agro-chemical shops in the communities, and local women and farmer group leaders. In doing so the transaction cost associated with obtaining the relevant information will be reduced. The danger here is that in designing such a policy, however, caution needs to be taken as it has the potential of excluding people from getting access to relevant resources and thereby increasing social inequality.

Moreover, as emerged from the FGD and the key informant interview, such leaders should be involved in training programmes and workshops so that they can reach out to other people in the community. This will also reduce the work load of the Agricultural Extension Agents while reaching most smallholder farmers within a particular geographical location. The empirical results also show that young farmers have probability of diversifying livestock. Thus, young farmers (youth) should be target and involved in such training programmes and workshops related to climate change. This will not only guarantee the future of food security status but also reduce youth unemployment in the country.

The trend analysis shows that rainfall is decreasing in the region and an increase in the number of dry spell days goes hand in hand with a decrease in the annual maize output. Moreover,

irrigation as an adaptation strategy is not common among smallholder farmers in the Central region of Ghana. This presupposes that farming in the region is rainfall dependent. The study recommends that government channel more resources into the investment of soil and water conservation strategies. Inter cropping should be encouraged with minimal reliance on natural rainfall and other external inputs yet guaranteed food security. This concept called 'climate smart agriculture' has been adapted in few districts in the country (GIZ, 2014). There is the need to extend this project to other regions and district of the country.

Lastly, perception indicators used in the study differ across all the three agro ecological zones. The study therefore recommends that in the designation of projects and adaptation technologies, policy makers or donors should not only concentrate on the technical aspect but also the social dimension such as how smallholder farmers perceive the changing climate. This, first of all, will create an avenue whereby perception of resource users can be integrated into climate change adaption projects. Also, it will enhance the flow of climate change information between smallholder farmers and donors or implementers of the project.

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APPENDICES

Appendix A: Statistical Results

Appendix A1: Correlation Coefficient between annual maize output (Mt/HA) and annual rainfall (mm) parameters

	Awutu Senya District	Assin South District	Mfantseman District	Regional (Average)
Correlation between Annual Maize output [Y] and Average annual rainfall [X]				
Pearson correlation coefficient	-0.0882	**0.3398**	-0.0557	**0.4246**
Correlation between Annual Maize output [Y] and Average Dry Spell Days [X]				
Pearson correlation coefficient	0.0022	0.0840	**-0.3017**	**-0.2127**

Appendix A2: Association between perception indicators and sex and location: Non-parametric test

Test Statistics	Precipitation has been unpredictable during the past 20 years	There has been delay in the onset of the wet season over the past 20 years	Incidence of flood has increased in the past 20 years	Temperature has been hot over the past 20 years	There has been prolong drought in the past 20 years	Bush burning has been rampant over the past 20 years
Mann-Whitney U Test; Grouping Variable: Sex of respondents						
Mann-Whitney U	5613.000	5683.000	5808.000	5211.500	5631.500	5527.500
Wilcoxon W	9441.000	9511.000	15399.000	9039.500	9459.500	9355.500
Z	-0.883	-0.735	-0.425	-1.774	-0.812	-1.130
Asymp. Sig. (2-tailed)	0.376	0.462	0.671	0.076	0.417	0.258
Kruskal Wallis Test; Grouping Variable: Sampled Districts						
$\chi 2$	6.336	38.372	4.712	16.272	15.577	25.690
DF	2	2	2	2	2	2
Asymp. Sig	**0.042**	**0.000**	0.095	**0.000**	**0.000**	**0.000**

Appendix A3: Pearson correlation coefficient among the continuous independent variables

```
. cor BondingSC BondinglinkSC BridgingSC BridginglinkSC AGE SIOPS EDUC_Years FAMEXPE LANDSIZE FARMINCOME MRKTDIST LOCATION
(obs=225)
```

