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CLIMATE SMART AGRICULTURE ADOPTION BY SMALLHOLDER FARMERS: A CASE STUDY OF ANAFOBIISI AND GOWRIE-KUNKUA COMMUNITIES IN THE BONGO DISTRICT OF GHANA

BY

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THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF MPHIL CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT DEGREE.

COLLEGE OF HUMANITIES

CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT PROGRAMMES

UNIVERSITY OF GHANA

LEGON

2015

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DECLARATION

I, Rahinatu Sidiki Alare, the author of this thesis, do hereby declare that, except for the references which are duly acknowledged, the work presented in this thesis: "CLIMATE SMART AGRICULTURE ADOPTION BY SMALLHOLDER FARMERS, A CASE STUDY OF ANAFOBIISI AND GOWRIE-KUNKUA COMMUNITIES IN THE BONGO DISTRICT OF UPPER EAST REGION" was entirely done by me under the Climate Change and Sustainable Development programme, college of Humanities, University of Ghana, Legon.

This work has never been presented either in whole or in part for any other degree in this university or elsewhere.

…….. Date……..

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This thesis has been presented for examination with our approval as Supervisors:

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Date……. Date……

Dr. Erasmus H. Owusu Dr. Kwadwo Owusu

(Principal Supervisor) (Co-Supervisor)

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DEDICATION

This thesis is dedicated to all smallholder farmers in both Anafobiisi and Gowrie-Kunkua communities in the Bongo District of Upper East Region who contributed their time and valuable information for its successful completion.

God Richly Bless You!

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ACKNOWLEDGEMENT

My greatest acknowledgement is to the Almighty God for how far He has brought me and for always being with me. I also wish to express my profound gratitude to my supervisors, Dr. Erasmus H. Owusu and Dr. Kwadwo Owusu for their time and valuable inputs.

I gratefully acknowledge the Open Society Foundation/B4C for the support through their scholarship that enabled me to successfully go through the Masters course in Climate Change and Sustainable Development (CCSD) programme. My heartfelt gratitude also goes to Dr. Jesse B. Naab, Senior Scientist (Agriculture and Climate Change) of WASCAL Competence Centre- Ougadougou, and Mr. Aaron Aduna, Vea Basin Coordinator of WASCAL and Basin officer of Water Resource Commission for their valuable inputs, God richly bless you. To the rest of WASCAL staff in Bolgatanga, I am really grateful to you for your warm hospitability and support.

I am also grateful to Mr. Alhassan Zimi, MoFA extension officer (Bolga), all staff of NABOCADO (Bongo office) and Mr. Jonas Awinepala Nyaaba (Field Assistant) for helping in identifying and locating respondents for this research. My profound gratitude also goes to all smallholder farmers in both Anafobiisi and Gowrie-Kunkua for their time and knowledge shared with me. To all institutions interviewed, I am really grateful.

My heartfelt gratitude goes to my family for their prayers, encouragement and financial support. Finally, to my friends, especially Samuel Guug, Abraham Opoku and the entire Mphil students of CCSD, I say a big thank you.

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ABSTRACT

Climate smart agriculture (CSA) has been proposed as the best way forward for agriculture in the face of climate change. This study was conducted to survey the types of CSA practices in Anafobiisi and Gowrie-Kunkua communities in the Bongo district of the Upper East Region of Ghana, and also to investigate the role of local institutions in facilitating the adoption of such practices and the impacts on livelihoods. Results of the study indicated that commonly adopted CSA practices included intercropping (100%) residue management (98%), improved forages (97%), composting (96%), crop rotation (96%), improved crop varieties (81%), planting on contours or ridges (76%), stone or grass bunds (69%), household and or community tree planting (64%), minimal tillage (44%), improved livestock breeding (16%), mulching (15%), irrigation (18%), manure management (2%) and rain water harvesting(2%). Major factors influencing the adoption of CSA included household head type, household size, awareness, income, and nature of the land. Financial constraints, water shortages, small land space, and insufficient information were the main reasons for the non-adoption of CSA practices. Survey results from institutional interviews indicated that institutions working within the district were effectively facilitating the adoption of CSA practices among smallholder farmers. An assessment of the impact of adoption of CSA practices on livelihoods showed that the adoption of some CSA practices has contributed to household food security, improved wellbeing and improved social inclusion among respondents. The study concluded that farmers in Anafobiisi and Gowrie-Kunkua are willing to adopt CSA practices, but will need additional support, knowledge and training to successfully adopt these practices.

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ABBREVIATIONS

ACDEP	Association of Church Development Projects
ADDRO	Anglican Diocesan Development and Relief Organisation
ASTI	Agricultural Science, Technology and Innovation
CAP	Community Action Plan
CARE	Cooperative for Assistance and Relief Everywhere
CCAFS	Climate Change, Agriculture and Food Security
CGIAR	Consultative Group on International Agriculture Research
CSA	Climate Smart Agriculture
DfID	Department for International Development
FAO	Food and Agriculture Organization
FMNR	Farmer Managed Natural Regeneration
FTC	Farmer Training Centre
GAIP	Ghana Agriculture Insurance Pool
GEF	Global Environmental Facility
GHGs	Greenhouse Gases
GSS	Ghana Statistical Service
GDP	Gross Domestic Product
ICRAF	International Centre for Research in Agroforestry
IFAD	International Fund for Agricultural Development
IPCC	Intergovernmental Panel on Climate Change
MIDP	Maradi Integrated Development Project
MoFA	Ministry of Food and Agriculture
NABOCADO	Navrongo-Bolgatanga Catholic Diocesan Development Office
NGO	Non-Governmental Organization

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NRMP	Natural Resource Management Project
OXFAM	Oxford Community for Famine Relief
SLM	Sustainable Land Management
USAID-ADVANCE	United State Agency for International Development – Agriculture Development and Value Chain Enhancement
YHF	Youth Harvest Foundation
WASCAL	West Africa Science Service on Climate Change and Adapted Landuse

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CHAPTER ONE

INTRODUCTION

1.1 Background

Small scale farming dominates agriculture in Sub-Saharan Africa (SSA) mostly operating on less than 2 ha in total landholdings. Moreover, it provides food security and income for many rural households as well as supplying the urban population with food and contributing to the national economies of their individual countries. Small scale farming faces the challenge of increasing production to provide food security for the projected human population of 9 billion by 2050 while preserving its environment and natural resource base. Population growth and increasing consumption of high calorie and meat-intensive diets are expected to double human food demand by 2050, (Tilman, Balzer, Hill, & Befort, 2011).

If current income and consumption trends continue, the Food and Agriculture Organization (FAO), estimates that agricultural production will have to increase by 70% by 2050 to satisfy expected demands of food and feed (FAO, 2013a). These challenges are compounded by the need for farmers to adapt to climate change and at the same time mitigate its contribution to climate change in order to slow the progression of this global challenge (FAO, 2009).

Increasing productivity to achieve food security is projected to entail a significant increase in emissions from the agricultural sector in developing countries (IPCC, 2014). Therefore, responding to the challenge of climate change has become a global priority. Achieving the needed levels of productivity in agriculture with lower emissions of GHGs will require a concerted effort to maximize synergies and minimize trade-offs between productivity and mitigation. Hence, the promotion of climate smart agriculture (CSA) by the Food and

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Agriculture Organization. CSA entails the adoption of farming practices and technologies to sustainably increase food production, build resilience to climate change (adaptation), reduces or removes greenhouse gases (mitigation) and enhance the achievement of national food security and development goals, (FAO, 2010).The idea is to promote the notion of addressing multiple goals simultaneously. By aiming to reduce poverty, address climate change, and reduce food insecurity at the same time, it is possible to make more efficient use of resources.

However, the challenge lies in the extent to which poor smallholder farmers can successfully adopt CSA practices with current surprises and shocks which climate change presents. Being climate smart therefore calls for adopting practices such as knowledge smartness, nitrogen smartness, energy smartness, water smartness, weather smartness and carbon smartness (Aggarwal, Zougmore, & Kinyangi, 2013). This hinges on developing new or enhancing existing institutions to support poor smallholder farmers to successfully adopt these practices.

There are usually many institutions – government agencies, researchers, development organizations, NGOs and the private sector – in any given location or region, as well as informal groups and networks that are promoting CSA activities at the local level. New types of initiatives and projects are now possible in Africa due to new and expanding global carbon markets and investments in project and programs making payments to smallholders for ecosystem service provision. For instance, in the Nyando River Basin in Western Kenya, through the assistance of institutions such as a partnership between Cooperatives for Assistance for Relief Everywhere (CARE), the World Agroforestry Centre (ICRAF) and the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) with funding from the Rockefeller Foundation, initiated the Sustainable Agriculture in a Changing Climate project (SACC), (CCAFS and CGIAR 2012a cited in FAO 2013). The project has

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not only made payments to poor smallholder farmers from carbon markets for the adoption agroforestry practices but has also introduced immediate interventions such as early maturing crop varieties, village saving and loan schemes and a lot more to provide short term food security and income as well as improving poor women participation. The project however relies on other local institutions such as the small savings and loan groups, village management committee and other emerging institution for the sustainability of the project, (CCAFS and CGIAR 2012a cited in FAO 2013).

Similarly in Nepal, rice farmers and their supporting institutions have successfully evolved and co-produced location-specific climate sensitive technologies such as improved rice varieties and agronomic practices. These have facilitated the adoption of technologies in a more efficient manner and has also improved knowledge network among farmers, scientist and institutions, (Chhetri, Chaudhary, Tiwari, & Yadaw, 2012).

In Upper East Region, there are similar institutions. The question is whether they are functioning well and are adequately equipped to cause change in the lives of poor rural farmers in disseminating information, technology as well as livelihoods improvements. Ensuring that institutions and incentives are in place to achieve climate-smart transitions is thus essential to meeting these challenges.

1.2 Problem Statement

Growing food crops and rearing of livestock underpin the livelihoods of rural households in Anafobiisi and Gowrie-Kunkua communities in the Bongo District of Upper East Region of Ghana. These two communities were purposively selected because of an ongoing project initiated by the Navrongo-Bolgatanga Catholic Diocesan Development Office

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(NABOCADO), a non-governmental organisation to promote sustainable agricultural practices and natural resource conservation.

The Medium Term Development Plan (MTDP) of the district stipulates that agriculture and its related work constitutes 58.8% of employment as compared to other occupations in the district Bongo District Assembly (2014). This, conventionally should enhance food security and improved wellbeing in the district, given the fact that the agricultural sector drives the Ghanaian economy.

Unfortunately, historical reports from Ghana Statistical Service, (GSS) (2014) has indicated Upper East Region as being one of the poorest among the ten (10) regions of Ghana, ranking 8th in the poverty profiling. Also, a survey conducted by World Food Program, WFP (2012) posits that the region is sagged by a higher proportion of food insecure households with 56% of the populace classified as being poor, exposing the region to other vulnerabilities including climate change and variability.

Crop farming in the Bongo district is faced with daunting challenges in shifting from subsistence to an agribusiness. Limited access to land, improved agricultural inputs and innovations, poor soils, storage facilities and markets are some of the factors affecting food insecurities and threats to improved livelihoods (Bongo District Assembly, 2014). Moreover, considering the fragility of the community's environment and much dependence on rain-fed agriculture, climate variability is further exacerbating existing woes as manifested in increasing temperatures, erratic rainfall patterns encouraging shifts in farming seasons and introducing new pests and diseases.

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Efforts to increase food production have only encouraged more synthetic fertilizer and related agrochemicals use, as well as an encroaching desertification from agricultural extensification, which are potential sources of GHGs. Hence, the need for the adoption of improved practices in agriculture which embraces increased food production and reducing its environmental footprint concomitantly (Beddington *et al*. 2012). Sustainable agriculture and now climate smart agriculture have been identified as the way forward in achieving this goal. Nonetheless, successful adoption of CSA practices in the study area in future will be dependent on the level of knowledge network among institutions and with farmers, (Agrawal, 2008) as climate change continuously exposes their vulnerability. Also Dethier & Effenberger (2012) are of the view that, though research and development as well as extension service are important, getting institutions right is of much importance for growth and a priority on the agricultural development agenda. There are several institutions, civil society organisations, both public and private institutions and other stakeholders in the region playing different roles at multi-stages in assisting smallholder farmers in various aspects of coping strategies and livelihood improvement. Yet what is not known is how far their activities have improved livelihoods of smallholder farmers in Anafobiisi and Gowrie-Kunkua communities with the climate change insurgence. The study, therefore, seeks to address the following research questions:

1. What current local CSA practices are being adopted by rural small-scale farmers and how do they perceive such practices?
2. What existing factors promote or inhibit the adoption of CSA practices?
3. What institutional arrangements are available to promote the transition to CSA at the smallholder level?

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4. To what extent is CSA practices influence livelihoods of rural small scale farmers?

1.3 Objectives of the study

The overarching objective of this research is to document local CSA practices adopted by smallholder farmers in Anafobiisi and Gowrie-Kunkua and how institutions can facilitate its successful adoption to promote improved rural livelihoods.

Specifically, this research aims at achieving the following objectives:

(i) To identify existing climate smart agriculture practices adopted by smallholder farmers in Anafobiisi and Gowrie-Kunkua.

(ii) To determine likely factors that may promote or militate adoption of CSA practices.

(iii) To evaluate existing local level institutions and their role in facilitating the adoption of CSA practices.

(iv) Assess the effects of CSA practices on smallholder farmer's livelihoods.

1.4 Relevance of the study

Climate smart agriculture has been stipulated to be a "unifying concept on climate change and agriculture" (Naess, 2011). Not only does it increase productivity, but it strategically positions farmers to build resilience and concomitantly mitigates GHGs with goals to improve food security and national development, notably among developing countries. However, CSA goes beyond the provisions of improved seeds to farmers or the conventional practices of institutions been reactive to situations than been proactive- often the kind of assistance given to smallholder farmers in the region. CSA calls for proactive and smart institutions to manage current and future climate risks likely to be experienced by

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smallholders, or assist smallholders in taking advantage of opportunities that climate change may present. For instance, successful adoption of CSA by smallholder farmers in Anfobiisi and Gowrie-Kunkua communities will require institutions to induce innovations which will boost food security, provide information and also assist them access storage facilities, markets and inputs. However, this still remains a challenge in the study area.

Despite the immensity of the problem, very little research has been carried out within that scope in Anafobiisi and Gowrie-Kunkua communities. Thus, this study seeks to generate useful information that could be used in developing an effective policy to promote sustainable agriculture in the district and beyond.

1.5 Definition of Concepts

1.5.1 Smallholder farmer

A Smallholder farmer is characterised by a farmer who has (a) small subsistence farms of less than 2 ha, (b) time and labour intensive with much dependence on family, and (c) have low asset base (The World Bank, 2003; Lipton, 2005; Nagayets, 2005; Hazell, Poulton, Wiggins & Dorward, 2007; MoFA, 2007).

1.5.2 Climate Change and Variability

Climate change refers to a change in the state of the climate that can be identified (eg. Using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer (IPCC, 2007).

Climate Variability

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Climate variability refers to variations in the mean state and other statistics (such as standard deviations, statistics of extremes, etc) of the climate on all temporal and spatial scales beyond that of individual weather events (IPCC, 2007).

1.5.3 Climate Smart Agriculture

Climate Smart agriculture is any agriculture practice that sustainably increase food production, build resilience to climate change (adaptation), reduces/removes greenhouse gases (mitigation) and enhance the achievement of national food security and development goals (FAO, 2010).

1.5.4 Institutions

Institutions are systems of established and embedded social rules that structure social interactions (Hodgson, 2006).

1.5.5 Sustainable Livelihoods

Sustainable livelihoods comprises the 'capabilities, assets (including both material and social resources) for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base' (DfID, 1999).

1.6 Scope of Study

Geographically, the study was carried out in two communities (Anafobiisi and Gowrie-Kunkua) in the Bongo district of the Upper East Region. These areas were chosen because of the existence of food insecurity, compounded by environmental and socio-economic stress. Distance however played an important factor in selecting these two communities, in reducing research stress, coupled with the presence of an existing project in these two communities,

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initiated by Navrongo-Bolgatanga Catholic Diocese, (NABOCADO) Bongo office which seeks to promote sustainable agriculture practices and natural resource conservation constituting components of CSA practices. Contextually, the study focused on smallholder farmers who at the same time were beneficiaries to this project to unearth their perception about some of the sustainable land management (SLM) practices introduced to them. The study also focused on institutions within Bolgatanga Municipal and Bongo district to assess their roles in facilitating CSA adoption among smallholder farmers.

1.7 Chapter Organization

The research work is presented in six chapters. Chapter One presents the background, which highlights issues surrounding smallholder farmers systems and climate change. It also highlights the significance of the study in the Bongo district. Chapter Two examines existing literature on climate smart agriculture which includes concepts, activities and processes involved in adopting climate smart agriculture practices. In Chapter Three I provided the detailed description of the study area and the methodology employed in collecting data from the field and other secondary related data. The results are presented in Chapter Four while discussion of the results is presented in Chapter Five. The last chapter, Chapter Six provides the summary of the study, conclusion and policy recommendation.

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CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter explores literature on smallholder farmers and climate smart agriculture adoption. It examines key concepts and examples of smallholder farming systems, climate smart agriculture practices and institutional roles in facilitating the adoption of CSA by smallholder farmers. It concludes with a summary of the conceptual framework that guides the research.

2.2 Defining Smallholder Farming Systems

Definition of smallholder farming systems by different authors have always brought about ambiguities which pose challenges in addressing the specific needs of smallholder farmers. Despite the controversies surrounding the acceptable definition, the commonest definition has always been associated with size, since it varies across several geographical regions, (Nagayets, 2005). For instance, studies have shown that smallholder farmers in sub-Saharan Africa occupy operational landholdings of 2 ha or less, while in South Asia and Latin America, they occupy average landholdings of 1.6 ha and 10 ha respectively, (Narayanan & Gulati, 2002; Conway, 2011). Risks conditions and resources may also vary across small holder farmers in different geographical regions, undermining the use of values or size to define smallholder farming systems. It is argued that sometimes ‘a small piece of irrigated peri-urban land, suitable for vegetable farming or herb gardening, has a higher profit potential than 500 hectares of low quality land in the Karoo in South Africa’ (Kirsten & van Zyl, 1998). Similarly, von Braun (2005) justifies that two farmers having the same size of

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farms cannot be meaningfully compared, especially in a situation where one cultivates high value crops and has access to markets and the other produces staple crops for consumption. Thus, for better understanding and for policy implications, other authors have conceptualized smallholder farming systems to include (a) small subsistence farms, (b) time and labour intensive with much dependence on family, and (c) low asset base (The World Bank, 2003; Lipton, 2005; Hazell *et al*., 2007).