	Bond~gSC	Bond~kSC	Brid~gSC	Brid~kSC	AGE	SIOPS	EDUC_Y~s	FAMEXPE	LANDSIZE	FARMIN~E	MRKTDIST	LOCATION
BondingSC	1.0000											
Bondinglin~C	0.1026	1.0000										
BridgingSC	0.1640	-0.2943	1.0000									
Bridgingli~C	0.1447	0.4412	0.0258	1.0000								
AGE	0.0563	-0.0243	0.0612	-0.0748	1.0000							
SIOPS	0.1125	-0.3049	0.6426	-0.1066	-0.0210	1.0000						
EDUC_Years	0.0843	-0.0143	0.3133	0.2023	-0.1408	0.3992	1.0000					
FAMEXPE	0.2446	0.1436	0.0584	0.0375	0.5276	-0.0632	-0.2054	1.0000				
LANDSIZE	0.0668	-0.0140	-0.0074	0.0735	0.2504	-0.1016	-0.0911	0.3184	1.0000			
FARMINCOME	0.0891	0.0356	0.0227	0.0247	0.1503	0.0101	-0.0127	0.1729	0.2310	1.0000		
MRKTDIST	-0.0080	0.1535	-0.1921	-0.0324	0.0391	-0.2325	-0.1123	0.0759	0.0872	-0.0189	1.0000	
LOCATION	0.1577	0.1768	-0.0275	0.0802	0.1128	-0.1139	-0.0997	0.3206	0.2015	-0.0030	0.2034	1.0000

Appendix A4: Test of Multicollinearity - VIF

```
. vif
```

Variable	VIF	1/VIF
Cluster_1	2.11	0.474368
SIOPS	1.86	0.538436
FAMEXPE	1.73	0.576804
Cluster2	1.55	0.643402
SEX	1.55	0.646556
AGE	1.47	0.679511
LOCATION	1.37	0.728575
Cluster4	1.37	0.729377
LANDSIZE	1.36	0.737571
LEADER	1.26	0.793872
Cluster3	1.21	0.829166
MRKTDIST	1.15	0.872833
FARMINCOME	1.09	0.918953
Mean VIF	1.47	

Appendix A5: Hausman Tests of IIA Assumption: Indigenous Adaptation Strategies

Ho: Odds are independent of other alternatives

Omitted	Chi2	DF	P > Chi2	Evidence
Soil and Water Conservation	2.46	42	1.0000	For Ho
Crop Diversification	0.12	42	1.0000	For Ho
Livestock Diversification	4.26	41	1.0000	For Ho
Diversify to Non-Farming Activities	13.32	42	1.0000	For Ho

Appendix A6: Marginal Effect of the Multinomial Logit model _ Indigenous Strategies

VARIABLES	Soil and Water Conservation	Crop Diversification	Livestock Diversification	Diversify to non-farming activities
Bonding SC	0.0064338	0.0296743**	0.0009501	-0.0138408
	(0.013289)	(0.011283)	(0.0127151)	(0.0130711)
$\text{Bonding}_{\text{link}}$ SC	0.025582	0.032605*	-0.0028801	0.004205
	(0.0199142)	(0.0167417)	(0.0145979)	(0.013977)
Bridging SC	0.0058869	0.0515977 ***	-0.0209976	0.0124416
	(0.0172584)	(0.0129086)	(0.0184728)	(0.0136489)
$\text{Bridging}_{\text{link}}$ SC	0.02139	0.0112786	0.0160283	-0.0130814
	(0.0226867)	(0.0206222)	(0.0185843)	(0.0193713)
Age	0.001617	0.0014845	-0.0072095**	0.003852
	(0.0024817)	(0.002388)	(0.0029337)	(0.0025677)
Sex	-0.0515151	-0.1748541**	0.1296005**	0.0155885
	(0.0669496)	(0.0680072)	(0.0641566)	(0.0488259)
SIOPS	0.0068914	-0.0149921**	0.0078415	-0.0093212
	(0.0060757)	(0.00539)	(0.0069015)	(0.0067911)
Farming Experience	0.0017916	-0.0040357	0.0113866***	0.0006865
	(0.002615)	(0.0031356)	(0.003258)	(0.0031921)
Land Size	-0.0034524	0.010576	0.0476639**	-0.0645631**
	(0.021326)	(0.0226487)	(0.0185344)	(0.0224192)
Farm Income	8.31e-06	0.0000102	5.25e-07	0.0000164**
	(6.98e-06)	(6.33e-06)	(7.38e-06)	(5.52e-06)
Leadership role	0.067749	0.0703305	-0.0337634	0.0006454
	(0.0543571)	(0.0546379)	(0.0483262)	(0.0526726)
Market Distance	-0.0098366	-0.0486707*	0.0328263	0.0309167
	(0.0262377)	(0.0282402)	(0.0224808)	(0.0222936)
Assin South	0.0763494	-0.011283	-0.0884964	0.0541819
	(0.0808238)	(0.0585431)	(0.07991)	(0.0593502)
Mfantseman	-0.0022094	0.2316166**	-0.164654**	-0.0441873
	(0.0633277)	(0.0789293)	(0.0664705)	(0.0475283)