In the same light, defining smallholder farming systems in Ghana have demonstrated varied opinions by different authors. Ghana's Food and Agriculture Sector Development Policy, FASDEP II, states that agriculture in Ghana is dominated by smallholder farming systems and it is characterised by landholdings of 2 ha coupled with the use of crude technologies to produce a greater percentage (80%) of the country's agriculture output. Chamberlin (2007) however posits that indeed, smallholders form a chunk of Ghana's rural economy and operates less than 3 ha with regional disparities across the country. Further analysis by Chamberlin indicates that Southern Ghana has an average landholding size less than a hectare, while Northern Ghana is dominated by larger landholdings with Upper East region been one of the regions with greater concentration of smallholders. Paradoxically, the prevalence of larger holding size in Northern Ghana has not translated into higher outputs due to factors not limited to poor soils, type of crops grown, labour constraints, rudimentary technologies or climatic factors. In cases where farmers are able to increase productivity, they are challenged by storage facilities and market access. More of smallholders in the South have taken advantage of the bimodal rainfall pattern, extension services and market access to grow both high value crops and staple crops for consumption and sale, improving livelihoods than their counterparts in the North. This, Al-hassan & Diao (2007) asserts that,

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the growth of high value crops backed by improved policies have contributed to the developmental gap between the North and the South, where Northern Ghana lags behind.

Generally, it is estimated that there are about 570 million farms in the world of which 72% have farm sizes that are less than a hectare, with only a percentage covering farm sizes of 10-20 ha, (FAO, 2014). Farm sizes are however gradually decreasing due rapid population growth with other competing needs for land use (Lowder, Skoet, & Singh, 2014). Thus, for the purpose of these study, smallholder farmers encompasses resource poor farmers operating on a holding less than 2 ha and depend on household members for most of the labour.

2.3 Smallholder Farmers and Food Security

Food security exist when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy lives, (FAO, 1996). It is estimated that two-thirds of the total population of 3 billion people in developing countries dwell on rural farms, deriving their livelihoods from agriculture Lipton (2005). At the same time, these are areas sagged by poverty, though some geographical disparities exist. They also include the majority of people suffering from chronic hunger, with much prevalence persisting in Africa FAO (2014), which undermines their source of livelihoods and threatens food security.

Smallholder farmers also face the challenge of increasing productivity to provide food security for the projected human population of 9 billion by 2050 while preserving their natural resource base. However, much of these growth is estimated to spur from regions where small holder farmers dominate – developing countries. Their quest to increase production are challenged by a lot of factors including:

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- Production Constraints: which includes much dependence on rain-fed agriculture, the use of rudimentary technologies to increase productivity and unsustainable agricultural practices which reduces soil fertility and exposes soil to erosion, hence low yields.
- Comprehensive land policy: For instance, the poor and the marginalised who are mostly women farmers, lack access to land or land-use rights. Moreover, rapid urbanization in developing countries and land grabs are gradually reducing areas available for agriculture.
- Lack of investments: smallholders are not able to sustainably increase productivity due to lower marginal returns from sales, high cost of inputs and the difficulty in accessing services (including markets, improved technologies and information, extension services, storage facilities) and credit.
- Environmental constraints: unsustainable farming practices have led to land degradation and water pollution which do not support crop growth and livestock rearing. More importantly, climate change impacts are reducing crop and livestock productivity (Haile, 2005; Thapa, 2009; Dioula, Deret, Morel, & Kiaya, 2013).

The situation is however not different from smallholders in Ghana and land sizes tend to decrease due to rapid population growth and competing land uses. Food insecurity and poverty has continued to be a major developmental challenge of northern Ghana, particularly Upper East region, (Al-hassan & Diao, 2007). Nonetheless, smallholders' contributions to global food demand cannot be overemphasized. It is estimated that globally, 50% of the world's cereals, 60% of the world's meat and 75% of the world's dairy products are provided by smallholder farmers, (Herrero *et al*., 2010). Although smallholders in India cultivate only

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44% of land, they are able to provide more than 50% of the total farm output (Thapa, 2009). Just like India, smallholder farmers in Ghana have also made significant contribution to national food security, as they supply both rural and urban food needs and contribute to national incomes of their individual countries.

Generally, the ability of smallholders to produce and to meet the food demands is seriously hampered by climate change. Thus, improving the resilience of small holder agricultural systems is essential for climate change adaptation and an ensured food secured world.

2.4 Climate Change and Smallholder Farmers

Climate change refers to a change in the state of the climate that can be identified (eg. Using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer (IPCC, 2014).

It is however attributable to both natural and anthropogenic causes increasing the concentration of greenhouse gases in the atmosphere. Gases responsible for the greenhouse effect are termed greenhouse gases and they allow the passage of the sun's radiation (visible light) but absorb reradiated heat (infrared) energy emitted from the earth and these gases occur naturally. Pidwirny (2006) contends that, these greenhouse gases are able to change the energy balance of the planet by absorbing long wave radiation emitted from the earth's surface and without it, life on the planet would probably not exist as the average temperature of the earth would be colder (-18^{o}C). In effect, greenhouse gases stabilize incoming energy of the sun and outgoing energy of the earth to make all life forms conducive.

Though caused by both anthropogenic and natural causes, anthropogenic activities have been strongly blamed for the increase in greenhouse gas concentration in the atmosphere which by

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far exceeds normal levels, causing global warming and subsequently climate change, (IPCC, 2007; Hansen & Sato, 2013; Wang, 2013). Anthropogenic causes of climate change is attributed to industrial processes which includes burning of fossil fuels for energy and transportation, agriculture systems and deforestation, (Pidwirny, 2006; Hansen & Sato, 2013; IPCC, 2014).

Globally, climate change is expected to cause the increase in the frequency and intensity of climatic events such as floods, droughts, cyclones, hurricanes and typhoons and such events will impact on socio-economic sectors including agriculture, water, energy and health, with increases in relatively small averages of temperature (Bates, Kundzewicz, Wu, & Palutikof, 2008; IPCC, 2014; UNFCCC, 2007). There are no doubts that climate change and variability is manifesting in Ghana. The primary feature of Ghana's climate is the alternate wet and dry season influenced by the Inter-tropical Climate Zone and the Monsoon winds. The country has over the years experienced increasing temperatures, rising sea levels, erratic rainfalls leading to floods and droughts, (EPA, 2011; Nelson & Agbey, 2005; Stanturf *et al*., 2011) affecting the livelihoods of many smallholder farmers.

Climate change and food security constitutes one of the greatest problems the world battles today, as climate change makes more visible the vulnerabilities of smallholder farmers and leaving a lot more people food insecure. Climate change is expected to impact agriculture through diverse means including: increasing temperatures, declining and erratic rainfall patterns, sea level rise inundating agricultural lands and introduction of new pest and diseases (IPCC, 2007). However, in Northern Ghana including Anafobiisi and Gowrie-Kunkua, climate variability is manifested through rising temperatures, shifts in rainfall season and introduction of new pest and diseases.

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Developing countries are expected to be more vulnerable to climate change due to their much dependence on rain- fed agriculture and productivity is expected to reduce up to 50% in Africa by the year 2020 due to increasing temperatures, (IPCC, 2014; Parry, Rosenzweig, Iglesias, Livermore, & Fischer, 2004). At the same time, there are increasing awareness of agriculture's contributions to GHGs in the atmosphere and increasing productivity to achieve food security in developing countries is projected to entail significant amounts of GHGs emissions, (FAO, 2009; IPCC, 2014; Smith *et al*., 2007). Thus, there is the need for agricultural systems to increase productivity, at the same time mitigate GHGs and this can be achieved through concerted efforts towards maximising synergies and minimising trade-offs between productivity and mitigation. Hence the adoption of climate smart agriculture, which would be discussed extensively in the next session.

2.5 The Concept of Climate Smart Agriculture

The impacts of changes in climate are often felt more by smallholders as they are already coping on degraded lands and lack the knowledge and capacities to adapt their production systems to climate change and variability (FAO, 2013a; Yaro, 2010). At the same time, increase in productions system among smallholders is projected to entail significant increase in emissions of GHGs (IPCC, 2014). This has necessitated the urgency to reduce concentrations of GHGs from the atmosphere and agriculture's vulnerability to changing climates. Enhancing food security while reducing ecological footprints of production systems will require sustainable approaches to agriculture (Smith *et al*., 2008; Beddington *et al*., 2012). Hence, the adoption of CSA as a "unifying concept on climate change and agriculture" (Naess 2011).

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CSA has its mandate to sustainably increase food production, build resilience to climate change (adaptation), reduces/removes greenhouse gases (mitigation) and enhance the achievement of national food security and development goals (FAO, 2010b). In another definition, CSA includes programmes that;

i. Support the livelihoods of smallholder farmers and build prosperity.
ii. Produce food farmers and consumer's needs.
iii. Improves people's nutrition, especially that of women and children.
iv. Help farmers adapt to existing and future climate risks.
v. Sustains the health of the land and increases its productivity
vi. Avoid loss of forest and biodiversity and
vii. Store carbon in the soil and reduce emissions of greenhouse gas from agriculture, (DfID, 2012).

CSA is however not a new phenomenon, it is only a new concept used to address climate change and agriculture but embodies existing strategies and sustainable land practices that can help achieve the 'triple wins' for food security, adaptation and mitigation, (FAO, 2010; Naess 2011). It also includes sustainable practices in fishery and aquaculture but for the purpose of this work, it is limited to sustainable practices in food crop production and livestock rearing. Many of the sustainable land management, SLM practices are noted for sequestering carbon and boosting farming systems' resilience to shocks, stresses and climatic risk, (McCarthy, Lipper & Branca, 2011). Moreover, it improves soil fertility, yields, soil moisture and soil water holding capacity by reducing runoff and erosion (Branca, Mccarthy, Lipper, & Jolejole, 2011). It however includes practices not limited to conservation agriculture, agroforestry, integrated livestock management and conservation watershed

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management (Grainger-Jones, 2011; McCarthy & Brubarker, 2014; Neufeldt et al., 2013). CSA interventions in climate smart villages are also classified to include; weather smart, water, carbon, nitrogen, energy and knowledge smartness (Aggarwal et al., 2013). Details of what these interventions entail are summarised in table 2.0.

Nonetheless, critics of CSA questions the sustainability of payments made to farmers from carbon markets Naess (2011) while others posit the uncertainties surrounding the impact of no-till on crop yields and carbon sequestration (Gattinger, Jawtusch, Muller & Maeder, 2011). Another issue of concern is the controversy surrounding off-setting of carbon on a less than 2 hectare farm, since most African farmers are smallholders operating on that scale, (Maryknoll, 2012). Literally, a less than 2 hectare cannot sequester a significant amount of carbon for sale. Thus, many are of the view that the concept of CSA is just a way of shifting the responsibility of mitigation from the global north to particularly, smallholder farmers of the global south (Maryknoll, 2012).

Yet, advocates of CSA are of the view that, considering the multifaceted impacts of climate change on agriculture, the adoption of CSA will require an integrated approach and coordination across all sectors linked with agriculture to maximise productivity and minimise trade-offs among other sectors. Moreover, CSA approaches should be seen as context and site- specific and may not apply to all agro-ecological regions, therefore the need for local level assessment to ascertain suitable approaches (FAO, 2013a; Peterson, 2014).

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Table 2.1 Climate smart village intervention

Weather Smart	Water Smart	Carbon Smart	Nitrogen Smart	Energy Smart	Knowledge Smart
Weather forecast ICT-based agro-advisories Index-based insurances Climate analogues	Aquifer recharge Rainwater harvesting Community management of water Laser levelling On-farm water management	Agroforestry Conservation tillage Land-use system Livestock management	Site-specific nutrient management Precision Fertilizers Catch cropping/Legumes	Biofuels Fuel efficient engines Residue management Minimum tillage	Farmer-to-farmer learning Community seed and fodder banks Market information Off-farm risk management

Source: Adapted from Aggarwal, Zougmoré & Kinyangi *(*2013).

2.6 Extent of CSA Adoption in Developing Countries

There are a number of sustainable agricultural practices adopted worldwide that have demonstrated greater potentials in improving food security, adapting to climate change and/or concomitantly mitigating GHGs. Though not exhaustive, for instance, a farmer managed natural regeneration, (FMNR) project under the Maradi Integrated Development Project, (MIDP) in the Maradi region of Niger which was near desertification has restored more than 5 million ha of land with over 200 million trees planted (Neate 2013). This has

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contributed to the production of an additional half a million tonnes of grains each year and enough fodder to support many livestock. It is also estimated to have improved the food security of about 2.5 million people in Niger and its neighbouring countries. Moreover, it is expected to contribute to climate change mitigation by sequestering greater amounts carbon (Neate, 2013).

Similarly, between 200,000 and 300,000 ha of degraded lands have been rehabilitated in the Sahel region through the construction of stone bunds on natural contour lines. Also, complementing stone bunds with planting trees, grass, hedges and in some cases, the use of organic mulch or the use of 'Zai' pits have been documented to reduce rainfall runoff, improve soil fertility and at the same time, increase crop yields. For example, both Burkina Faso and Niger are reported to have increases in cereal yields through widespread adoption of stone bunds on contour lines (Cooper *et al*., 2013).

Moreover, Malawi has been recorded to be one of drought-prone countries in Africa which has greatly had a toll on food security in the country. Thus, a weather-based insurance has been introduced to farmers in Malawi to stabilise income streams, improve people's livelihoods by hedging against risk and access to finance (Hess & Syroka, 2005). The weather-based insurance instrument pays out in events that are triggered by a publicly observable index. Hence, the adoption of weather based insurance scheme is estimated to enhance food security in Malawi (Giné, 2009; Hess & Syroka, 2005).

India has developed similar projects as well. For instance, during a pilot study in 2003, ICIC Lombard reinsured the risk of 230 farmers in groundnut and castor-bean who bought the insurance with one of the major reinsurance companies in BASIX; a Hyderabad-based group of companies with a mission to promote a large number of sustainable livelihoods, including

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the rural poor and women, through the promotion of financial services and technical assistance in an integrated manner (Manuamorn, 2007).

In Ghana, Lee (2012) has identified a number of ongoing project including the Climate Steward program by Rocha Ghana. The project has multiple goals of contributing to climate mitigation, livelihood improvement and biodiversity through planting native tree species. The young trees planted will maximises land use, provide extra food and income for farmers while as the trees grow larger, they can be pruned for firewood or cut for timber since their shades may prevent the needed sunlight for crop growth. Trees planted will also sequester carbon.

2.7 Institutions and CSA Adoption

Case studies across the globe and more especially in developing countries have demonstrated that the cost and finance associated with the adoption of new practices, land tenure rights, farmers' age, poor incentives, educational level, gender, climate, shortages of labour and water are some of the factors influencing the level of adoption of new practices among farmers (Deressa *et al*., 2009; FAO, 2013b; Lee, 2012; Wollenberg *et al*., 2012). Moreover, the adoption of CSA practices will require new approaches and techniques in transforming agricultural systems to concomitantly increase food security, build resilience and mitigate climate change to which smallholders lack the capacity to develop them. For instance, these new approaches include the adoption of SLM practices complemented by dissemination of useful information within a climate lens context. Nonetheless, the successful adoption and development of all these factors however will hinge on the level of institutional involvement, (Dethier & Effenberger, 2012; FAO, 2013a; Meinzen-Dick, Bernier, & Haglund, 2013; Scherr, Shames, & Friedman, 2012).

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Thus, for the purpose of this discussion, "institutions are systems of established and embedded social rules that structure social interactions" (Hodgson, 2006). This definition however integrates both formal and informal systems and encompasses organisations, social and cultural norms as well as conventions which enhances smallholders' decisions to successfully and sustainably adopt CSA practices. On the local level, institutions relevant to adaptation includes;

- Local public institutions which constitutes local governments, local agencies (for example, extension service and other arms of higher levels of government operating at local level)
- Civil society institutions also involves rural producer organizations, cooperatives saving and loans and thirdly,
- Private institutions which includes service organizations such as NGOs and charities, private business that provide insurance or loans, (Agrawal, 2008).

The importance of institutions are demonstrated in their ability to develop innovations to adapt to changing climates (Amaru & Chhetri, 2013; Chhetri *et al*., 2012; Rodima-Taylor, Olwig, & Chhetri, 2012), links to accessing mitigation finance for smallholder farmers, (Mccarthy, Lipper, & Branca, 2011) and at the local level, they play instrumental roles in the area of information gathering and dissemination, resource mobilization and allocation, skill development and capacity building, providing leaderships and networking with other decision makers and institutions (Agrawal, 2008) as well as interventions that improves sustainable livelihood outcomes (Scoones, 1998). Understanding the importance of institutions and more importantly local level institution is crucial to achieving climate change adaptation as well building capacities of vulnerable groups since adaptation strategies are

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often local. Nonetheless, for the successful adoption of CSA practices, four key institutional functions have been identified and summarised to include;

- The need for institutions to provide information on changing climatic conditions and response actions/adaptation strategies.
- Developing new or enhancing existing innovations and disseminating new practices and technology.
- Investing in physical infrastructure and/or capacity building.
- Lastly, providing insurance to cope with risk in instances of climate risks and risk associated with adopting new practices (Meinzen-Dick, Bernier & Haglund, 2013).

Moreover, a number of concrete examples have demonstrated the importance of institutions in facilitating the adoption of new innovations and practices in building resilience to climatic impacts and in some cases, paying smallholder farmers from carbon markets for adopting practices that enhances ecosystem services. For instance, In Nepal, rice farmers and their supporting institutions have played instrumental roles in co-producing location-specific climate sensitive technologies such as improved rice varieties and agronomic practices. These have facilitated the adoption of technologies in a more efficient manner and has also improved knowledge network among farmers, scientist and institutions (Chhetri *et al*., 2012).