Appendix A7: Hausman Tests of IIA Assumption: Introduced Adaptation Strategies

Ho: Odds are independent of other alternatives

Omitted	Chi2	DF	P > Chi2	Evidence
Soil and Plant Related Strategies	3.37	28	1.0000	For Ho
Improved Varieties and Breeds	1.90	28	1.0000	For Ho
Recommended Agricultural Practice	7.00	28	1.0000	For Ho

Appendix A8: Marginal Effect: Introduced Adaptation Strategies

VARIABLES	Soil and Plant Related Strategies	Improved Varieties and Breeds	Recommended Agricultural Practices
Bonding SC	0.0257561*	-0.0003604	0.0016771
	(0 .0148957)	(0.0120394)	(0.0144132)
$\text{Bonding}_{\text{link}}$ SC	0.0278783	0.019026	-0.0284804
	(0.0204389)	(0.0174751)	(0.0186225)
Bridging SC	0.0120586	.0226531*	-0.008692
	(0.0169667)	(0.0133539)	(0.0211206)
$\text{Bridging}_{\text{link}}$ SC	-0.0108115	.0351219*	0.0262579
	(0.0232765)	(0.0203355)	(0.019593)
Age	0.0027265	-0.0010723	-0.0038594
	(0.0029342)	(0.0022539)	(0.0026638)
Sex	0.1387704*	0.2301721**	-0.2406227***
	(0.0781962)	(0.0715294)	(0.0596449)
SIOPS	0.0016527	0.0052604	0.0017473
	(0.006602)	(0.0058622)	(0.0069166)
Farming Experience	-0.0008052	0.0040877	0.0046138*
	(0.0033832)	(0.002585)	(0.0027242)
Land Size	0.0028754	-0.0444264**	0.0159598
	(0.0218306)	(0.0201321)	(0.0250508)
Farm Income	4.53e-06	0.0000103*	7.13e-06
	(6.99e-06)	(5.57e-06)	(6.79e-06)
Leadership role	0.1031115*	-0.0711059	.1103914*
	(0.0558215)	(0.0513201)	(0.0603631)
Market Distance	0.0038495	0.0129635	0.0115092
	(0.0318356)	(0.025023)	(0.0272446)
Assin South	0.0526242	0.0105839	-0.0564153
	(0.0944123)	(0.0821506)	(0.0576754)
Mfantseman	-0.0569609	-0.0756217	0.2289176**
	(0.0793934)	(0.0671827)	(0.0723518)

Appendix A9: Occupational Sample used in the analysis

SIOPS	OCCUPATION TITLE*
71	National government official including minister
63	National local government official
50	Radio, television & other announcers
72	Meteorologists
61	Agricultural veterinary officer
56	Agricultural extension officer
32	Machinery renter
32	Shop sales person (agro chemical shop)
78	Higher education Professionals (University professor, lecturer, etc).
60	Secondary education teacher
57	Primary education teacher
58	Authors, journalists & other writers
40	Farmer (crop production)
40	Animal producer (farmers into livestock and poultry production)
50	Trader
54	Health inspector
60	Pastor
31	Driver (van)

Source: Ganzeboom & Treiman (1996). As pointed out by Ganzeboom and Treiman (1996), the SIOPS scale was generated by averaging the national prestige scores, appropriately rescaled to a common metric. Prestige scales reflect the classical sociological hypothesis that occupational status constitutes the single most important dimension in social interaction

*Occupation title was defined in the study as the most income source

Appendix B1: Check List for Focus Group Discussion

Questionnaire ID/ Household Number:	Date: …. /……. /2015
Climate Zone:	Climatic zone Code:
District:	District Code:
Community:	Community Code:
Facilitator 1:	
Facilitator 2:	

A. DEMOGRAPHIC INFORMATION

Categories	Total	Male	Female	Number of hectares of land cultivating	
				$\geq 2\ ha$	$< 2\ ha$
Interview Group Composition					
No. of female head household					

B. CONCEPT AND PERCEPTION OF CLIMATE CHANGE

B1.What is your understanding about climate change? During your lifetime (over the past 20 years), have you noticed any changes in climate? How?

B2. How do you perceive the change in climate in terms of frequency and distribution of the following?

i. rainfall ii. temperature iii. drought iv. flood and storm iv. bush fire

C. IMPACT AND ADAPTATION TO CLIMATE CHANGE

C1. How does this change in climate affect you and your community? What kinds of problems do you have to face because of impacts of Climate change?

(**Facilitator:** Farmers attention can be drawn to crop and livestock production, water availability, food availability (food security), migration, livelihood, poverty, etc.).

Is there any benefit or advantage of Climate Change as well? If so, what are those?

C2. What do you do to cope or adapt to the impact of Climate Change you have observed on your:

i. Farm? ii. Community?

How effective are these coping mechanisms? Will they help you in the future (long term use?)

D. INDIVIDUAL SOCIAL CAPITAL (NETWOKING ACTIVITIES)

D1. Where do you receive information about these changes in climate and the coping mechanism? (e.g. Extension officers, group members, interaction with friends and acquaintances, companies, NGOs, etc.).

D2. Do the information help you to make decision in farming practices? How reliable are these sources of information? Do women face any problem getting that information?

D3. What are the most important or effective groups or organizations in this village? How effective is the group meeting its objective? Do you think this organization or group help the farmers to cope or adapt to climate change impact discussed earlier? What about learning from your friends?

D4. How do you perceive the effectiveness of Agricultural Extension Services in this community?

D5. Has there been any workshop that addresses the effect of climate change on livelihood for farmers in this community or district?

D6. If yes in any of the above, complete the table below

Name of organization/ institution	Type 1=Government, 2=NGO, 3=Private, 4= An Individual, 99 = Don't know	How many of you attended?	
		Male	Female

D7. Does the Government have any rule/ regulation that you know which support adaptation to climate change?

D8. Do you receive any agricultural technical support from the Government in implementing adaptation?

D9. If yes, what kind of technical support do you receive?

D10. If no, what kind of support would you want to receive?

Appendix B2: Check List for Key Informants Interview

Questionnaire ID/ Key Informant Number:	Date: …. /……. /2015
Climate Zone:	Climatic zone Code:
District:	District Code:
Community:	Community Code:
Facilitator 1:	
Facilitator 2:	
Name of the Respondent (expert):	

A. PERCEPTION, IMPACT AND ADAPTATION OF CLIMATE CHANGE

A1. In your opinion, do you see any changes associated with climate over the past 20 years? *If too difficult for you, has the following element increases, decreased or remain the same?*

a). Rainfall b). Temperature c). Drought d). Flooding

A2. What are some of the effects of these changes you have observed in this community? How do you perceive these effects in the future?

A3. Are you into farming? How have you adapted/coped with the change in climate? What are some of the adaptation strategies you have adopted?

B. INDIVIDUAL SOCIAL CAPITAL (NETWORKING AMONG FARMERS)

B1. How do you perceive the effectiveness of extension services in the community?

B2. What are some of the challenges have you experience with extension services in this community?

B3. In your opinion do you think farmers based organization (FBO) is good enough? Is every farmer able to join these groups? Have you experience any challenges with FBO?

B4. How do you perceive the relevance of networking among farmers?

B5. Do you think by networking with friend, and acquaintances, farmers can learn from one another and adopt innovation practices that can help mitigate the effect of climate change? Have you had any personal experience by learning from friends?

Appendix B3: Household level questionnaire

PROJECT TITLE: *SOCIAL CAPITAL AND CLIMATE CHANGE ADAPTAION STRATEGIES: THE CASEOF SMALLHOLDER FARMERS IN THE CENTRAL REGION OF GHANA.*

The main objective of this study is to assess the influence of individual network-based social capital on the climate change adaptation strategies of smallholder farmers in the central region of Ghana. The study is a partial fulfillment for the award of Master Degree in Development Studies (University of the Western Cape, South Africa). Please respond to the following survey items by checking the appropriate response next to each question/item. All information is confidential. Your co-operation is needed and will greatly be appreciated.

HOUSEHOLD LEVEL QUESTIONNAIRE

Questionnaire ID/ Household Number:	Date: …. /……. /2015
Name and Initial of Interviewer:	
Climate Zone:	Climatic zone Code:
District:	District Code:
Community:	Community Code:

E. DEMOGRAPHIC INFORMATION

1. Name of the household head (respondent). [_ _]

2. What is your sex? [ ] 1 = Male 0 = Female

3. What is your age? [_ _ _ _ _ _]

4a. What is the highest level of formal education?[ ] 0 = None 1 = Basic (Primary/JHS/Middle) 2=Secondary (Secondary/Vocational/O/A level) 3=Tertiary (Training college/Polytechnic/University) 4 = Koranic 5 = Others, specify: _ _ _ _ _ _ _ _

4b. What is the highest level of formal educationin years? [_ _ _ _ _ _]