In another instance, payments are made to smallholder farmers from carbon markets for adopting practices that enhances ecosystem services. For instance, institutional partnerships involving Cooperatives for Assistance for Relief Everywhere (CARE), the World Agroforestry Centre (ICRAF) and the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) and Rockefeller Foundation initiated a project

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called Sustainable Agriculture in a Changing Climate (SACC) in the Nyando River Basin in Western Kenya. The project has not only made payments to poor smallholder farmers from carbon markets for the adoption of agroforestry practices but has also introduced immediate interventions such as early maturing crop varieties, village saving and loan schemes and a lot more to provide short term food security and income as well as improving poor women participation. The project however relies on other local institutions such as the small savings and loan groups, village management committee and other emerging institution for the sustainability of the project (CCAFS and CGIAR 2012a cited in FAO 2013a).

Elsewhere in Niger, local communities have been playing a leading role in the country's development with the support of a Community Action Plan (CAP) of which many of the initiatives implemented have contributed to mitigating climate change and enhancing the resilience of the country's agriculture system to the effects of climate change. For instance, more sustainable land management have been implemented on nearly 9000 ha with a goal of increasing agricultural productivity, vegetative cover and carbon sequestration and as well reducing water erosion on 88% of sites. The project will also support social protection measures such as cash transfers, seasonal labour-intensive public work programmes and safety nets for the most vulnerable. This project is however financed by World Bank, Global Environmental Facility, GEF and International Fund for Agricultural Development (IFAD) and with the support of local institutions and community members for the sustainability of the project (Neate, 2013)

Thus, the importance of institutions cannot be overemphasized, since it goes beyond providing support and linkages to other services to inducing attitudinal transformation of

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smallholder farmers in turning away from farming practices and strategies which are not climate resilient.

2.8 Smallholder Farming and Sustainable Livelihood Outcomes

The concept of sustainable livelihood approach is gaining increasing popularity as the dominant approach to implementing development interventions among a number of international agencies. The concept's first appearance in literature dates back to the Brundtland Commission Report of 1987 on sustainable development and later evolved and crystallised as a concept through the works of Chambers & Conway (1991) cited in Solesbury (2003). They posit that 'a livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living: a livelihood is sustainable if it can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets and provide sustainable livelihood opportunities for the next generation' (Chambers & Conway, 1991). In another simplified definition and for the purpose of this research, sustainable livelihoods comprises the 'capabilities, assets (including both material and social resources) for a means of living.

There are several types of sustainable livelihood frameworks developed by international organizations which includes but are not limited to United Nations Development Programme (UNDP), Cooperative for Assistance and Relief Everywhere (CARE), Oxford Community for Famine Relief (OXFAM0, International Fund for Agricultural development (IFAD) and Department for International Development (DfID) livelihood frameworks. Though their similarities far outweighs their differences, DfiD livelihood framework is preferred for this research. It is holistic, people centred, builds on the strength of vulnerable people rather than focusing on their weakness. It also focuses on multilevel partnerships, imbibes as well as

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integrates all dimension of sustainable development (social, economic, institutional and ecological), (Carney *et al*., 1999).

The DfID livelihood framework pinpoints that the interactions between the various livelihood assets which includes human, financial, natural, physical and social resources are the basis for which livelihoods are constructed. However, these assets can directly or indirectly be impacted by shocks, trends or seasonality (vulnerability context) which shapes livelihood outcomes of vulnerable groups which includes smallholder farmers. Smallholder farmers are continuously threatened by climate change and variability, health and economic shocks, population growth and other developments minimising farm sizes for production, which impedes improved livelihood outcomes. Thus, there is a need for a thorough risk assessment to identify likely risks that can impede on improved livelihoods, since most vulnerable groups often lack the capacity to cope or build resilience to shocks. Moreover, since the factors that often impede improved livelihoods are beyond their control, there is a need for the development of institutions playing pivotal roles in addressing their needs. Under the framework, 'transforming structures and processes' is used in replace of institutions. Transforming structures and processes extends throughout the whole framework, they could cushion a vulnerable groups (which includes smallholder farmers) during an external shock such as climate change, influence accessibility to various livelihood assets or shape livelihood outcomes such as more ncome, increased wellbeing, reduced vulnerability, improved food security and more sustainable use of natural resources (see Figure 2.1).

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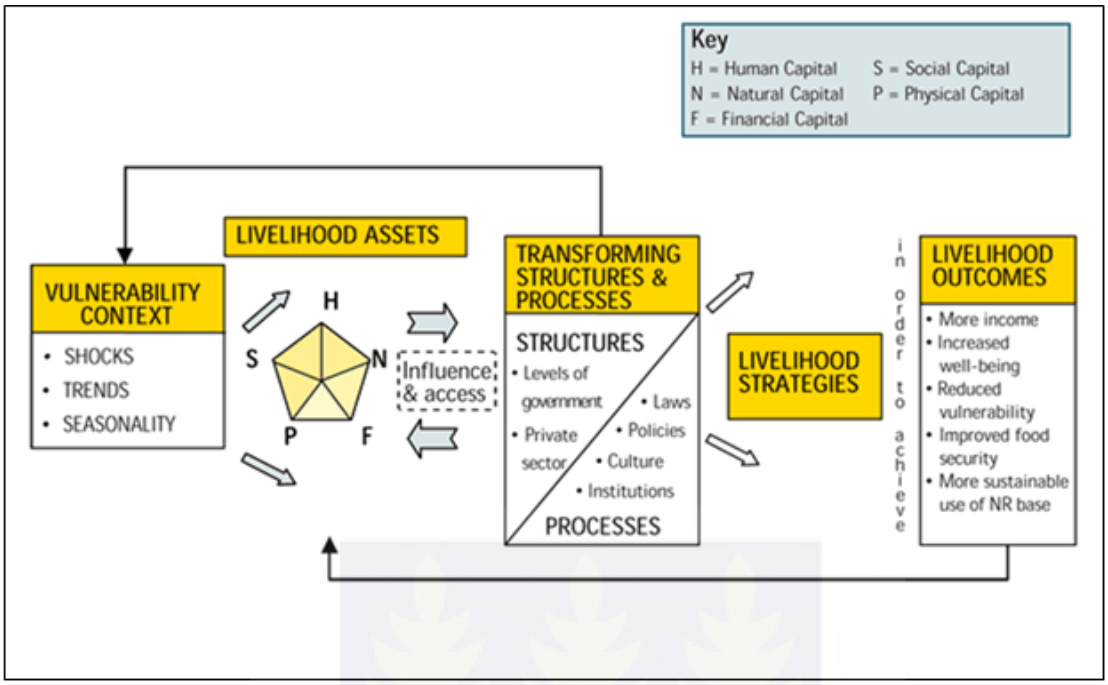

Figure 2.1: DfID Livelihood Framework, Source: Adopted from DfID, 1999.

Nonetheless, Smallholder farming has contributed to livelihood development of many people, (Lipton, 2005) and global food security (Herrero *et al*., 2010) through coordinated and collaborative roles of institutions (Agrawal, 2008).

2.9 Conceptual Framework for the Study

Figure 2.2 provides a schematic representation of climate through its manifestations such as increasing temperature, erratic rainfall patterns-causing shifts in farming seasons and introduction to new pest and diseases will have devastating effects on agriculture affecting food security. Concomitantly, studies have shown that agriculture through its activities such as manure management, enteric fermentation from livestock, deforestation as a result of extensification and the use of other synthetic agrochemicals which are sources of GHGs contributes to climate change, (Smith *et al*., 2007).

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Thus, CSA has been identified as the unifying concept between climate change and agriculture (Naess, 2011). As defined by (FAO, 2013a), CSA "sustainably increases productivity, builds resilience, reduces/removes GHGs while enhancing the achievement of national food security and developmental goals". Its adoption is place/context-specific, and in attaining its desired impact on global agricultural development, there will be a need to establish a local level assessment to ascertain its suitability. However, the adoption of CSA practices just like any other farm practice across the globe is contingent on several factors including: farmers land tenure status, farm size, gender, age, wealth, educational level and membership in agricultural organization, (Deressa *et al*., 2009). Moreover, Below *et al*., (2012) asserts that farmers adoption rates also depends on awareness of the new practice, willingness on the part of the farmer to adopt them and the outstanding benefits of adopting such practices.

Nonetheless, overcoming barriers to successful adoption of CSA practices and adaptation to climate change hinges on developing or enhancing existing institutions and fostering partnership between public and private institutions, (Agrawal, 2008; Dethier & Effenberger, 2012), which forms the basis of this research. There are several institutions in both Bolgatanga Municipal and Bongo district playing different roles in assisting smallholder farmers, but what is not known is how well they are functioning to improve livelihoods of these farmers.

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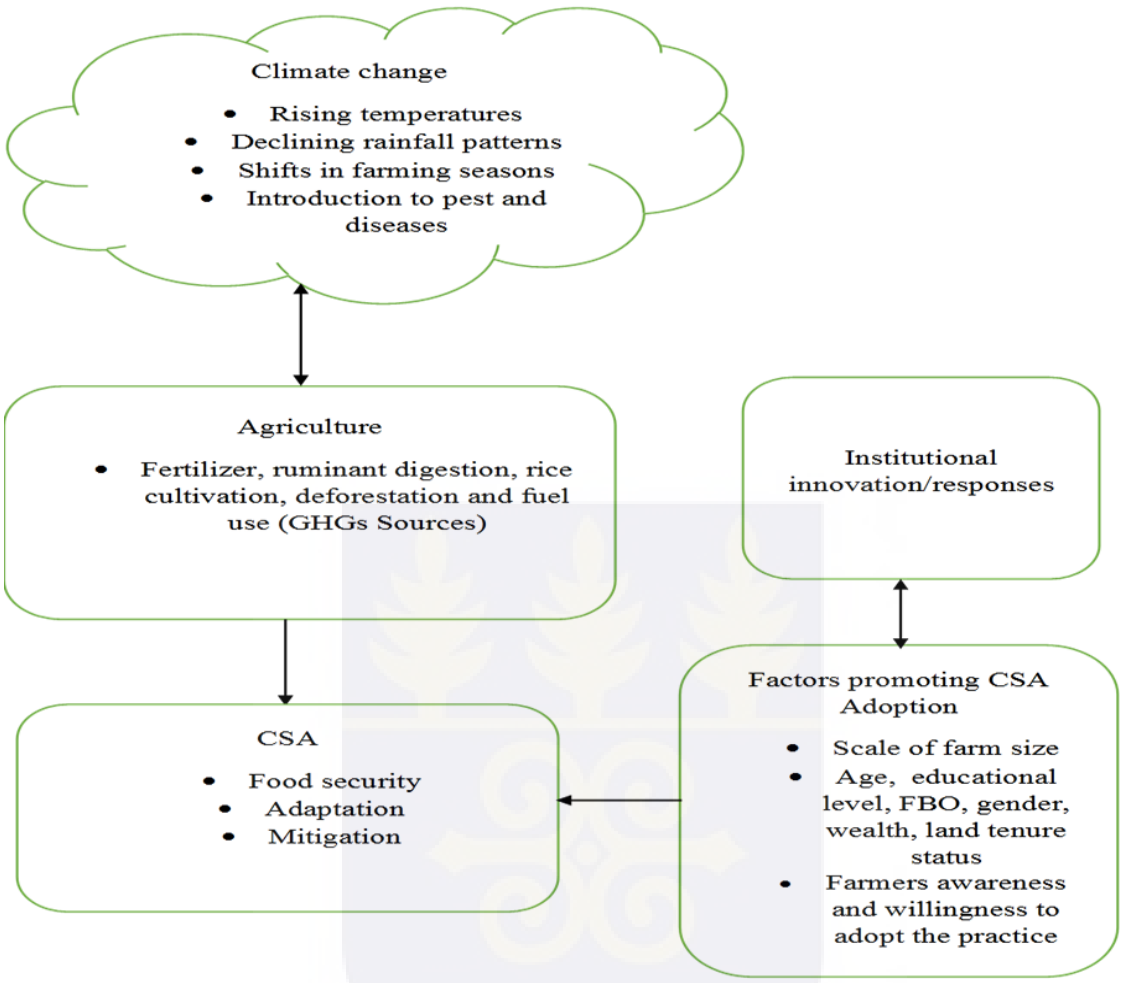

Figure 2.2: Conceptual framework of the study,

Source: Author's Construct

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CHAPTER THREE

STUDY AREA AND METHODOLOGY

3.1 Introduction

This section presents a brief description of the study area. It provides a description of the research design and methods that were employed in data collections and concludes by presenting the data sources and how data obtained was analysed.

3.2 Description of Study Area

3.2.1 Location and Size

The study was carried out in two communities, Anafobiisi and Gowrie-Kunkua in the Bongo district of the Upper East Region of Ghana. The Bongo district is located between longitude 0^o and 1^o West and latitudes 10^o 30'N and 11^o N and bordered to the north by Burkina Faso, to the east by Nabdam district, to the west by Kasena-Nankana district and to the south by Bolgatanga Municipality. The land is relatively flat with a few hills to the East and southeast. It covers a total land area of 459.5 square kilometres (Bongo District Assembly, 2014). Figure 3.1 shows a map of Ghana, Bongo district and the location of Anafobiisi and Gowrie-Kunkua communities. The two communities were purposively selected because of an ongoing project initiated by the Navrongo-Bolgatanga Catholic Diocese (NABOCADO) in Anafobiisi to promote sustainable agricultural practices and natural resource conservation.

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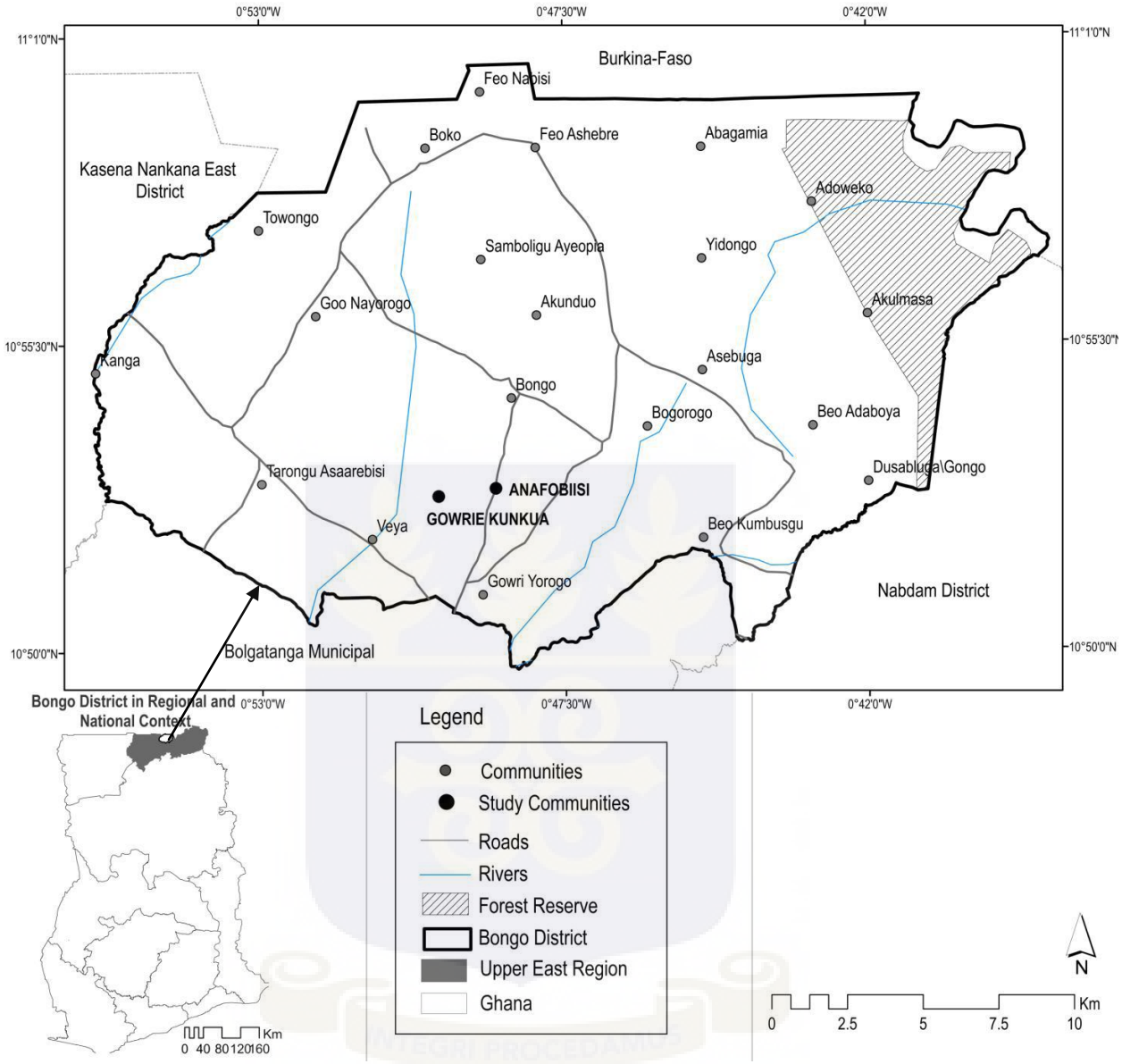

Figure 3.1: Map of Bongo district showing Anafobiisi and Gowrie-Kunkua communities (*Author's Construct, January, 2015*)

3.2.2 Topography and Drainage of Study Area

The Bongo district including the study areas are dominated by outcrops of igneous rocks making farming activities difficult to carry out. It is estimated that the rocks cover about 40% of the districts land surfaces thereby reducing landholding sizes and affecting farming

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activities and agriculture productivity as well (Bongo District Assembly, 2014). Moreover, the occurrences of sheet and gully erosion in the study area have affected food crop production as fertile soils are carried away and exposing the communities to desertification (Bongo District Assembly, 2014).