5. Marital status of respondent: [ ] 0 = Single 1=Married 2=Divorced/Separated 3 = Widowed

6. What is your major occupation (most income earning source)? [_ _ _ _ _ __ _ __ _ _ _ _ _ _ _ _]

7. How many years of farming experience do you have? [_ _ _ _ _ _]

8. What is your household size (number of people who eat from the same pot)? [_ _ _ _ _ _]

9. What is your residential status? [ ] 1 = Indigene 0 = Migrant

10. Do you belong to any association? [ ] 1 = Yes 0 = No

10b. If 'Yes', what type of association is it? | | | | | | |

(Multiple associations allow)

1 = Farmer Based Organization 2 = Finance/Credit Association 3 = Business or Traders group 4 = Religious/spiritual group 5 = Others (specify): _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

11. Do you hold any leadership position in any of these associations? [ ] 1= Yes 0=No

F. INFORMATION ON THE PERSONAL NETWORK OF RESPONDENTS

In this section I would like to know your personal relation including the kind of occupation you meet and have contact with. The first part contains a list of occupations that people can have. Does anyone in your family, among your friends or acquaintance have one of these occupations?

11. Position Generator

Job		**Nobody [0]**	**Core Family [1]**	**Extend-ed Family[2]**	**Friend [3]**	**Acqua-Instance [4]**
J1	National government official including minister	[ ]	[ ]	[ ]	[ ]	[ ]
J2	National local government official	[ ]	[ ]	[ ]	[ ]	[ ]
J3	Radio, television & other announcers	[ ]	[ ]	[ ]	[ ]	[ ]
J4	Meteorologists	[ ]	[ ]	[ ]	[ ]	[ ]
J5	Agricultural veterinary officer	[ ]	[ ]	[ ]	[ ]	[ ]
J6	Agricultural extension officer	[ ]	[ ]	[ ]	[ ]	[ ]
J7	Machinery renter	[ ]	[ ]	[ ]	[ ]	[ ]
J8	Shop sales person (agro chemical shop)	[ ]	[ ]	[ ]	[ ]	[ ]
J9	Higher education Professionals (University professor, lecturer, etc).	[ ]	[ ]	[ ]	[ ]	[ ]
J10	Secondary education teacher (SHS, JHS, etc.)	[ ]	[ ]	[ ]	[ ]	[ ]
J11	Authors, journalists & other writers	[ ]	[ ]	[ ]	[ ]	[ ]
J12	Farmer (crop production)	[ ]	[ ]	[ ]	[ ]	[ ]
J13	Animal producer (farmers into livestock and poultry production)	[ ]	[ ]	[ ]	[ ]	[ ]

NB: Interviewer*: begin with asking if ego knows a family member in that occupation. If* ***yes****, then move to the next occupation.* ***If not****, then ask about friends in that occupation …If ego says somebody is both a family member and a friend, s/he should be counted as a family member.*

12. Now I would like to know the following on each of the people named in Q11.

	A	B	C	D	E	F	G	H	I	J
Job	Name of the person known	Sex **(Use Codes)** 1=Male 0= Female	Age	Marital status **(Use Codes)** 1=single 2=married 3=divorce /separated 4=widow	How often do you usually have contact with the person in a month? (**use Codes**) 0 = Nile 1 = Once 2 = Twice 3 = Thrice 4 = Four time or more	How long have known this person (in years)?	How close are you to this person? (**Use Codes**) 1=Not close at all 2= Not close 3=Somehow Close 4=Close 5=Very close	Can you indicate how much you trust this person? (**Use Codes**) 1 = Do not trust at all 2 = Do not trust 3 = Somehow trust him/her 4 = trust him/her 5 = Trust him/her very much	Do you receive inform-ation about climate change or farming from any of these? 1=Yes 0=No	Do you give inform-ation about climate change or farming to any of these? 1=Yes 0=No
J1		[ ]		[ ]	[ ]		[ ]	[ ]		
J2		[ ]		[ ]	[ ]		[ ]	[ ]		
J3		[ ]		[ ]	[ ]		[ ]	[ ]		
J4		[ ]		[ ]	[ ]		[ ]	[ ]		
J5		[ ]		[ ]	[ ]		[ ]	[ ]		
J6		[ ]		[ ]	[ ]		[ ]	[ ]		
J7		[ ]		[ ]	[ ]		[ ]	[ ]		
J8		[ ]		[ ]	[ ]		[ ]	[ ]		
J9		[ ]		[ ]	[ ]		[ ]	[ ]		
J10		[ ]		[ ]	[ ]		[ ]	[ ]		
J11		[ ]		[ ]	[ ]		[ ]	[ ]		
J12		[ ]		[ ]	[ ]		[ ]	[ ]		
J13		[ ]		[ ]	[ ]		[ ]	[ ]		

13. Name Generator Questions

I would like you to mention a maximum of two people in your network whom you are likely to attend to in each of the following domain.

NG1-11	Name of first person NG1	Name of second person NG2
In times of need whom would you ask for external agricultural inputs such as chemical fertilizer, manure, seeds, and seedlings?		
Whom would you ask to lend you farm machinery, like mower, sprayer, plowing machine?		
If you have a problem on your farm whom would you ask for advice/information concerning this problem?		
If you need any information about rainfall and temperature, whom would you ask?		
During harvesting season whom will you ask to help you on your farm?		
If you need information about irrigation whom will you consult?		
Whom would you ask for a small sum of money as a credit? (approximately, GHs 200)		
Whom would you ask for a huge sum of money as a credit? (approximately, GHs 500)		
Whom would you ask to help you on farm (example, weeding, application of fertilizer, etc.)?		
Whom would you ask to borrow drought animal such as buffaloes or cattle?		
If you need any information about improved variety and breeds, whom would you ask?		
Whom do you discuss important agricultural matter?		

14. Is there anyone who is important to you whose name is not yet in the list? [ ]
1=Yes, 2=No
I would like to add this person to the list. What is/are the activities you usually share with this person?

Name of this person: _

Activities you share with _

15. With these people you have named in Q13 and Q14, answer the following question about each of them [**INTERVIEWER**: Codes for column **E**, **G** and **H** used in **Q12** apply to **Q15**)

	A	B	C	D		E	F	G	H	
NG	Name of the person known	Sex 1=Fem-ale 0= Male	Age	What is the main occupation of this person (most income source)?	How do you relate to this person? 1=core family 2=Extended family 3=friend 4=Acquintance	How often do you usually have contact with the person? (in a month)	How long have known this person (in years)?	How close are you to this person?	Please indicate how much you trust this person?	Do you give information about farming to any of these? 1=Yes; 0=No
NG1-1		[ ]				[ ]		[ ]	[ ]	[ ]
NG1-2		[ ]				[ ]		[ ]	[ ]	[ ]
NG1-3		[ ]				[ ]		[ ]	[ ]	[ ]
NG1-4		[ ]				[ ]		[ ]	[ ]	[ ]
NG1-5		[ ]				[ ]		[ ]	[ ]	[ ]
NG1-6		[ ]				[ ]		[ ]	[ ]	[ ]
NG1-7		[ ]				[ ]		[ ]	[ ]	[ ]
NG1-8		[ ]				[ ]		[ ]	[ ]	[ ]
NG1-9		[ ]				[ ]		[ ]	[ ]	[ ]
NG1-10		[ ]				[ ]		[ ]	[ ]	[ ]
NG1-11		[ ]				[ ]		[ ]	[ ]	[ ]
NG2-1		[ ]				[ ]		[ ]	[ ]	[ ]
NG2-2		[ ]				[ ]		[ ]	[ ]	[ ]
NG2-3		[ ]				[ ]		[ ]	[ ]	[ ]
NG2-4		[ ]				[ ]		[ ]	[ ]	[ ]
NG2-5		[ ]				[ ]		[ ]	[ ]	[ ]
NG2-6		[ ]				[ ]		[ ]	[ ]	[ ]
NG2-7		[ ]				[ ]		[ ]	[ ]	[ ]
NG2-8		[ ]				[ ]		[ ]	[ ]	[ ]
NG2-9		[ ]				[ ]		[ ]	[ ]	[ ]
NG2-10		[ ]				[ ]		[ ]	[ ]	[ ]
NG2-11		[ ]				[ ]		[ ]	[ ]	[ ]

Farm and Other Characteristics

16. What is the size of your total land? Any unit allow [_ _ _ _ _ _ _ _ _ _ _ _ _ _ _]

17. What is the total area under cultivation? [_ _ _ _ _ _ _ _ _ _ _ _ _ _]

18. Have you received any extension services in the past 12 month? [   ]   1=Yes,   2=No

19. How many times did you receive these services in the past 12 month? [_ _ _ _ _ _ _]

19b. List any comment you have on extension services

i)   _
ii)   _
iii)   _

20. Which of these productive assets do you own? (Multiple answers possible)

☐☐☐☐☐☐

1 = Tractor   2 = Oxen plough   3 = Water Pump   4 = Wheel Barrow   5 = Cutlass   6 = hoe