However, Gowrie-Kunkua is drained by the Vea Dam, which encourages dry season farming. Anafobiisi on the other hand has no stream, river or dams, hence, barely practice dry season farming. Ponds and puddles are created in the rainy season but quickly dry up during the dry season. Seasonal drought coupled with insufficient water bodies within the district hamper agricultural productivity, contributing to food insecurity (Bongo District Assembly, 2014).

3.2.3 Soils

The upland soils are mainly developed from granite rocks and consequently are coarse textured, shallow and low in organic matter and therefore low soil fertility. The inland valleys have soils ranging from sandy-loam to salty-clays. They have higher natural fertility but are more difficult to till and are prone to seasonal water-logging and floods (Bongo District Assembly, 2014).

3.2.4 Vegetation

The vegetation consists of a mixture of short deciduous trees, scattered shrubs and grasses. Dominant economic trees in the district includes *Adonsonia digitata* (Boabab), *Vitellaria paradoxa* (Shea), *Azadirata indica* (neem) and *Parkia biglobosa* (Dawada). Other species common in the area are acacia Species which are usually source of feed for livestock (Bongo District Assembly, 2014).

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3.2.5 Climate

The climate of Bongo District is characterised by a uni-modal rainfall pattern which begins in June and ends in October with a long term mean annual rainfall of about 900 mm. Mean daily maximum temperatures could be as high as 45^{o}C in March and as low as 15^{o}C in December as a result of cold dry winds from the Sahara region (Blench, 2006). Mean monthly temperature is about 25^{o}C. Relative humidity figures are usually high in the rainy season (>92%) and low (15%) in the dry harmattan period from November to March (Bongo District Assembly, 2014).

3.2.6 Livestock

The District has the potential to support commercial livestock production by virtue of the large expanse of grass land bordering the Nabdam and Burkina Faso. Production of indigenous chicken especially the guinea fowl, the local fowls, and ruminant production are also on the ascendancy (Bongo District Assembly, 2014).

3.2.5 Land tenure Systems

Portions of the lands are under the custody of the 'Tindanas' (original custodians) while the rest are communally owned. Land use rights are inherited via the patrilineal system and more often, the male children have access and control of the land use. Women get access to land only through allocations made to them by their husbands. However, this is done after considerations that there would be no shortage of farm land during the farming season when the woman is cropping her own farm. Widows with sons are usually permitted to keep land their husbands possessed and farm it until their sons are old enough to farm. In such case the land passes automatically to the children (Bongo District Assembly, 2014). Thus, lack of

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access and control of land can impede agricultural development, since women are known to supply a large proportion of agricultural food crops (FAO, 2007).

3.3 Sources of Data

To successfully implement this research, data on CSA practices adopted and institutional support to smallholder farmers in Anafobiisi community were obtained both from secondary and primary sources;

3.4.1 Primary Data

Primary data was obtained from reconnaissance survey, semi-structured questionnaires and participatory focus group.

3.4.2 Secondary Data

Secondary data was accessed through books, articles, conference papers, dissertations as well as web reports to review literature. Searches were refined to key words such as "smallholder farmers", "climate smart agriculture practices", "institutions and climate change" as well as "sustainable livelihood frameworks". Secondary data on the district profile was also obtained from Bongo District Assembly to give a vivid description about the study site.

3.5 Research Design

In identifying local CSA practices adopted by smallholder farmers and their perception about such practices, an exploratory and descriptive designs were used. This is built on the assertion that exploratory, descriptive or causative depicts the design of any research (Burns and Bush, 2002; De Vaus, 2001). It was assumed that, farmers may be familiar with a particular agricultural practice but may not necessarily associate it with CSA or understand the concept. Thus, such farming practices were explored to identify the existing CSA

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practices and the benefits for adopting such practices. Similarly, exploratory and descriptive designs were used to discuss actors within the CSA system and all three designs were used to assess the contribution of CSA practices to livelihoods outcomes.

3.6 Research Method

Research method is the systematic procedure of collecting data, analysing and interpreting data that researchers propose for their study (Creswell, 2003). However, in documenting existing local CSA practices and institutional roles in facilitating its adoption among smallholder farmers required an array of data from different sources which makes the adoption of a mixed method important. Mixed method approach involves using both qualitative and quantitative approaches in tandem in a study or collecting and analysing both forms of data in a single study (Creswell, 2003).This method is justified by the goal of triangulation as posited by Denzin (1970) cited in (Bryman, 2004) in achieving an integrated research, and offset biases associated with adopting only quantitative or qualitative methods, (Creswell, 2003). Similarly, Olsen (2004) also asserts that the use of both quantitative and qualitative methods enhances a formal system of reasoning for a broader understanding of the subject matter. To achieve this method, research tools such as a semi-structured questionnaire, participatory focus group discussion were employed.

3.6.1 Reconnaissance Survey

The reconnaissance survey involved a rapid assessment of the study site through observations to know the terrain of the site, as well as obtaining useful information that could enhance the research. It also served as a platform to inform stakeholders of the community the intention to conduct the research in their area.

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3.6.2 Semi-structured Questionnaires

Semi-structured questionnaires for both household and institutional were developed to cover aspects of the objectives of the study. This included the identification of CSA practices adopted by smallholder farmers and factors that promoted or militated the adoption, effects of CSA practices on smallholders' livelihood as well as institutional roles in facilitating CSA adoption among smallholder farmers. Another advantage observed during my data collection was the high response rate through the use of the semi-structured questionnaires. It is semi-structured because it contains both open ended and close ended questions. Open ended questions gave respondents the opportunity to provide their own answers to be filled in the provided space while close ended questions restricted them to choose from the alternative answers provided.

3.6.2.1 Validity and Reliability of the Semi-structured Questionnaires

Validity refers to the correctness of a measurement whereas reliability refers to the consistency of a measurement (Leedy & Ormrod, 2010). They however posit that, both validity and reliability of a measuring instrument influence the extent to which one gets a broader understanding of the phenomenon he/she is studying as well as make useful conclusions of the data acquired. To ensure that the interview guide was valid and reliable, first of all, the questions were developed and drawn to find responses to the specific objectives of the research. The questionnaires were later pretested to ascertain its validity and reliability and the necessary corrections were made.

3.7 Sampling Frame

The sampling frame for the study consisted of smallholder farmers who were beneficiaries in the Natural Resource Management Project (NRMP) initiated by the Navrongo-Bolgatanga

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Catholic Diocesan Development office (NABOCADO), in both Anafobiisi and Gowrie Kunkua communities in the Bongo district. This meant that if one was a smallholder farmer in any of the two communities but not a beneficiary in the project, he/she was not interviewed. This sampling frame was chosen because smallholder farmers within this group (also the only active farmer based association in both communities) had been exposed to some of the sustainable land management practices which are also considered as CSA practices by NABOCADO Bongo office and could therefore help in sharing their experiences in adopting these practices. For this study, adoption refers to the uptake or implementation of any farming practice for at least the last twelve (12) months prior to data collection (Peterson, 2014).

3.8 Sample size and Sampling Technique

The selection of sampling units for the study used purposive sampling for both household survey and institutional interviews while simple random sampling was used for the selection of participants for the focus group discussion. Purposive sampling is described as a non-probability sampling where an informant/respondent is deliberately selected due to some qualities the informant/respondent may possess (Teddlie & Yu, 2007). Tongco (2007) also notes that purposive sampling can be used if time and resources are constraining factors in adopting a random sampling.

In Anafobiisi and Gowrie-Kunkua, the total number of beneficiaries in the NRMP consisted of 801 members of which 51% were women. The 801 beneficiaries in Anafobiisi constituted 81 households out of which 76 households were interviewed. Likewise, in Gowrie-Kunkua, 61 households were identified, out of which 55 households were interviewed. Thus a total of 131 respondents were interviewed in both communities for the household survey. Though

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care was taken to have equal numbers of both males and females respondents, females dominated in responding to the questionnaires, since most men had travelled out of the community to engage themselves in seasonal jobs at the time of the field work. In instances where in a household a husband and a wife are both beneficiaries in the NRMP project, men were preferred to respond to the interview guide. This was done just to increase the response rate of men.

3.8.1 Sampling Technique and Size for Focus Group Discussions

Focus group discussions were held amongst smallholder farmers in Anafobiisi and Gowrie-Kunkua of the Bongo district. Holistically, this was carried out to complement the semi-structured interviews to unearth more information on locally adopted CSA practices, challenges associated with adoption and benefits. Also, the essence of the participatory focus group was to get views of various groups on a gender lens, as well as give participants the opportunities to validate statements made by other discussants.

Simple random sampling was used in generating participants for the focus group discussion. This was done to give each respondent in the accessible population the opportunity of been selected, that is basically to avoid bias (Teddlie & Yu, 2007). Twenty participants were randomly selected from each community (which included 10 men and 10 women) to participate in focus group discussions using Microsoft Excel 2013 version. Male participants had different sessions from the females in the discussions. This was done because, in mixing both genders, women were very unlikely to speak and more males would end up dominating the discussion (Morgan, 1997). This was done by inputting all names of male respondents in Anafobiisi into Excel and the random numbers formula was entered to generate five random

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names without repetitions. The same procedure was done for female respondents in Anafobiisi and the whole procedure repeated in Gowrie-Kunkua.

Male participants had different sessions from the females in the discussions. This was done because, in mixing both genders, women are very unlikely to speak and more males would end up dominating the discussion. This was also done to have varied views and experiences from both male and female participants. Moreover, the essence of selecting 20 participants (*ie*. 10 participants from each community) was to control and comfortably host smaller groups, more often than not, larger groups are difficult to manage and they tend to limit each participants' opportunity to share insights and observation (Morgan, 1997). Discussions were however recorded with permission from respondents. This was done to allow full focus and an easy way of retrieving the exact words of respondents.

3.8.2 Conducting Institutional interviews

Institutions were purposively sampled based on their involvement with smallholder farmers. As much as possible, almost all institutions which provide assistance to smallholder farmers in Bongo district and the region at large were interviewed. However, institutions which were outside Bolga Municipal and Bongo district could not be interviewed because of their distance from the study area and insufficient resources to cover that. Besides, some institutions did not directly or indirectly support smallholder farmers in Bongo, they provided assistance to other smallholder farmers (eg. Presbyterian Agriculture Station in Bawku West District and Action Aid in the Builsa district). In all, representatives from twelve (12) institutions were interviewed, one government institution and eleven non-governmental institutions. They included:

- Ministry of Food and Agriculture, MoFA (Bongo Distrrict office)

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- Navrongo-Bolgatanga Catholic Diocesan Development Office
- United State Agency for International Development – Agriculture Development and Value Chain Enhancement (USAID-ADVANCE)
- Association of Church Development Projects (ACDEP)
- Youth Harvest Foundation
- World Vision International
- Ghana Agriculture Insurance Pool
- Farmer Training Centre
- Anglican Diocesan Development and Relief Organisation (ADDRO)
- Trade Aid
- Trias Ghana
- West Africa Science Service on Climate Change and Adapted Landuse (WASCAL)

3.9 Methods of Data Analysis

Administered semi-structured questionnaires were examined in order to detect and eliminate errors by verifying whether the responded interview guides were complete and accurate. The Statistical Package for Social Sciences, SPSS Version 21 was used for data entry and analysis which included descriptive analysis and test statistics. Microsoft Excel 2013, was used to generate all graphs and pie charts.

Descriptive Statistics

Descriptive statistics was used to determine which local CSA practices were adopted by respondents. The results was presented in tables and charts for meaningful interpretations. Also, it was used to present findings of the likely factors that could influenced the adoption

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of locally available CSA practices. Lastly, it was used to present findings on the livelihood outcomes of smallholder farmers and the role of local level institutions in facilitating the adoption of CSA practices among smallholder farmers.

Chi Square Analysis

To determine which factors were likely to influence the adoption of available local CSA practices, first practices with high response rates were selected and compared using a chi square test. The chi square was done to test whether there were significant difference between a CSA practice and the likely factors that may influence its adoption.

The chi square formula is represented as:

$$\chi_c^2 = \sum \frac{(O_i - E_i)^2}{E_i} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(i)}$$

Where χ^2 = Chi square value

$\sum$= Summation

O_i = Observed value

E_i= Expected value

Thus, the selected CSA practices included Crop Rotation, Composting, Improved Forages and Residue Management. Factors likely to influence the adoption of the selected CSA practices also included sex, age, income, educational levels, household type, household size, access to credit, awareness, access to information and the type of land.

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Binary Logistic Regression Analysis

A binary logistic regression was next performed to examine which of the explanatory factors (sex, age, income, educational levels, household type, household size, access to credit, awareness, access to information and the type of land) were more likely to influence the adoption of the selected CSA practices. The choice of these variables are based on theories and previous empirical findings in literature, (Below *et al*., 2012; Deressa *et al*., 2009; Souza, Cyphers & Phipps, 1993).

The model is specified as

$$\log it\,(Yi) = In\left[\frac{Pi}{1-Pi}\right] = \beta o + \sum \beta i Xi + \mu i \ldots\ldots\ldots\

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2. Food security = food availability at household; the number of times a household consumed a meal. An average of three times daily was expected; otherwise the situation was categorised as insecure.
3. Wellbeing = child's education funded from rural agriculture income
4. Vulnerability = reduction or improved social inclusion or community leadership; membership of a farmer or community associations was measured.
5. Sustainable use of natural resources = perception of farmers of the impact of rural farming, using SLM practices on the physical environment. This was measured with a Likert scale to determine the extent of agreement (DfID, 1999; Egyir & Beinpuo, 2009).

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CHAPTER FOUR

RESULTS

4.1 Introduction

The results of the study are presented in this chapter. The chapter begins with the results of the socio-economic characteristics of sampled households, followed by results of commonly adopted CSA practices including factors that promote or inhibit the adoption of CSA practices. It also highlights livelihood outcomes of respondents and institutional activities which promotes local CSA practices adoption.

4.2 Socio-economic characteristics of the sampled households

This section deals with the gender of respondents, type of household heads, household size, age distribution of household members, and educational status. It also highlights respondents' access to land and household decision making. These characteristics are thought to influence agricultural production and would hence influence the decision to adopt or not to adopt climate smart agricultural practices.

Table 4.1 shows that approximately 73% of the respondents were females and 27% were males.

Table 4.1: Gender of respondents

Gender	Anafobiisi		Gowrie-Kunkua		Total	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Male	19	25	16	29.1	35	26.7
Female	57	75	39	70.9	96	73.3

Source: Survey data, 2015

In Anafobiisi village, 27.6% were within the age groups of 31-35 groups, whereas Gowrie-Kunkua recorded 23.6% of the respondents were within 36-40 age brackets, (see Table 4.4).

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Also, a lower percentage (1.3%) was recorded for ages within 20-25 in Anafobiisi, while a lower percentage (5.5%) was recorded for ages within 51-55 in Gowrie-Kunkua. The mean age for Anafobiisi was 40.49 as against Gowrie-Kunkua recording a mean age of 37.18, indicating younger and vibrant groups who are more likely to adopt CSA practices.

Table 4.2: Age distribution of respondents

Age	Anafobiisi		Gowrie-Kunkua		Total	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
20-25	1	1.3	6	10.9	7	5.3
26-30	3	3.9	7	12.7	10	7.6
31-35	21	27.6	9	16.4	30	22.9
36-40	17	22.4	13	23.6	30	22.9
41-45	12	15.8	10	18.2	22	16.8
46-50	11	14.5	7	12.7	18	13.7
51-55	11	14.5	3	5.5	14	10.7
Mean	40.49		37.18			
Maximum	55		54			
Minimum	24		20			
standard Deviation	7.697		8.671			

Source: Survey data, 2015

The heads of households interviewed were predominantly (68.4%) males while female headed households constituted 26.7% of the respondents (Table 4.3).

Household size gives an indication of available labour especially if considered against the background of age distribution of the household. Most households interviewed had from 6 to10 persons per household (Table 4.4). In Anafobiisi, 50% of the respondents belonged to this category as compared to 37% of respondents' from Gowrie-Kunkua. The mean household size for both Anafobiisi and Gowrie-Kunkua was 6.8 and 7.8, respectively. Moreover, the most represented household sizes (6-10 persons) was closely related to the recorded district's average household size of 5-10 persons (Bongo District Assembly, 2014).

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Table 4.3: Household type of respondents

Household Type	Anafobiisi		Gowrie-Kunkua		Total	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Male Headed with Single Wife	52	68.4	31	56.4	83	63.4
Male Headed with Multiple Wives	7	9.2	3	5.5	10	7.6
Male Headed, Divorced, Single or Widowed	0	0	3	5.5	3	2.3
Female Headed, Divorced, Single or Widowed	17	22.4	18	32.7	35	26.7

Source: Survey data, 2015

Table 4.5 summarises the educational background of respondents. Majority of the heads of households in both Anafobiisi and Gowrie-Kunkua had no formal education, representing 80.3% and 72.7% respectively. About 18.4% of the respondents in both Anafobiisi and Gowrie-Kunkua had basic education/Middle form.

Table 4.4: Household size of respondents

Household size	Anafobiisi		Gowrie-Kunkua		Total	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
1-5	21	27.6	12	21.8	33	25.2
6-10	50	65.8	37	67.3	87	66.4
11-15	3	3.9	5	9.1	8	6.1
15-20	2	2.6	1	1.8	3	2.3
Mean	6.8		7.4			
Maximum	16		13			
Minimum	3		4			
Standard Deviation	2.633		2.249			

Source: Survey data, 2015

Also, 1.3% of the respondent from Anafobiisi had secondary school or 'O' Level education as compared to 3.6% from Gowrie-Kunkua. Only 5.5% of the respondents from Gowrie-

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Kunkua attained tertiary education. None of the respondents in Anafobiisi had tertiary education while 5.5% of the respondents from Gowrie-Kunkua attained tertiary education.