7 = Knapsack   8 = Other (specify) _ _ _ _ _ _ _ _ _ _ _ _ _

21. Which of these household assets do you own?

☐☐☐☐☐☐

1 = TV sets   2 = Radio   3 = Bicycle   4 = Motorcycle   5 = Car

6 = Other (specify): _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

22. What is the main source of water for drinking and for household chores? [   ]

1=Pipe borne 2=Dam 3=Rain 4=River, lake, stream 5=Wells/Borehole

6 = Other (specify): _ _ _ _ _ _ _

23. a). Do you have access to irrigation water?   [   ]   1 = Yes,   0 = No

24. b). If ‘yes’ what is the source of this water?   [   ]   1 = river/lake/stream,

2 = Dam/pond   3 = Well/borehole   4 = pipe borne   5 = other (specify): _ _ _ _ _ _ _ _ _

25. What is the distance from the nearest market?   [   ]

[INTERVIER: respondents can give the answer in **miles**: __ _ _ _ _ _ _ _ _ _ _]

1 = Less than 1 km   2 = 1 – 5 km   3 = 6 – 10 km   4 = Over 10 km

26. This question seeks to obtain production history during the last season. Which of these crops did you cultivate for cash?

A What crop did you cultivate in the previous season?	**B** Area cultivated	**E** Quantity harvested (**Use codes**) 1 = Basket 2 = Bowl 3 = Pan 4 = Bags 5 = bunch 6 = count		**D** Quantity sold (**Use codes**) 1 = Basket 2 = Bowl 3 = Pan 4 = Bags 5 = bunch 6 = count		**E** Price per unit sold (GHs)
		QTY	**CODE**	**QTY**	**CODE**	
Maize						
Rice						
Cassava						
Yam						
Plantain						
Pineapple						
Vegetables:						
Groundnut						

27. a). Did you harvest cocoa last year? [ ] 1 = Yes 0 = No

27. b). If yes, how many bags (kilograms) did you harvest and sold? _ _ _ _ _ _ _ _ _ _ _ _

28. This question seeks to obtain production history of your livestock

Type of livestock	Quantity	Quantity sold last year	Price per unit
Cattle			
Sheep			
Goat			
Fowl			
Turkey			
Guinea Fowl			
Pig			
Others:			

29.a) Are any members of your household (family) currently living outside the village and financiallysupporting your household (i.e. providing remittance income)? [ ]

1 = Yes 0 = No

29. b). If "yes" over the past 12 months how much (an estimate) did you receive from the family member outside this village? GHs_ _ _ _ _ _ _ _

30. Apart from farming, do you engage in any activity that generates income to support the household? 1 = Yes 0 = No

30b. On average, how much do you receive from the activity(ies) mentioned in Q30 per month or year? Month: GHs_ _ _ _ _ _ _ or Year: GHs_ _ _ _ _ _ _

D. CLAIMATE CHANGE INFORMATION: PERCEPTION AND ADAPTAION STRATEGIES

30. Comparing 1990s with the recent past 10 years, i.e. 2000s, have you notice any change in any of the following? (INTERVEIWER: if respondent finds it difficult, jump to Q31)

a).	Rainfall pattern	[ ]	1 = Yes	2 = No	3 = Don't know
b).	Temperature	[ ]	1 = Yes	2 = No	3 = Don't know
c).	Drought	[ ]	1 = Yes	2 = No	3 = Don't know

31. Looking back to the past 10 years, have the following weather elements increased, decreased or remain the same)?

a).	Rainfall pattern	[ ]	1 = Increased	2 = Decreased	3 = remained the same
b).	Temperature	[ ]	1 = Increased	2 = Decreased	3 = remained the same
c).	Drought	[ ]	1 = Increased	2 = Decreased	3 = remained the same

32. Please respond to the following questions using the scale of **1=Strongly Disagree** and **5=Strongly Agree.**

		Strongly disagree [1]	Disagree [2]	Neutral [3]	Agree [4]	Strongly Agree [5]
a).	Precipitation has been unpredictable during the past 20 years	[ ]	[ ]	[ ]	[ ]	[ ]
b).	there has been delay in the onset of the	[ ]	[ ]	[ ]	[ ]	[ ]

	wet season over the past 20 years					
c).	incidence of flood has increased in the past 20 years	[ ]	[ ]	[ ]	[ ]	[ ]
d).	temperature has been hot over the past 20 years	[ ]	[ ]	[ ]	[ ]	[ ]
e).	there has been prolong drought in the past 20 years	[ ]	[ ]	[ ]	[ ]	[ ]
f).	bush burning has been rampant over the past 20 years	[ ]	[ ]	[ ]	[ ]	[ ]