Table 4.5: Educational background of respondents

Educational Level	Anafobiisi		Gowrie-Kunkua		Total	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
No formal education	61	80.3	40	72.7	101	77.1
Primary	9	11.8	6	10.9	15	11.5
JHS/Middle Form	5	6.6	4	7.3	9	6.9
SHS/O Level	1	1.3	2	3.6	3	2.3
Tertiary	0	0	3	5.5	3	2.3

Source, Survey data, 2015

Table 4.6 shows the ownership of land in the two communities. The survey revealed that respondents owned 57.1% and 65.5% the land in Anafobiisi and Gowrie-Kunkua respectively. Some respondents (2.6% in Anafobiisi and 7.3% in Gowrie-Kunkua) rented lands for farming activities. Also, some household interviewed (30.3% in Anafobiisi and 1.8% in Gowrie-Kunkua) practiced both sharecropping and farmed on their own lands. Very few households (1.3% of the respondents in Anafobiisi and none in Gowrie-Kunkua) practiced only sharecropping.

Table 4.7 summarises who makes the decision concerning land for farming in the household. (34.5% in Gowrie-Kunkua and 30.3% in Anafobiisi) only the man or husband decided on what to cultivate on the land.

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Table 4.6: Access to land

State of Access to Land	Anafobiisi		Gowrie-Kunkua		Total	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Owned	48	57.1	36	65.5	84	64.1
Rented	2	2.6	4	7.3	6	4.6
Borrowed	2	2.6	1	1.8	3	2.3
Sharecropped	1	1.3	0	0	1	0.8
Both Owned and Sharecropped	23	30.3	1	1.8	37	28.2

Source: Survey data, 2015

However, there were also households (22.4% of the respondents in Anafobiisi and 30.9% in Gowrie-Kunkua) in which on the woman or wife made decisions about the land use. Women who made decisions about the land were basically female household heads. It is interesting to note that there was gender parity in some households as in 36.6% of respondents in Anafobiisi and 25.5% in Gowrie-Kunkua, both men and women made the decision about the land. In a few households, (8% in Anafobiisi and 5% in Gowrie-Kunkua), others like sons, in-laws and/or grandparent made the decision about land use.

Table 4.7: Land decision-making by respondents

Land Decision Making	Anafobiisi		Gowrie-Kunkua		Total	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Only man/Husband	23	30.3	19	34.5	42	32.1
Only woman/wife	17	22.4	17	30.9	34	26
Both man and woman	28	36.8	14	25.5	42	32.1
Other	8	10.5	5	9.1	13	9.9

Source: Survey data, 2015

Livestock rearing is a major economic activity in Bongo district. Major livestock reared in Anafobiisi and Gowrie-Kunkua included Goats, Sheep, Cattle, Pigs and Poultry. About 97% of the respondent owned livestock while 3% owned none (see Figure 4.1).

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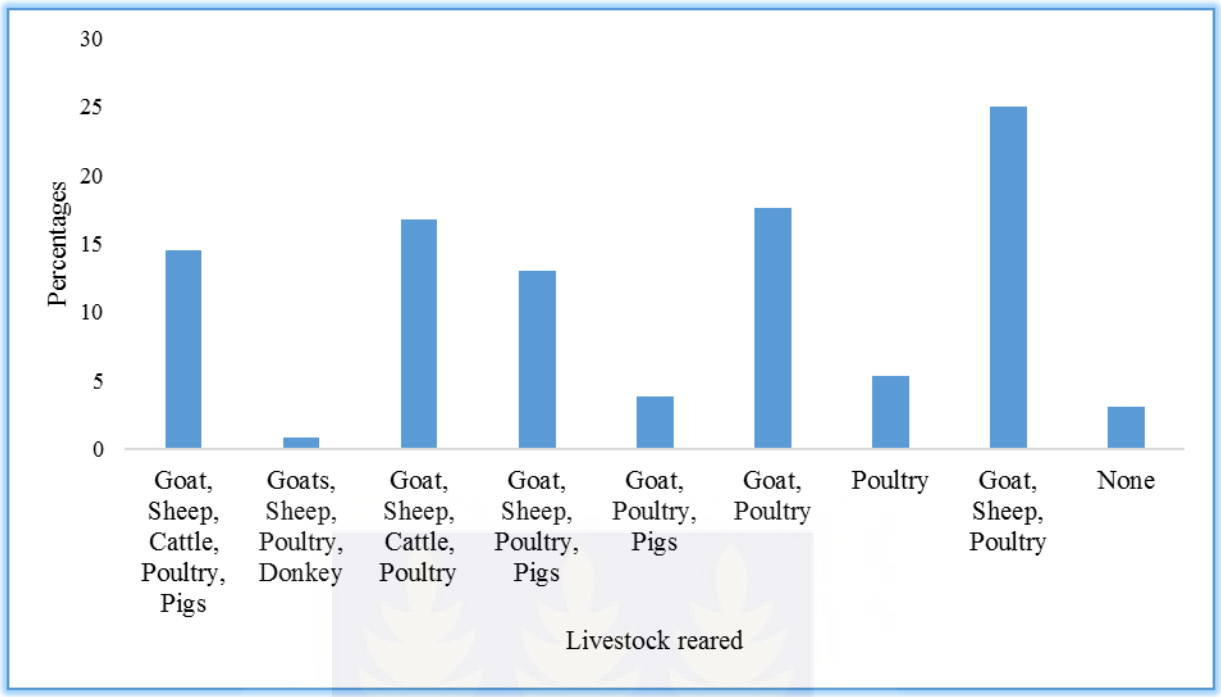

Figure 4.1: Percentage of household who owned various livestock

Source: Survey data, 2015

4.3 Current CSA practices adopted by smallholder farmers.

4.3.1 Locally adopted CSA practice by smallholder farmers

The survey revealed that in both communities, many of the households were already aware of the CSA practices shown to them (see table 4.8). Widely adopted climate smart practices were intercropping, residue management, improved forages, crop rotation, composting and improved crop varieties. Figure 4.2 further compares the awareness and rate of adoption of practices in both communities. The least adopted practices were manure management, rain water harvesting representing 2% each, mulching (15%) and improved livestock breeding (16%).

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Table 4.8: CSA adoption rates of respondents

Practice	Aware of Practice (%)	Currently using Practice (%)	Willingness to introduce Practice (%)
Tree Planting	99	64	36
Composting	99	96	7
Crop Rotation	99	96	4
Mulching	82	15	84
Intercropping	100	100	100
Manure Management	84	2	98
Improved Forages	99	97	3
Improved Livestock Breeds	89	16	82
Improved Crop Varieties	97	81	19
Irrigation	97	18	80
Minimal Tillage	97	44	55
Stone/ Grass Bunds	99	69	31
Rain Water Harvesting	82	2	93
Residue Management	99	98	2
Planting on Contours	99	76	24

Source: Survey data, 2015

4.3.2 Factors likely to influence the adoption of CSA practices.

To identify factors that influenced the adoption of CSA, practices with higher adoption rates were selected which included composting (96%), crop rotation (96%), improved forages (97%) and residue management (98%). Intercropping (100%) could not be computed since adoption rates were skewed toward one direction.

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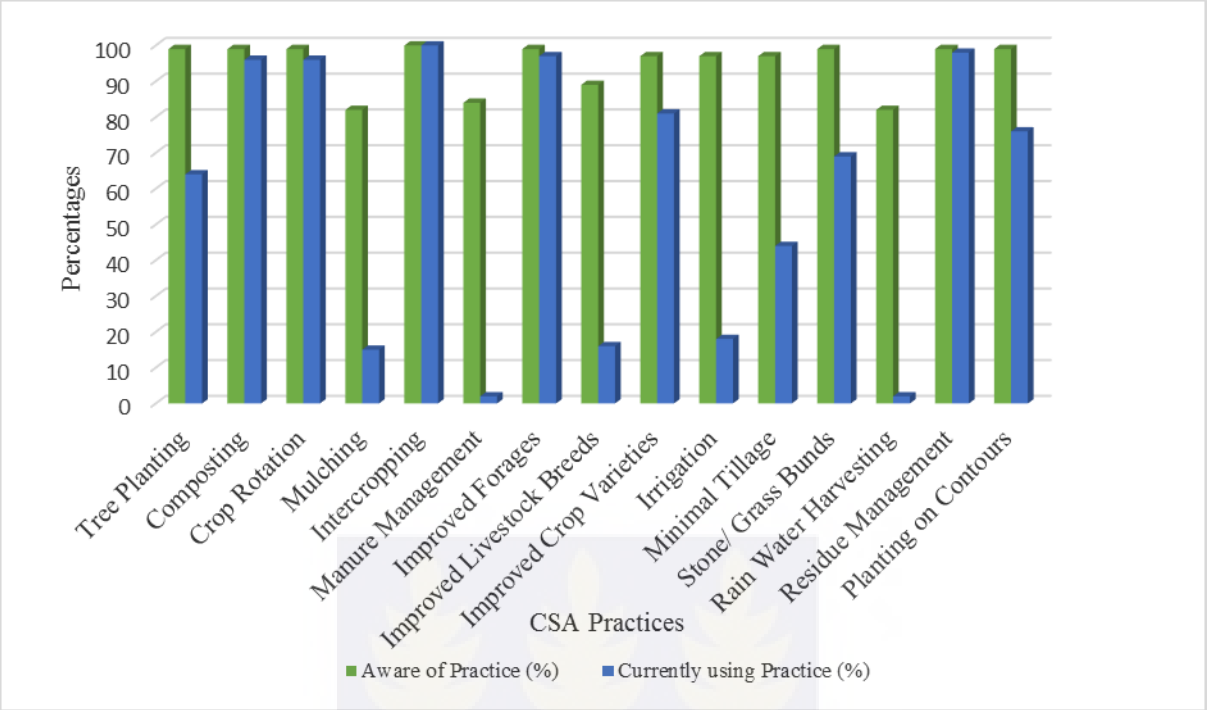

Figure 4.2: CSA awareness and adoption rates

Source: Survey data, 2015

However, since the CSA practices studied here were many, a binary logistic regression was estimated separately for each practice using variables such as age, sex, income, educational level, household size, household type, awareness, access to credit, access to information and type of land to ascertain likely factors that would influence its adoption and the results presented in Tables 4.9, 4.10, 4.11 and 4.12 respectively.

4.3.2.1 Factors likely to influence the adoption of composting as a CSA practice.

The survey revealed that most respondents adopted composting as a CSA practice and the adoption rates did not differ between the sexes of the respondents. Moreover, factors likely to influence the adoption of composting did not differ by age, income, educational level,

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household size, awareness, access to credit, access to information and type of land. The type of household as a factor differed ($\chi^2 = 7.68$, $p = 0.06$), (See Appendix1).

When these factors were combined in a logistic regression model, which explained 37.9 % of the variances, it appeared that both male headed households and not farming on a rocky land negatively influence the adoption of composting at a significance level of 0.05%. This implied that female headed households and farming on a rocky land were factors which were more likely to influence the adoption of composting as a CSA practice. (Table 4.9).

4.3.2.2 Factors likely to influence the adoption of crop rotation as a CSA practice

Similarly, in analysing factors likely to influence the adoption of crop rotation as a CSA practice, the factors and adoption rates of crop rotation were first compared using a chi square test. Survey results indicated that factors likely to influence the adoption of crop rotation did not differ by sex, age, educational level, household type, household size, access to credit and access to information. However, income ($\chi^2 = 5.96$, $p = 0.05$), awareness ($\chi^2 = 11.8$, $p = 0.00$) and the nature of land differed ($\chi^2 = 3.76$, $p = 0.05$), (see Appendix). When these factors were combined in a binary logistic regression model, which explained 45.5 % of the variances, it appeared that none of the factors were likely to influence the adoption of crop rotation as a CSA practice. Thus, the adoption of crop rotation as a CSA could be influenced by factors other than the factors used in this study (Table 4.10).

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Table 4.9: Factors likely to influence the adoption of composting as a CSA practice based on a binary logistic regression

Variable	B	SE	DF	Significance
Sex				
Male	16.46	6.026.24	1	1.00
Female				
Age				
(20-40)	1.61	1.09	1	0.14
(41-60)	-	-	-	-
(>60)	-	-	-	-
Income				
Average	-0.39	0.72	1	0.59
High	-	-	-	-
Low	-	-	-	-
Educational level				
Non-formal education	18.35	10139.42	1	1.00
Formal education	-	-	-	-
Household type				
Male Headed	-2.65	1.07	1	0.01**
Female Headed	-	-	-	-
Household size				
(1-5)	-	-	3	0.92
(6-10)	-18.13	21316.22	1	1.00
(11-15)	-17.48	21316.22	1	1.00
(16-20)	-0.47	25066.16	1	1.00
Awareness				
No	2.51	42301.34	1	1.00
Yes	-	-	-	-
Access to credit				
No	-3.00	22381.52	1	1.00
Yes	-	-	-	-
Access to information				
No	-17.61	15562.97	1	1.00
Yes	-	-	-	-
Nature of land (Rocky)				
No	-2.42	1.31	1	0.06**
Yes	-	-	-	-

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Constant	37.23	49859.70
number of observations	131	
Chi Square	0.807	
Df	15	
Significance	0.112	
Nagelkerke R^2	0.379	
-2log Likelihood	36.521	

*Source: Survey data, 2015, ** represents 5% significance level,*

4.3.2.3 Factors likely to influence the Adoption of Improved Forages as a CSA Practice

Moreover, in analysing which factors would likely influence the adoption of improved forages as a CSA practice, the survey results indicated that factors such as sex, age, income, educational level, household type, awareness, access to credit, access to information and type of land did not differ with the adoption rates of improved forages. However, household size ($p = 0.01$) as a factor differed with the adoption of improved forages with more (98.9%) of household sizes of 11 to15 more likely to influence its adoption (see Appendix).

Again, when these factors were combined in a logistic regression model, which explained 40.7 % of the variances, it appeared that household sizes were more likely to influence the adoption of improved forages as a CSA practice. Thus, household sizes of 11-15 or larger household sizes were more likely to adopt improved forages as a CSA practice since they provided additional labour for farming activities (Table 4.11).

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Table 14.10: Factors likely to influence the adoption of crop rotation as a CSA practice based on binary logistic regression analysis

Variable	B	SE	DF	Significance
Sex				
Male	0.62	1.47	1	0.67
Female	-	-	-	-
Age				
(20-40)	0.61	1.28	1	0.64
(41-60)	-	-	-	-
(>60)	-	-	-	-
Income				
Average	0.95	0.62	1	0.13
High	-	-	-	-
Low	-	-	-	-
Educational level				
Non-formal education	17.19	9969.15	1	1.00
Formal education	-	-	-	-
Household type				
Male Headed Household	17.92	5802.52	1	1.00
Female Headed Household	-	-	-	-
Household size				
(1-5)	-	-	3	1.00
(6-10)	-17.50	21274.83	1	1.00
(11-15)	-17.76	21274.83	1	1.00
(16-20)	1.83	27042.36	1	1.00
Awareness				
No	-	-	-	-
Yes	21.20	11921.19	1	1.00
Access to credit				
No	-16.72	25413.81	1	1.00
Yes	-	-	-	-
Access to information				
No	-17.49	15290.82	1	1.00
Yes				
Type of land (Rocky)				
No	-18.03	5217.46	1	1.00
Yes	-	-	-	-

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Constant	32.87	29179.49
number of observations	131	
Chi Square	17.65	
Df	12	
Prob (chi square)	0.13	
Nagelkerke R^2	0.455	
-2log Likelihood	24.818	

Source: Survey data, 2015

4.3.2.4 Factors likely to influence the adoption of residue management as a CSA practice

When the factors were compared with adoption rates of residue management in a chi test analysis, results indicated that all factors did not differ with the adoption of residue management as a CSA practice. For instance, sex, age, income, educational level, household type, household size, awareness, access to credit access to information, and type of land (see Appendix 1). Since all factors did not differ with the adoption of residue management, no regression analysis was carried out. Thus, the adoption of residue management may be due to other factors than the factors discussed in this study.

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Table 24.11: Factors likely to influence the adoption of improved forages as a CSA practice based on a binary logistic regression analysis

Variable	B	SE	DF	Significance
Sex				
Male	16.72	5053.19	1	1.00
Female	-	-	-	-
Age				
(20-40)	1.89	1.65	1	0.25
(41-60)	-	-	-	-
(>60)	-	-	-	-
Income				
Average	-16.57	4151.58	1	.00
High	-	-	-	-
Low	-	-	-	-
Educational level				
Non-formal education	15.90	9819.30	1	1.00
Formal education	-	-	-	-
Household type				
Male Headed Household	-1.56	1.61	1	0.33
Female Headed Household	-	-	-	-
Household size				
(1-5)			3	0.104
(6-10)	3.47	2.00	1	0.08**
(11-15)	4.11	1.86	1	0.03**
(16-20)	0.81	1.93	1	0.68
Awareness				
No	-18.52	40192.97	1	1.00
Yes	-	-	-	-
Access to credit				
No	0.33	21285.28	1	1.00
Yes	-	-	-	-
Access to information				
No	-15.87	15281.15	1	1.00
Yes	-	-	-	-
Type of land (Rocky)				
No	-0.31	1.35	1	0.82
Yes	-	-	-	-

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Constant	82.18	44767.27
Number of observations	131	
p-value	13.41	
Df	12	
Sig.	0.34	
Nagelkerke R^2	0.407	
-2log Likelihood	22.377	

** represents 5% significance level, Source*: Survey data, 2015*

4.3.3 Factors influencing non- adoption of CSA practices

Figure 4.3 shows the distribution of factors influencing non-adoption of CSA practices. 100 % of the respondents attributed financial constraints as reasons for abandoning some practices. For instance, cost involved in buying receptacles to store water or digging reservoirs, buying farm inputs, paying for labour and structures to keep compost or manure. 72 % of the respondents also attributed their disinterest to water shortages while small land space and insufficient information represented 49.5 % and 20 % respectively.

4.4 Contribution of CSA to livelihoods of farmers

The DfID framework was used to determine farmers' livelihood that could be influenced by CSA practices adopted. The indicators of livelihood measured included were income, food security, wellbeing, vulnerability and sustainable use of natural resources. The results of the study in figure 4.4 indicated that majority of the farmers barely sold their food crops representing 78 %. The 22 % who sold their crops only sold them to raise money to respond to pressing needs. Thus, a monthly income could not be recorded from their farming activities. The situation was also the same for respondents who owned livestock, monthly income could not be accounted for as they were sold when the need arises.

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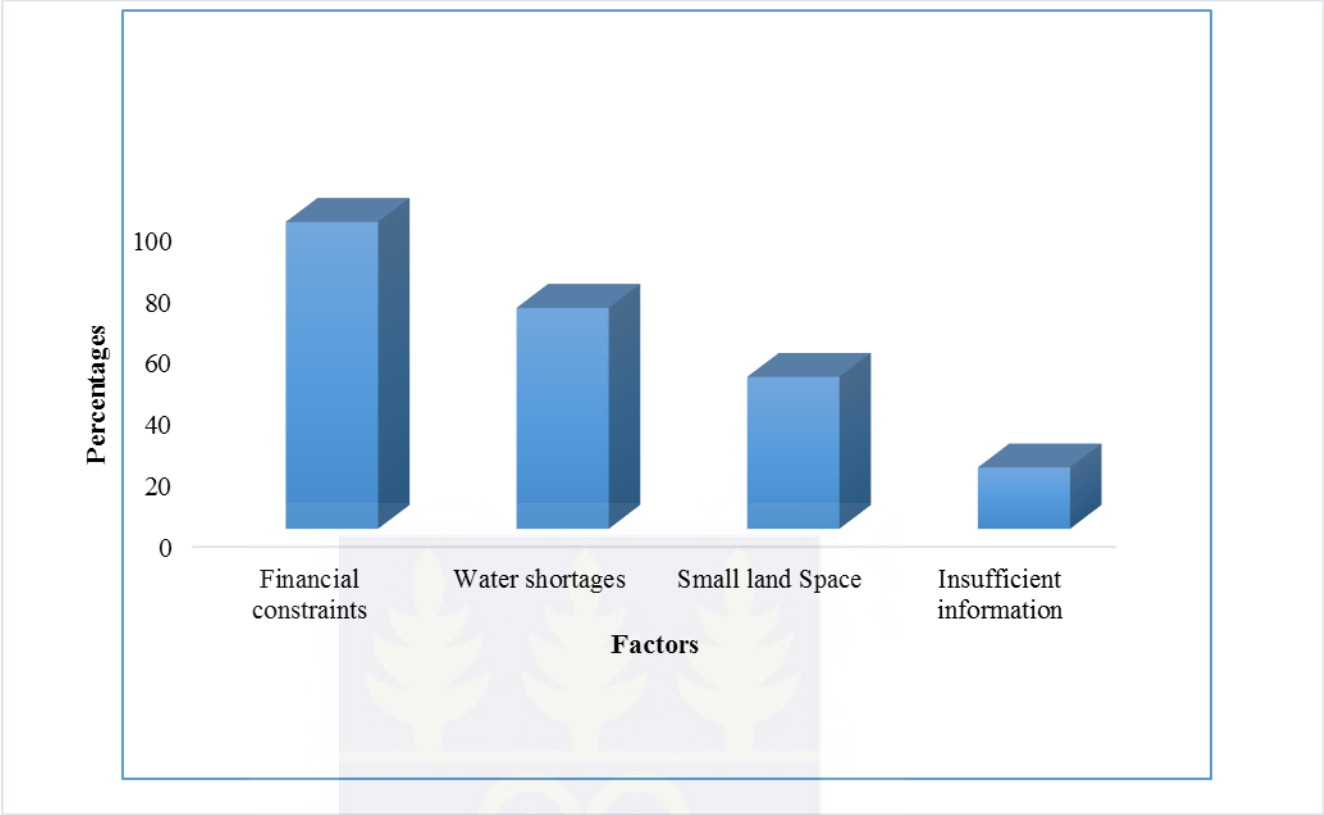

Figure 4.3: Factors influencing non-adoption of local CSA practices

Source: Survey data, 2015

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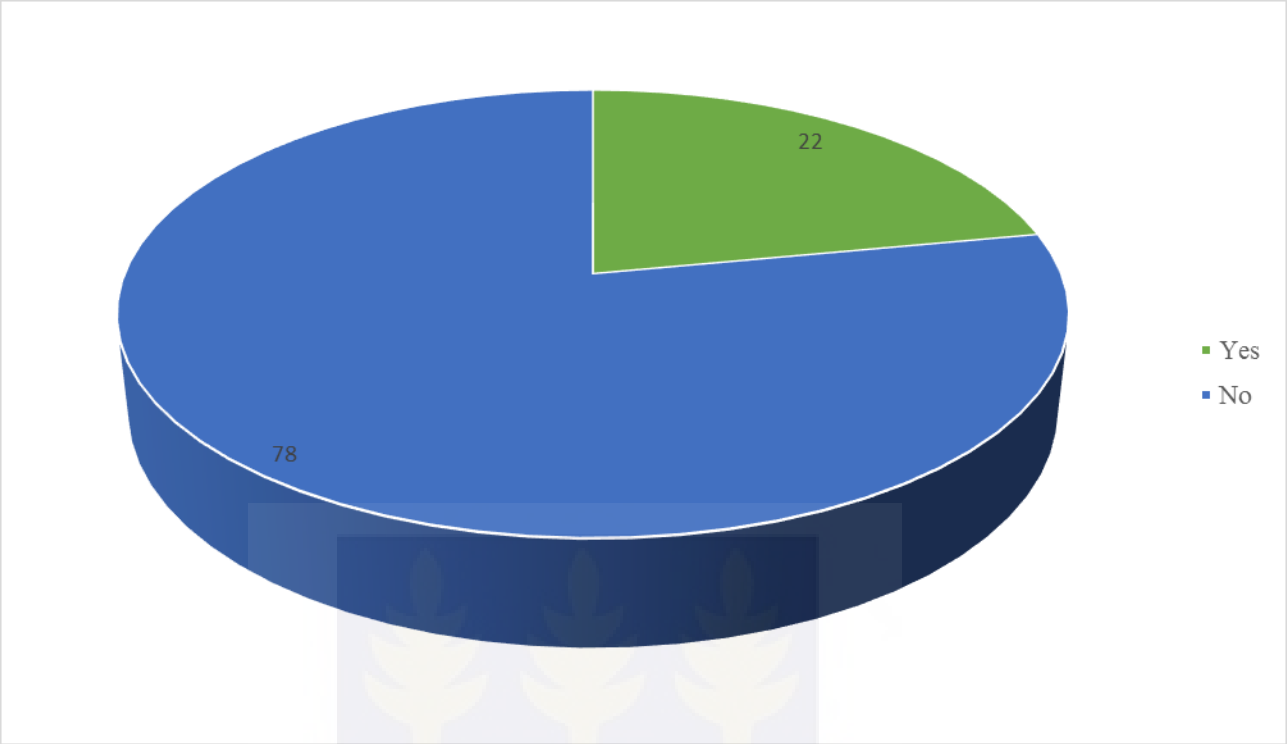

Figure 4.4: Percentage of farmer who sell food crops

Source: Survey data, 2015

Food security was measured using the number of times a farmer had a meal in a day. From figure 4.5, majority of the respondents (76.3 %) had meals three times in a day, whereas 27.3 % of responded could only afford meals twice in a day. No value was recorded for respondents who had meals once in day, indicating that more of the respondents were food secure. Thus, the adoption of local CSA practices have contributed to food security among farmers.

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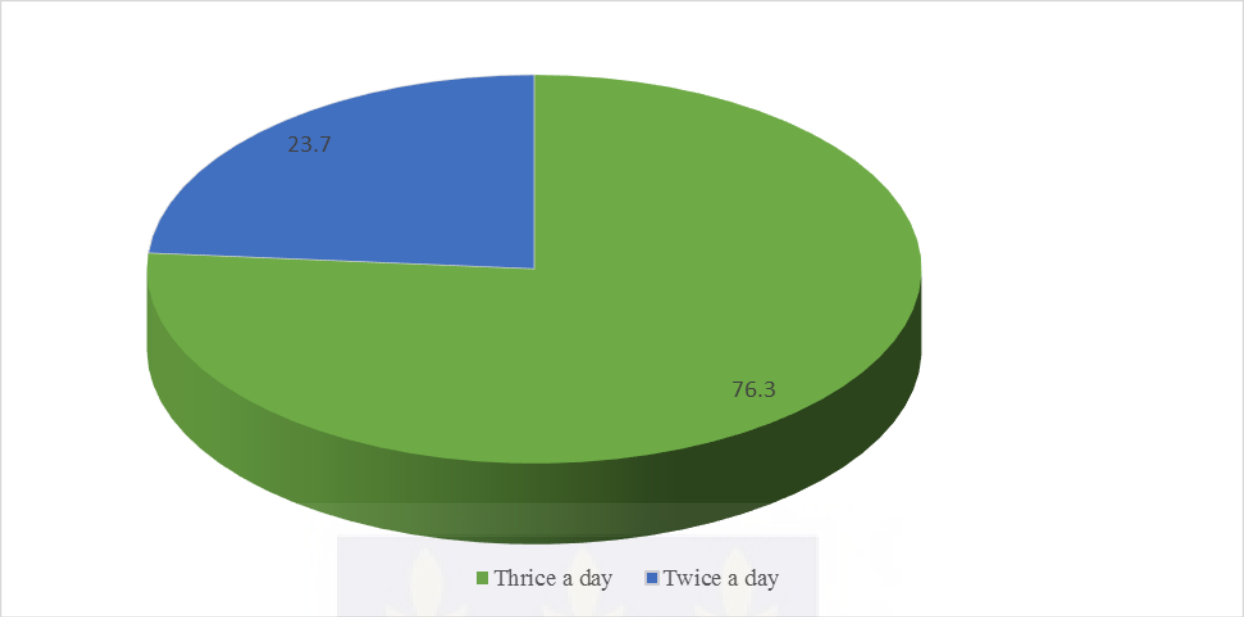

Figure 4.5: Proportion of farmers and the number of meals they had in a day

Source: Survey data, 2015

However, table 4.12 and figure 4.6 summarises the proportion of weekly food financed by farming activities. Since, farmers in both Anafobiisi and Gowrie-Kunkua barely bought food or fed on their produce, food finances were measured by the quantity of staple grains (guinea corn, millet and rice) and legume (beans) consumed within a week. Food expenses between the ranges of GH¢ 41- 60 were financed by 42 % of the respondents. 38.2 % of the respondents financed household food expenses constituting GH¢21-40 where as food expenses within the ranges of GH¢61-80 were financed by 15.3 % of the respondents.

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Table 4.12: Proportion of weekly food expenditure financed by farming

Food expenses (GH¢)	Percentage of Respondent (%)
1-20	1.5
21-40	38.2
41-60	42
61-80	15.3
81-100	3.1
Mean	46.6
Maximum	100
Minimum	15
Standard Deviation	16.4
Mode	30

Source: Survey data, 2015

Moreover, 3.1 % of the respondents financed food expenses between GH¢ 81-100, followed by 1.5 % of the respondents financing between GH¢1-20. The mean weekly expenditure on food was GH¢46.6 with a mode of GH¢30. The maximum amount that was spent on food per week by a household was GH¢ 100 and Minimum amount was GH¢ 15. However, 100 % of the farmers consumed what the produce.

The wellbeing of a farmer was measured by the child's educational cost that was financed by the farmer through agricultural activities. Table 4.13 summarises the proportion of children school expenses financed by agricultural activities and Figure 4.7 shows the source of funds in financing a child's school expenses. 8.4 % of the respondents could not fund their child's education through agricultural activities. 59.5 % of the respondent funded between GH¢1-GH¢100 of children educational cost, 19.1% funded between GH¢101-GH¢200, 5.3 %

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funded between GH¢201-GH¢300, 4.6 % funded between GH¢301-GH¢400, 2.3 % funded between the GH¢401-GH¢500 and 0.8 % funded between GH¢501- GH¢600 of children's educational cost in the year 2015.

Figure 4.6: Percentage of weekly food expenditure

Source: Survey data, 2015

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Table 4.13: Proportion of children school expenses financed by agricultural activities

Funding Child's Education (GH¢)	Percentages (%)
0	8.4
1-100	59.5
101-200	19.1
201-300	5.3
301-400	4.6
401-500	2.3
501-600	0.8
Mean	103.5
Maximum	550
Minimum	0
Standard Deviation	107.2
Mode	0

Source: Survey data, 2015

CSA is seen as an activity which could make rural farmers less vulnerable to shocks, trends or seasonality and encourages farmer- to- farmer learning. Thus, in this context vulnerability was measured based on social inclusion which indicated whether a farmer belonged to a farmer based association or not. Results indicated that 100% of the farmers interviewed belonged to a farmer based association which indicates that the involvement in the natural resource management project instituted by NABOCADO-Bongo office has improved the social inclusion of farmers.

In terms of sustainable natural resource management, results from figure 4.8 indicated that 98.5% strongly perceived that the adoption of CSA practices will promote environmental soundness whereas 1.5% moderately agreed.

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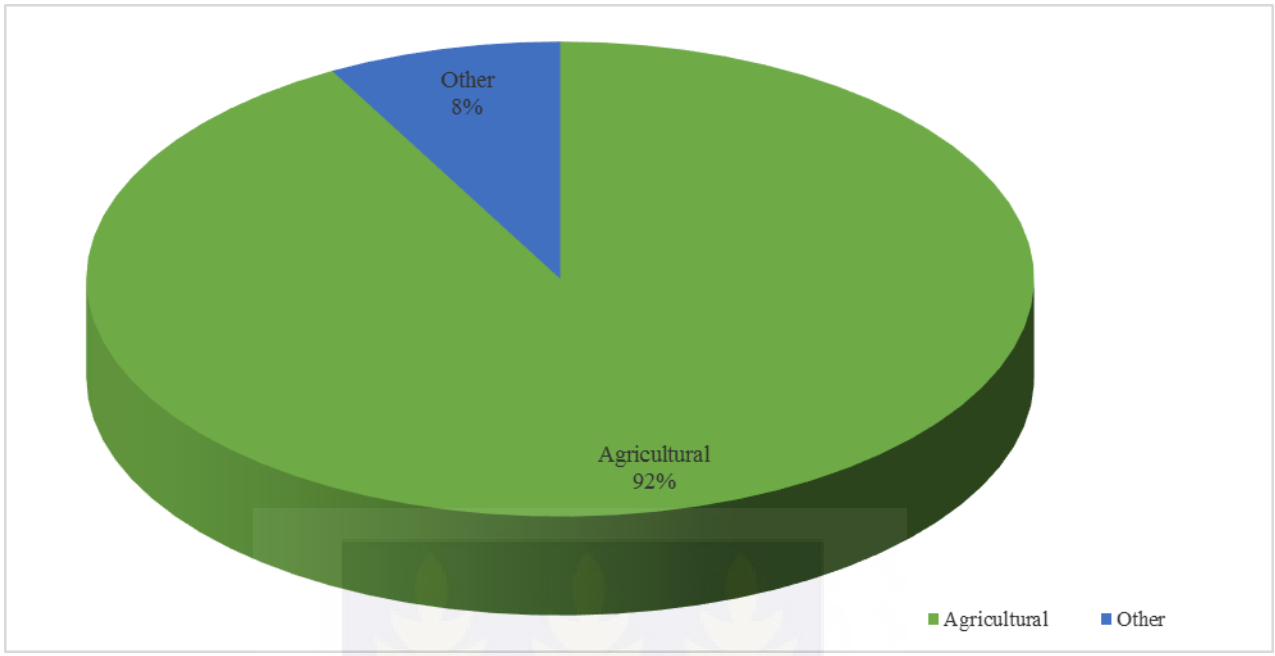

Figure 4.7: Source of farmers' child educational fund

Source: Survey data, 2015.

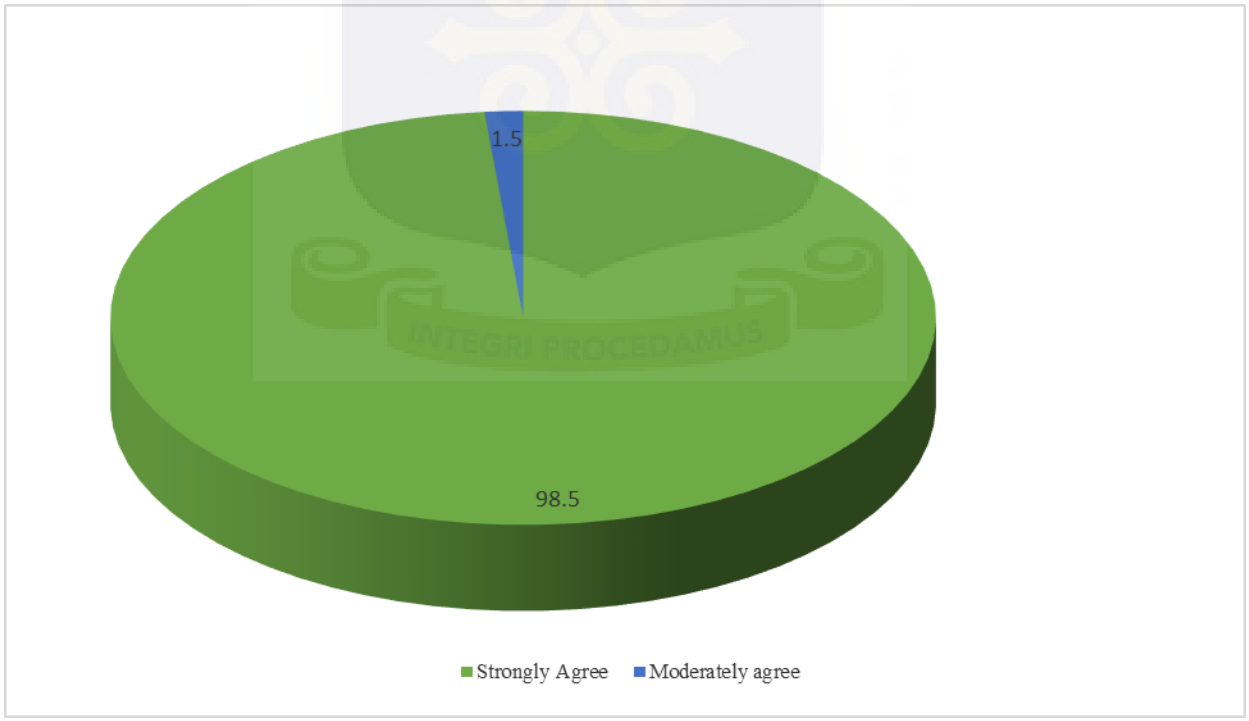

Figure 4.8: Perception of CSA practice adoption on the environment

Source: Survey data, 2015

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4.5 Local Level Institutions and their Roles in Facilitating the Adoption of CSA practices among Smallholder Farmers.