33. Have you made any adjustment in your farming practices to climate variability and change?

[ ] 1= Yes, 0=No

	Indigenous Adaptation Strategies	1 = Yes 0 = No
The following are some of the indigenous practices identified in the literature. Which of these have you adjusted in your farming practices to mitigate the long term shift in temperature and rainfall?	Soil and water conservation strategies	[ ]
	Changing planting date and period	[ ]
	Crop diversification (i.e. multiple cropping)	[ ]
	Livestock diversification strategy	[ ]
	Diversification to non-farming activities	[ ]
		[ ]
	Introduced Adaptation Strategies	
	Irrigation	[ ]
	Crop Insurance	[ ]
	Soil and plant related strategies (pesticides, fertilizer application)	[ ]
	Improve variety and breeds	[ ]
	Recommended Agricultural Practice (i.e. recommended spacing, planting distance, etc.)	[ ]

3***Soil and water conservation strategies**: Cover crops and legumes, planting of trees, mulching,

……..……..*End of Interview*…….

Thank You!

Appendix C: Summary of Research Report

PROBLEM STATEMENT	OBJECTIVES	METHODS	RESULTS	CONCLUSIONS	RECOMMENDATIONS
Climate modelling predicts that rainfed maize output in Ghana will decrease below 25 percent by 2020 if nothing is done. Adaptation measures need to be taken to mitigate the effect. The process of adaptation involves the interdependence of agents through their relation with each other. This concept usually termed social capital is lacking especially in Ghana.	1&2. To identify the type of social relations and analyse the strength of ties among smallholder farmers.	i. Descriptive statistics with application of independent sample t test ii. K-means cluster analysis	Smallholder farmers have networked with people (family members, friends and acquaintances) of different socio-economic status. The four individual social capital identified (based on tie strength and socio-economic status) are bonding, bridging, $bonding_{link}$, and $bridging_{link}$	The kind of social relations (i.e. the four individual social capital identified) differ significantly by sex of the respondents (ego).	-
	3. To analyze the trend of rainfall pattern over the past 20 years and its association (correlation) with annual maize output.	Trend analysis with application of Pearson Correlation Test	There is high intra and inter annual variations in the annual pattern of rainfall and maize output in all the three districts in the Central region of Ghana	There is a positive correlation between rainfall pattern and maize output. There is also a negative correlation between number of dry spell days and maize output.	Government and smallholder farmers should channel more resource into the investment of soil and water conservation strategies while encouraging inter cropping with minimal reliance on natural rainfall.
	4. To ascertain the perception of the smallholder farmers on climate change and their coping strategies	Descriptive statistics, FGDs & interview. Application of Mann-Whitney U and Kruskal Wallis test	Smallholder farmers have perceived a change in the climate especially with regard to delay in the onset of wet season, unpredictability of rainfall and rising temperature	Smallholder farmers have perceived a change in the climate and their perception differs across location.	In the designation of projects and adaptation technologies, policy makers or donors should not only concentrate on the technical aspect but also the social dimension such as how smallholder farmers perceive the changing climate
	5.To analyse the effect of individual social capital and other controlled factors on the adaptation strategies of the smallholder farmers	Multinomial Logit Model & FGDs as well as key informant interviews	Individual social capital has a significant positive influence on the adaptation of both indigenous and introduced adaptation strategies. Sex has a mixed influence. While age, SIOPS, and land size have a negative influence farming experience, farm income, leadership position, and location have positive influence on climate change adaptation strategies.	Individual social capital such as bonding, bridging, $bondingl_{ink}$ and $brridging_{link}$ have a significant positive influence on climate change adaptation strategies. Other variables such as sex, age, SIOPS, land size, farming experience, farm income, leadership position, and location have a significant influence on climate change adaptation strategies.	i. Climate change adaptation technology to smallholder farmers need not only be accomplished through the usual technology transfer network of agricultural researchers and extension agents. Rather, it will be imperative to increased contact with a wide variety of local actors who provide information and resources for agricultural production ii. Such leaders and young people should be involved in training programmes and workshops so that they can reach out to other people in the community.