In all, twelve institutions were interviewed which included a governmental institution, a public-private institution and ten Non-Governmental Organizations (NGOs) (see Table 4.14). It is worth noting that, MoFA, YHF, and NABOCADO were the only institutions operating in these two communities. All other institutions were interviewed to acquire additional information about their activities in other communities and for comparative studies.

Ministry of Agriculture, Bongo office represented the governmental institution, with a mandate to improve agricultural production in the district through extension or diffusion as well as research and policy development. The NGOs included Navrongo-Bolgatanga Catholic Diocesan Development Office, (NABOCADO), United State Agency for International Development- Agriculture Development and Value Chain Enhancement (USAID-ADVANCE), Association of Church Development Projects (ACDEP), Youth Harvest Foundation, World Vision International, Farmer Training Centre (FTC), Anglican Diocesan Development and Relief Organization (ADDRO), Trias Ghana, West Africa Science Service Centre on Climate Change and Adapted Landuse (WASCAL) and Trade Aid. They basically have a mandate to build the capacities of farmers to improve food security in the district and the region as a whole through advocacy, research and diffusion. The public-private institution interviewed was Ghana Agriculture Insurance Programme with a mandate to develop a sustainable agricultural insurance system and the introduction of innovative and demand-oriented crop insurance products to protect against financial risks caused by extreme weather events and other forms of climate change.

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All institutions interviewed were involved in some aspects of CSA promotion. For instance, NABOCADO Bongo office, FTC, USAID-ADVANCE, ADDRO, Trade AID, Youth Harvest Foundation, ACDEP and Trias Ghana were all involved in promoting sustainable land practices in the region which are deemed as CSA practices. Moreover, USAID-ADVANCE Youth Harvest Foundation and ADDRO collaborated with Inigtia and Esoko to provide seasonal weather forecast to farmers to anticipate and prepare for likely weather patterns in the growing season. At the same time, Esoko also provided daily market pricing of food products to enable farmers get good prices for products sold or bought. However, MoFA Bongo office used the analogue system of collecting data on market prices of products which is later communicated to other partnering institutions or farmers through extension agents. An interview with World Vision International (Tongo office) revealed interesting innovations introduced to farmers in Tongo which included the Farmer Managed Natural Regeneration project adopted from the Maradi Integrated Project adopted in Niger. The project is instituted to regenerate degraded lands in the Talensi district with a long term goal of improving livelihoods of people within the district. It is instituted through a partnership between World Vision Australia and World Vision Ghana. Bee keeping and livestock rearing have been introduced as an alternative livelihood strategy in the district. Similar projects have also been established in the Bongo district, where bush burning and deforestation have been discouraged by paying fines to enskinned tree chiefs in the various communities in the district when caught in the act. Just like FMNR project in the Talensi district, crop residues have also been used as fodder and manure to improve soil fertility.

GAIP had also demonstrated remarkable performance in the area of providing insurance to both crop and livestock farmers considering the uncertainties that climate change may

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present. For instance, GAIP made payments to a lot of recipients of claims under the Drought Index Insurance products in Northern Ghana. A farmer in Bazua (Bawku East district) facilitated by ADVANCE accrued his production cost which was affected by dry spells during the farming season. An interview with GAIP Bolga branch also disclosed that in addition to the crop insurance, they were currently having insurance packages for livestock such as piggery and poultry.

Table 4.14: Institutional activities promoting the adoption of CSA in both Bongo District and Bolgatanga Municipal

Institution	Mandate	Target Group	Services	Information Delivery Mechanism
MoFA-(Bongo)	Develop and effective implementation of district agricultural programs	Individual Farmers, Women's Group, Farmer based associations, Poor farmers, Local authorities, Other institutions working in the locality	**Food Security**: Improved seeds, post-harvest loss management, improved agronomic Practices, support with input seeds, block farm programme **Climate Change Mitigation**: Household Tree planting, Sensitization of hazards in bush burning **Weather and Climate Change**: Sensitization and Information dissemination **Market Related Decision**: Establishing Commodity Value Chain with ACDEP, Market price forecasting	Extension services, information vans, radio talk shows, demonstration fields, workshop trainings
Youth Harvest Foundation	Improved food security within the region, developing youth skills and sexual and reproductive health rights	Farmer based association, Local authorities	**Food Security**: Post-Harvest loss Management **Weather and Climate Change**: Seasonal weather forecasting through partnership with Esoko **Market Related Decision**: Information on market prices of food crops.	ICT platform (Esoko Services), Mobile Phones, Workshops
World Vision International	Working with children, families and communities to	Individual Farmers, Women's Group, Farmer based associations, Poor farmers, Local	**Food Security**: Bee keeping, Livestock rearing, Improved crop varieties. **Climate Change Mitigation**: Household and community tree planting.	Extension services, Information vans, Demonstration fields, Workshop trainings,

	overcome poverty and injustice	authorities, Other institutions working in the locality	**Market Related Prices**: Information on market prices of food crop	Radio talks shows, Community dramas, Night Videos
ACDEP	To contribute to the socio-economic development of northern Ghana.	Individual Farmers, Women's Group, Farmer based associations, Poor farmers, Local authorities, Other institutions working in the locality	**Food Security**: Improved seeds, Capacity building **Climate Change Mitigation**: Household and community tree planting **Weather and Climate Change**: Early warning information on climate risk, daily local forecast **Market Related Prices**: Linking farmers to buyers	Extension Services, Radio talk shows, Early adopters
Trade Aid	To help the productive poor to create and manage viable business in order to escape poverty.	Individual Farmers, Women's Group, Farmer based associations, Poor farmers, Local authorities, Other institutions working in the locality.	**Food Security**: Improved agronomic practices, improved crop varieties, post-harvest loss management **Climate Change Mitigation**: Household tree planting **Weather and Climate Change**: Seasonal forecast through partnership with GMeT.	Group Discussions, Radio Stations, Demonstration fields, Workshops/Trainings/Seminars
ADDRO	Promoting dignified and meaningful life through improved security and livelihood support.	Individual Farmers, Women's Group, Farmer based associations, Poor farmers, Local authorities, Other institutions working in the locality	**Food Security**: Improved seeds, small ruminants and livestock, **Climate Change and Mitigation**: Household tree planting **Weather and Climate Change**: Weather forecasting through partnership with Esoko, drought tolerant seeds **Market Related Prices**: Market prices of goods through Esoko platform, linkages between farmers and buyers	Workshop training, community durbars, Extension Services
TRAIS Ghana	Empowering FBOs to sustain farming activities and	Farmer based association, Other institutions working in the locality	**Food Security**: Commodity value chain **Climate Change and Mitigation**: Household tree planting **Weather and Climate Change**:	Video vans, Workshop, Demonstration fields, Night Videos.

	developing it as an Agribusiness.		Sensitization **Market Related Decision**: Linkages between farmers and buyers	
Farmer Training Centre (FTC)	Building capacities of farmers and institution as well as promoting improved food security in the region.	Individual Farmers, Women's Group, Farmer based associations, Poor farmers, Local authorities, Other institutions working in the locality	**Food Security**: Improved seeds and livestock, capacity building **Climate Change and Mitigation**: Household tree planting **Weather and Climate Change**: Sensitization	Demonstration Fields, Radio Stations, seminars
ADVANCE-USAID	Improved food security, promoting agribusinesses	Individual Farmers, Women's Group, Farmer based associations, Poor farmers, Local authorities, Other institutions working in the locality	**Food Security**: Improved seeds, agro processing Climate Change and Mitigation: links to buyers **Weather and Climate Change**: Crop and livestock through collaboration with GAIP, Weather forecasting through collaboration with Esoko and Ignitia **Market Related Decision**: Linkages between farmers and buyers	Demonstration fields, Seminars
NABOCADO (Bongo office)	Promoting improved food security.	Individual Farmers, Women's Group, Farmer based associations, Poor farmers, Local	**Food Security**: Improved seeds, small ruminants **Climate Change and Mitigation**: Household tree planting	Mobile phones, Radio stations, Early adopters, Workshops

		authorities, Other institutions working in the locality	**Weather and Climate Change**: Sensitization **Market Related Decision**: linkages between farmers and buyers	

Source: Survey data, 2015

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CHAPTER FIVE
DISCUSSIONS

5.1 Introduction

This chapter presents discussions on key findings of the research. It begins by discussing findings on local CSA practices adopted by smallholder farmers, followed by factors influencing the non-adoption of CSA practices. It also highlights findings on CSA and livelihood development in the study area as well as institutional roles in facilitating the adoption of CSA practices.

5.2 Local CSA Practices Adopted by Smallholder Farmers

From survey results, there is an indication that, local CSA practices have been promoted and adopted by both institutions and farmers respectively without necessarily using the CSA terminology. Improved agronomic practices or sustainable agriculture were common terminologies used to describe some of these CSA practices.

Widely adopted practices included intercropping, residue management, improved forages, crop rotation, composting and improved crop varieties This is consistent with other studies (Branca *et al*., 2011; Garrity, Akinnifesi, & Ajayi, 2010; Giller, Witter, Corbeels, & Tittonell, 2009; Scherr, Shames, & Friedman, 2012; Stringer *et* al., 2009) that confirmed that, the adoption of these practices have been associated with the promotion of food security, soil organic matter enhancement, carbon sequestration and livelihood development which supports both adaptation and mitigation objectives. For instance, intercropping is widely adopted in these communities because it promotes both diversification of crop production and offset crop losses as an adaptive strategy. The crops often intercropped included Millet, Guinea corn, and vegetables such as (Kenaf, Amaranth, Pepper, Tomatoes and Okra). To

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smallholder farmers in both communities, the over ridding goal in adopting CSA practices should be contingent on improving their crop yields. Food security is continuously threatened in these areas as a result of prolonged hunger gaps often experienced from erratic rainfall patterns and poor yields. Thus, for CSA to be successfully adopted by smallholders, there is the need to develop strategies that will provide multiple benefits.

5.3 Factors influencing non-adoption of CSA practices

The results of the study were consistent with other studies in sub-Saharan Africa (Deressa *et al.*, 2009; Mccarthy *et al*., 2011; Peterson, 2014) that confirmed that financial constraints, water shortages, small land space and insufficient information impeded the successful adoption of CSA practices. This accounted for the low adoption rates of irrigation, rain water harvesting, improved livestock breeds and manure management because it required major investments. To appropriately address this, there is the need for institutional support including collaborative efforts through public-private partnerships to invest in CSA practices with high start-up costs.

On the other hand, practices which promote soil water conservation such as minimal tillage (ploughing with a hoe) and mulching were the least adopted in both communities. For instance, those who adopted minimal tillage, practiced it on only small portions of their farms. Most respondents expressed their disinterest in this practice because of the tedious nature in carrying out that task as it required extra labour. Moreover, farmers adopted minimal tillage because they could not afford the cost in renting a tractor. Therefore, smallholder farmers in these two communities adopted minimal tillage because of the high cost in buying or renting a tractor to plough farmlands and not necessarily because it is a CSA strategy. Though, large household sizes were recorded in both communities which gives

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an indication of available labour, most young men and women were either in school during farming periods or in urban areas doing other menial jobs. Thus, finding additional labour elsewhere comes with an additional cost to farmers, since they have to pay for services rendered to them.

The adoption of mulching is purported to improve soil water retention, reduction of soil temperatures, limits leaching of soil nutrients and promotes high yields especially in semi-arid agro ecosystems (Branca *et al*., 2011). The adoption of mulching as a CSA practice is however impeded by lack of available grasses to undertake that initiative. Seasonal variations such as low humidity and high temperatures scorch grasses and crops residues. Moreover, low productivity is also associated with less crop residues for use as mulch. The little available ones have other competing uses such as livestock feed and fuel for domestic uses. Therefore, there is the need to promote agricultural intensification to maximise productivity on farmlands, at the same time, institutions need to design innovative ways to address this issue.

5.4 CSA and Livelihood Development

Having access to land is an asset for agricultural development. Most land sizes of respondents from field observations revealed an average land size less than a hectare, compelling most farmers to acquire land elsewhere to increase crop cultivation for subsistence. Generally, apart from increased population density in the district, the rocky nature of land makes further decreases in land sizes leaving only small portions for crop production. This was very conspicuous in Anafobiisi. Besides these factors, declining rainfall patterns in the district also promoted crop failures and increased the duration of hunger gaps.

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Therefore, crop farming was not perceived as an enterprise for income generation in both communities but rather, for subsistence. On the other hand, livestock rearing was deemed a major economic activity in both communities and its economic importance was demonstrated in its ability to finance ones ward's education and other social functions. To promote crop farming as an agribusiness in both communities, there will be the need to encourage sustainable agriculture intensification with support from institutions or diversify livelihoods (Ellis, 2000). Nonetheless, both crop farming and livestock rearing will need to be improved in both communities since they have implications for both agriculture and livelihood developments (Bryan *et al*., 2013).

5.5 CSA and Gender Perspectives

The adoption of climate smart practices implies that households will make a decision to change their practices, such as a modification in farming practices. This decision making is likely to take place according to gender roles which has implications for livelihoods. Contrary to previous findings in literature where women are less likely to adopt innovative practices due to lack of awareness or socio-cultural restraints, in this study, female headed households recorded high response rates for adopting composting due to support from institutions such as NABOCADO. The adoption of composting is associated with low capital investments and the ease in it usage (Below *et al*., 2012; Peterson, 2014). This could also account for the ready adoption by female headed households. Thus, there is a need to mainstream gender lenses in designing CSA practices for the successful adoption of all sects of farmers. It is also interesting to note that there was a gender parity in some households in both Anafobiisi and Gowrie-Kunkua communities were both men and women made

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decisions about the land. This indicates that there are improvements in female participation in decision making.

5.6 Local level institutions and their roles in facilitating CSA adoption

5.6.1 Structural arrangement of institutions

The successful adaptation of smallholder farmers to changing climate has been proposed to hinge on the role of local level institutions (Agrawal, 2008; Dethier & Effenberger, 2012; FAO, 2013a). Therefore local level institutions have a role in structuring risk and impacts, acting as links between individual and collective actions as well as mediating external interventions (Agrawal, 2008). As part of Ghana's effort to decentralise governance, the district MoFA office was established to implement government's programmes at the district level to help improve food security through extension and diffusion. NABOCADO and YHF in partnerships with MoFA, promoted developmental projects or complemented government's efforts to improve food security at the district level. Consistent with findings in literature on local level institutions in rural areas (IFAD, 2003), the government institution (MoFA) had insufficient human resource, lacked technical know-how and finances to effectively promote CSA adoption in these two communities as well as in the district as a whole. Advocates of institutional partnerships have demonstrated that such partnerships between the institutions offset the limitations of each institution (Agrawal, 2008; IFAD, 2003; Uphoff & Buck, 2006). There are instances of institutional partnerships between the institutions identified in this study. For instance, MoFA collaborated with ACDEP (an NGO) to promote commodity value chains in other communities in the district. YHF also partnered with ESOKO (a private institution located outside the district) to provide weather and pricing information to farmers through an SMS platform.

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Though three types of institutions (public, private and civil societies) have been identified in literature to facilitate adaptation strategies at the rural level (Agrawal, 2008; Meinzen-Dick *et al.*, 2013; Uphoff & Buck, 2006), findings of this study showed the existence of two types of institutions influencing adaptation strategies in both communities. This involves a public institution (MoFA) and civil societies (NABOCADO and YHF). Market or private institutions which play key roles in serving as a link between farmers and aggregators were physically not present in these communities. Even if they were available, smallholder farmers in Anafobiisi and Gowrie-Kunkua communities would not be able to take advantage of their presence given that they produce just enough for subsistence. Besides, farmers only sold livestock when they needed money to finance their wards fees, pay hospital bills or respond to other social functions.

However, further analysis of the findings of this study showed that, the institutional role of structuring impacts and risks were not effectively carried out. Smallholder farmers doubted the credibility of weather information relayed on radio stations. They noted that, weather information on rainfall events did not occur as reported. In addition, most farmers were not aware of the existence of agricultural insurance products such as drought-index insurance products for crop or livestock. They also had reservations about taking credits from financial institutions to support their farming activities. Elsewhere, a farmer in Bazua (Bawku East district) facilitated by USAID-ADVANCE (an NGO) recouped his production cost as a result of crop failure due to dry spells during the farming season by buying a drought-index insurance product from GAIP. Having access to agricultural inputs, access to credit and markets as well as insurance have been proposed to improve food security and wellbeing (FAO, 2013a; Lipton, 2005; McCarthy, Lipper & Branca, 2011). The erratic nature of the

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rainfall patterns and the fear of not being able to pay back credit was enough to deter farmers. Therefore creating awareness of the existence of these institutions, understanding the kind of services rendered, the provision of credible seasonal and daily weather information as well as promoting the adoption of improved agricultural practices will enable a smallholder farmer to comfortably shift from subsistence to an agribusiness for an improved livelihood.

Though the focus of the study was to unearth the role of formal institutions in facilitating the adoption of CSA, the focus group discussion session revealed that community or traditional leaders were strongly involved in natural resource management. For instance, Anafobiisi community had a 'tree chief' whose duty was to ensure the protection and preservation of woodlots, Therefore any community member who defied any of the rules by cutting down a tree without any proper consultation was asked to pay a fine. These fines ranged between a query, an amount of GHC100- GHC 200 or the provision of tree seedling for replanting. These leaders also mediated between the community and any external intervention. Also, it was revealed that there have been collaborations among community leaders, MoFA and NGOs in these communities. Like any other institution anywhere in sub-Saharan Africa (Brautigam & Knack, 2004), they are constrained financially to effectively monitor the preserved woodlots.

The findings of this study suggest that, to achieve any effective adaptation action in these communities and the district as a whole, there will be a need to enhance existing institutions. These inference calls for building capacities of the staffs of MoFA and the existing local NGOs in diffusing place-specific technologies, recruiting more extensions agents to adequately meet the needs of farmers, as well as equipping them financially to effectively discharge their duties.

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5.6.2 Mode of technology or information dissemination

Access to information has been identified as a key tool for both climate change adaptation and successful adoption of CSA (McCarthy, Lipper & Branca, 2011). However, access to information and adoption of CSA practices will be contingent on the level of institutional development within a locality. Mechanisms by which information on CSA practices were disseminated to smallholder farmers includes; extension services, mobile phones, demonstration fields, radio talk shows, night videos, community durbars, workshops and through early adopters. This demonstrates that more institutions had developed and introduced innovative ways of diffusing information to farmers. Also, it augments the declining extension service in developing countries as discussed in FAO (2008).

As indicated earlier, farmers doubted the credibility of weather information reported. However, they had local knowledge in predicting weather and climate and these are consistent with findings of other studies (Ajani, Mgbenka, & Okeke, 2013; Nyong, Adesina, & Osman Elasha, 2007). Currently local people rely on their own experience and traditional knowledge as their main source of weather and climate related information. Some of these include, migration patterns of some birds; the movement of some species of ants; observing the gathering and colour of clouds; the direction of the wind and its smell; excessive heat as well consulting soothsayers.

5.6.3 Characteristics of groups served by the institution

Promoting inclusivity in service delivery by institution is key to ensuring social justice and equity (Agarwal, 2001; Meinzen-Dick et al., 2013; Uphoff & Buck, 2006). An assessment of the characteristics of groups served by MoFA, NABOCADO and YHF indicated that most of these institutions worked with individual farmers, farmer based association, women groups,

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local authorities, ethnic groups, disabled groups, other institutions working in the locality and poor farmers. Due to financial challenges leading to under resourcing of extension agents by MoFA, they could not effectively render their services to all the socially differentiated groups identified. Also, most of the NGOs worked based on a donor's request, institutional mandate or a request made by the community which are often project-based. Therefore, the objective of the project as well as its scope determines the characteristic of the group to be served.

Nonetheless, since each group may have different needs in terms of information, technology or farming strategy, it is critical to equip these institutions to adequately respond to their individual needs. For instance, some female respondents could not bund their farms with stones. This activity was often carried out by their husbands or assistance from males in these communities. Providing information on alternative strategies (for example, grass bund) which has the same function as stone bund but can be carried out with ease by female farmers is crucial.

Facilitating effective CSA adoption goes beyond providing information and diffusing technologies. Identifying inclusivity as a priority in both decision-making and in the assessments of costs and benefits of any intervention will enhance CSA adoption (Meinzen-Dick *et al.*, 2013).

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CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATION

6.1 Introduction

This chapter presents the summary, conclusion and relevant recommendations based on the findings of the study.

6.2 Conclusion

This study sought to explore local CSA practices adopted by smallholder farmers in Anafobiisi and Gowrie-Kunkua and how institutions can facilitate its successful adoption to promote improved rural livelihoods.

The results indicate that commonly adopted local CSA practices included: household and or community tree planting, composting, crop rotation, mulching, intercropping, manure management, improved forages, improved livestock breeding, improved crop varieties, irrigation, minimal tillage, stone or grass bunds, rain water harvesting, residue management and planting on contours or ridges. The commonly adopted practices are intercropping (100%), residue management (98%), improved forages (97%), composting (96%) and crop rotation (96%), and least for rain water harvesting (2%), manure management (2%), mulching (15%) and improved livestock breeds (16%).

There are indications that female headed households and rocky farmland types are the only likely factors that influence the adoption of composting as a CSA practice. It was also revealed that financial constraints, water shortages, small land size and insufficient information are the common barriers to effective adoption of local CSA practices.

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In assessing the contribution of local CSA practices to livelihood improvement of smallholder farmers, the results indicated that, farmers are not able to maximise yields on their lands, therefore, did not sell their produce to generate income. The situation is compounded by the rocky nature of the land including small land space for crop farming and the erratic nature of the rains. Despite these, food security has improved with about 76 % of farmers having meals three times in a day. In terms of funding child education as a measure of improved wellbeing, 91.6% of respondents funded through the sale of livestock. Moreover, by virtue of promoting climate smart agricultural practices 100% of the respondents have become more socially included and perceive that the adoption of local CSA practices would improve and maintain a healthy and sound environment.

Only three (MoFA, NABOCADO and YHF) of the intuitions surveyed are working in selected communities. Two types of institutions influencing adaptation strategies in both communities were identified. These were; public institutions such as MoFA and civil society organisations such NABOCADO and YHF. There are no market or private institutions physically present in these communities. All the above institutions through partnerships or collaborations double as linkages between farmers and aggregators. The commonly cited services rendered to smallholder farmers included food security (eg. promoting improved agronomic practices), climate change mitigation (eg. tree planting), weather and climate related decisions and market related decisions through collaborations with other institutions (eg. weather information). Further analysis of these institutional roles indicated that their role in structuring impacts and risks were not effectively carried out. Smallholder farmers doubted the credibility of weather information relayed on radio stations. More often than not, weather information on rainfall events did not occur as reported. In addition, most farmers

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were not aware of the existence of agricultural insurance products such as crop or livestock insurance. Awareness and access to these services will be key to appropriate adaptation strategies for livelihood development.

Though institutions developed new technologies in disseminating information, findings of this study showed that farmers have a large wealth of local knowledge in predicting climate and weather. There is therefore the need to integrate indigenous knowledge into climate policies and programmes for effective uptake of adaptation strategies. Financial constraints, inadequate human resource and lack of technical-know how are some of the challenges faced by all the institutions.

In conclusion, farmers in Anafobiisi and Gowrie-Kunkua are willing to adopt local CSA practices, but will need the necessary technical and financial support from various institutions.

6.3 Recommendations

The following recommendations are given based on the results presented.

The study revealed that farmers in both Anafobiisi and Gowrie-Kunkua are into subsistence farming which did not provide any source of income to households. For farming activities to move from being subsistence to an agribusiness, there is the need for improvement in soil fertility and these calls for intensification of agriculture in these areas. Moreover, the weak farmer based association in both Anafobissi and Gowrie-Kunkua must be revamped to take advantage of packages such as access to credits or buyer or innovations, which cannot be accessed on individual basis.

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In order to attain risk reduction, farmers must shift focus from subsistence crop production to other local economic activities in the district such as livestock rearing, basket weaving and shea butter processing which are being promoted by government, non-governmental organisations as well as private institutions.

Most farmers showed interest in the dry season farming since it will reduce the prolonged hunger gaps often encountered. However, they could not finance the acquisition of receptacles or the creation of reservoirs to store water for that activity. Thus, it is recommended that, practices with high start-up cost such as rain water harvesting or irrigations schemes should be funded by government in collaboration with civil societies or the private sector.

For smallholders to access agricultural inputs, there is the need for subsidies on agriculture inputs. For instance, most farmers could not cultivate new improved crop varieties or improved livestock breeds because of the high cost associated with it.

There is the need for the provision of credible meteorological information such as seasonal climate predictions and updates to help farmers plan their activities. Most farmers doubted the credibility of weather related information given to them from the media because there are several instances where weather events did not occur as predicted. Therefore, there is the need for Ghana Meteorological Agency to strengthen the credibility of climate information reaching farmers, so they can confidently rely on such information and adapt to reduce the risk of crop failures. To reduce risk and improve disaster preparedness as well as uptake, it is important to integrate existing indigenous knowledge in predicting weather and climate by smallholder farmers into scientific research, climate policies and programmes.

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Considering the complexities in terms of changing farmer's behaviour and strategies in adopting CSAs, there will be the need for frequent extension services to farmers to enable them successfully adopt best practices. Extension services will also serve as a platform for sensitising farmers on the importance of adopting CSA practices and ensure both men and women can successfully operate in an environment without political, economic or socio-cultural hindrances.

The findings of this study suggest that, to achieve any effective adaptation action in these communities and the district as a whole, there will be a need to enhance existing institutions. These calls for building capacities of staff of both MoFA and the existing local NGOs in diffusing place-specific technologies; recruiting more extensions agents to adequately meet the needs of farmers, as well as equipping them financially to effectively discharge their duties.

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APPENDICES

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CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT

This study is being carried out by Rahinatu Sidiki Alare, a graduate student of the University of Ghana, Legon on the topic: ***Climate Smart Agriculture Adoption by Smallholder Farmers: A Case Study of Anafobiisi in the Bongo District***, in partial fulfillment of the award of a Master of Philosophy in Climate Change and Sustainable Development. All information gathered will be treated with much confidentiality and would solely be for academic purposes. Your support and contribution would be very much appreciated.

Section 1: Household Data

Location of house ……..

Household number ……

Date of interview ……

Name of Household head……

Name of Interviewer ……..

Questionnaire Number ……

1.1 Respondent's Sex

a. Male
b. Female

1.2 Respondent Age

……..

1.3 Relationship of respondent to household?

a. Head
b. Spouse
c. Parent
d. Child
e. Grandchild
f. Other, Specify……...

1.4 Ethnic group

……

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1.5 Household type

a. Male headed with single wife
b. Male headed with multiple wives
c. Male headed, divorced, single or widowed
d. Female headed, divorced, single or widowed
e. Others, specify…….

1.6 Household size (A household is defined as a group of people who eat from the same pot) …….

1.7 What is the highest level of education attained?

a. No formal education
b. Primary
c. JHS/Middle form
d. SHS/O'level
e. Tertiary

1.8 State of access to land?

a. Owned b. Rented c. Borrowed d. Sharecropped e. Both Owned and Sharecropped

1.9 Who is responsible for making decisions about the land?

a. Only man/husband
b. Only woman/wife
c. Man and woman jointly responsible
d. Other, specify……

2.0 Which of the following crops do you grow?

1. Millet	8. Okro	15. Onions
2. Sorghum	9. Potatoes	16. Maize
3. Guinea Corn	10. Yam	17. Tobacco
4. Groundnut	11. (Alefu)	18. Soya Bean
	12. Tomatoes	19. Shea nuts
5. Rozelle	13. Pepper	20. Bambara Beans
	14. (Perha)	
6. Bean		
7. Rice		

Others,
Specify……

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2.1 Which of the following livestock do you rear?

1. Goats
2. Sheep
3. Cattle
4. Chickens
5. Pigs
6. Others, specify…….

Section 2: Climate Smart Practices

Kindly fill the entire column

2.0-Practice	2.1-Are you aware of the practice	2.2-Are you using [practice] currently on your farm or have you used it in the past 12 months?	2.3-Did you previously use [practice] on your farm even though you are not using it now?	2.4-Would you start using or reintroduce [practice] if you could?	2.5-Which practices are the most important? Mark (*) up to three practices from those marked YES in 2.1
	1=Yes>>2.2 0=No>>Next practice	***1=Yes>>Next practice 0=No>>Next practice, then 2.3, 2.4 and 2.5***	1=Yes 0=No	**1=Yes 0=No**	
Agroforestry/tree planting					
Composting					
Crop rotation					
Mulching					
Intercropping					
Manure management					
Improved forages					
Improved livestock breeding					

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Improved crop varieties					
Irrigation					
Minimal tillage					
Stone bunds					
Rain water harvesting					
Residue management					
Planting on contours or ridges					

2.6 What do you perceive as the benefits, if any, of using practice(s) marked "**YES"** in **Q2.1** above?

Practices	**Benefits**

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Kindly fill in the questions in the table below:

Practice (write in from 2.5)	2.7-What is your main source of information for [practice]?	2.8-Who made the decision to start using [practice]?	2.9-Who is primarily responsible for performing [practice]?

2.7	2.8/2.9
1- Government extension workers 2- NGOs 3- Community meetings 4- Farmer organizations 5- Research stations/Researchers 6- Religious groups 7- Agri-service providers, seed companies 8- Family members 9- Neighbors 10- Radio 11- TV 12- Newspaper/Bulletin 13- Schools/Teachers 14- Cell phone/Internet 15- Traditional knowledge 16- Agricultural Shows 17- Farmer Field Days 18- Own experience 19- Other (specify)	1- Husband 2- Wife 3- Both husband and wife 4- Male child 5- Female child 6- Other (specify)

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2.10. What types of feed are fed to livestock during both **dry** and **wet** season?

Livestock	Dry	Wet
Goat		
Sheep		
Cattle		

2.11. Are there any changes in feed resource availability over the last 5years?

a. Yes b. No

2.12. If **YES,** identify feed resource which are no longer available.

I. ……

II. ……

III. ……

2.13 What are the existing factors preventing the adoption of CSA practices?

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Section 3: Livelihood Outcomes

3.1 What is your main source of economic activity?

a. off-farm activities b. on- farm activities

3.2 Do you sell produce from your farm?

a. Yes b. No

3.2 What is your total monthly income from your main economic activity?

…….

3.3 How much money is spent on feeding within a week?

…….

3.4 How many times do you have meals in a day?

a. Once b. Twice c. Thrice

3.5 Do you consume some of what you produce?

a. Yes b. No

3.6 Are you able to fund your child's education from on-farm activities?

a. Yes b. No

3.7 What proportion of your income is used in funding your child's education?

……..

3.7 Which of the following associations do you belong to?

a. Farmer based association b. Other community based association

3.8 Which of the following associations do you play more active roles in?

a. Farmer based association b. Other community based association

3.9 Kindly list the kind of activities you get involved based on the association you play more actives roles in

……
…..

……
…..

3.10 In your own opinion, will the adoption of CSA practices positively impact the environment?

a. Strongly agree b. moderately agreed c. agree d. disagree

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CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT

This study is being carried out by Rahinatu Sidiki Alare, a graduate student of the University of Ghana, Legon on the topic: ***Climate Smart Agriculture Adoption by Smallholder Farmers: A Case Study of Anafobiisi and Gowrie-Kunkua in the Bongo District***, in partial fulfillment of the award of Master of Philosophy in Climate Change and Sustainable Development. All information gathered will be treated with much confidentiality and would solely be for academic purposes. Your support and contribution would be very much appreciated.

Section 1: Institutional information

Name of institution:
Institutional address:
Contact number:
Email address:
Person interviewed:
Position/function in the institution:
Male/female:
Name of interviewer:

1. Type of institution
   a. Government (Regional) b. Government (District) c. NGO (International).
   d. NGO (National) e. NGO (Local) f. Private sector (profit making)
2. Institutional interest/ mandate

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……
……
……
……
……

3. Does your institution directly work with or specifically target any of the following?
    a. Individual farmers
    b. Farmer based association
    c. Women groups/ individual women
    d. Local authorities
    e. Other institutions working in the locality
    f. Poor farmers
    g. All of the above

4. What kind of services do you extend to smallholder farmers on:
    i. Agricultural decision making

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ii. Natural resource management

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iii. Food security

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iv. Weather and climate change related decisions

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v. Markets related decision

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vi. Climate change mitigation

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vii. Other types

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……

5. How often do you extend such services to small holder farmers?

……
……
……

6. What objective(s) does your institution seek to fulfil in the area of supporting farmer decision making by providing information and services?
   a. ……
   b. ……
   c. ……

7. What mechanisms are available to enable smallholder farmers access information on farm inputs (eg. fertilizer, machinery, diverse set of seeds and breeds, early warning systems for floods, drought, pest and diseases)?

……
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8. Through what media does your institution disseminate information, new practices and technologies?

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……

9. What are the current activities implemented by your institution, the target groups and priority?

Project	**Target group**	**Priority (scale of 1-5)**

10. Are you into climate smart agriculture (CSA) practice?
    a. Yes b. No

11. If 'YES' what CSA interventions is your institution rendering to farmers?

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12. In which localities does your institution render such services to?

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13. How long have you been rendering such services to localities identified?

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14. How do you select beneficiaries?

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15. Any challenges associated with selecting beneficiaries?

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……

16. From your point of view, what is the relative importance in the portfolio of your institution that you place on climate smart agriculture activities? Please tick.

	None	Low	Medium	High	Very high
Allocation of time					
Allocation of staff					
Allocation of budget					
Other( )					

17. From your point of view, what is/will be the driving agenda for rendering climate smart agriculture services to smallholder farmers?
    a. Request from Donors
    b. Mandate of my institutions
    c. Request from farmer based associations
    d. Request from individual farmers
    e. Other (specify)……..
    f. All of the above…….

18. Are there well-functioning and accessible markets to enable farmers sell their produce?
    a. Yes b. No
19. What mechanisms are put in place to improve the use of informal seed system among smallholder farmers?

……
……
……
……
……

20. Do you provide incentives to farmers for adopting climate smart agriculture practices?
    a. Yes b No

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21. If "Yes", what kind of incentives are available?
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    ……
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22. Are there any social safety nets to support smallholder farmers?
    ……
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23. If yes, which kinds are available?
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24. Are there any available opportunities in partnering with other private/public institutions to invest in climate smart agriculture practices?
    ……
    ……
    ……
    ……
    ……

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Chi Square test Analysis of factors and the Adoption of CSA Practices

Variable	Composting		Crop Rotation		Improved Forages		Residue Management	
	X2	Sig.	X2	Sig.	X2	Sig.	X2	Sig.
Sex	2.79	0.1	0.12	0.73	1.50	0.22	0.74	0.39
Age	0.55	0.46	8.94	0.12	0.49	0.49	0.54	0.82
Income	2.03	0.36	5.96	0.05*	1.88	0.39	0.93	0.63
Educational level	0.89	0.35	1.63	0.2	0.49	0.48	0.24	0.62
Household type	7.68	0.05*	8.65	0.03*	1.36	0.71	0.67	0.88
Household Size	1.63	0.65	0.92	0.82	12.77	0.01*	0.75	0.86
Awareness	0.06	0.81	11.8	0.00	0.03	0.86	0.02	0.9
Access to credit	0.17	0.68	0.12	0.73	0.11	0.77	0.05	0.83
Access to Information	0.29	0.59	0.21	0.65	0.16	0.69	0.08	0.78
Type of farmland	2.33	0.13	3.76	0.05*	0.11	0.74	1.47	0.23