Antioch University
AURA - Antioch University Repository and Archive

Dissertations & Theses

Student & Alumni Scholarship, including Dissertations & Theses

2018

Exploring Perceptions of the Potential of Agricultural Insurance for Crop Risks Management Among Smallholder Farmers in Northern Ghana

John Bosco Baguri Sumani
Antioch University, New England

Follow this and additional works at: https://aura.antioch.edu/etds

Part of the Agricultural and Resource Economics Commons, and the Environmental Studies Commons

Recommended Citation
Sumani, John Bosco Baguri, "Exploring Perceptions of the Potential of Agricultural Insurance for Crop Risks Management Among Smallholder Farmers in Northern Ghana" (2018). *Dissertations & Theses*. 425.
https://aura.antioch.edu/etds/425

This Dissertation is brought to you for free and open access by the Student & Alumni Scholarship, including Dissertations & Theses at AURA - Antioch University Repository and Archive. It has been accepted for inclusion in Dissertations & Theses by an authorized administrator of AURA - Antioch University Repository and Archive. For more information, please contact dpenrose@antioch.edu, wmcgrath@antioch.edu.

ANTIOCH UNIVERSITY
NEW ENGLAND
Department of Environmental Studies

DISSERTATION COMMITTEE PAGE

The undersigned have examined the dissertation entitled:

Exploring Perceptions of the Potential of Agricultural Insurance for Crop Risks Management Among Smallholder Farmers in Northern Ghana

Presented by John Bosco Baguri Sumani, candidate for the degree of Doctor of Philosophy, and hereby certify that it is accepted.

Committee Chair: James W. Jordan, Ph.D., Department Environmental Studies, Antioch University New England, Keene, NH, USA

Committee Member: Jean Kayira, Ph.D., Department of Environmental Studies, Antioch University New England, Keene, NH, USA

Committee Member: Helen Greatrex, Ph.D., International Research Institute for Climate and Society, Colombia University, New York, USA

Defense Date: May 10, 2018
Date Submitted to Registrar's Office:

Signatures are on file with the Registrar's Office, Antioch University New England, Keene, NH, USA

Exploring Perceptions of the Potential of Agricultural Insurance for Crop Risks Management Among Smallholder Farmers in Northern Ghana

By

John Bosco Baguri Sumani

A dissertation submitted in partial fulfillment of the requirements for the award for the degree of

DOCTOR OF PHILOSOPHY

In

Environmental Studies

At Antioch University New England

2018

© 2018

John Bosco Baguri Sumani

ALL RIGHTS RESERVED

Abstract

Smallholder farmers in Northern Ghana are exposed to multiple agricultural risks, which require various adaptation strategies to address. However, these strategies are only partially effective. Agricultural insurance has been promoted to assist smallholders in low-income countries to manage their key agricultural risks. The Ghanaian government and its collaborating partners introduced three agricultural insurance programs (AIPs) since 2009. In countries other than Ghana, some post-piloting evaluations of AIPs have revealed mixed outcomes, with some schemes resulting in unintended socio-ecological and maladaptive consequences. Despite these concerns, no study has explored the potential of agricultural insurance for smallholders' crop risks management in Ghana. Thus, this research was undertaken to address this gap. It also investigates stakeholders' perspectives of the potential of AIPs in promoting sustainable farming agricultural practices and climate change mitigation. I employed a convergent research design to address these issues using stratified, purposeful, and random sampling. Focus groups, informant interviews, and questionnaires were utilized to solicit responses. The resultant data and themes were analyzed using SPSS and Excel. This research revealed that agricultural risks, including those related and unrelated to weather and climate—have been adversely affecting smallholders, and have been addressed by farmers through food rationing, out-migration, and technology-based adaptation strategies. Some reported benefits of AIPs were the motivations to increase crop production, farm investments, and financial protection. This study provides scholarly, practical, regulatory, and policy-focused insight into agricultural insurance growth. My findings indicate that further attention and research are needed to building awareness about AIPs, the design of farmer-sensitive contracts, and their subsidization by government. I recommend future research focus on addressing

issues of upstream and downstream agro-risks management and on replicating this study in other geographical locations where smallholder farmers struggle to survive

Keywords: Agricultural insurance, agricultural risks, crop risks management strategies, sustainable farming practice, climate change mitigation, smallholder farmers, Northern Ghana

Dedication

I dedicate this dissertation project to my dear wife, Alice Dakurah, and lovely children; Bright, Roland, and twins Jayden and Jaylen, for their support and understanding of my always being away at the time they needed me most. I also pay tribute to my parents, Sumani Nyebadi of blessed memory, and Naamah Zindiyele Nyebadi, for all they have done to catapult me this far, irrespective of the tumultuous times and challenges.

Acknowledgments

I wish to acknowledge the contribution of my committee members, Drs. James W. Jordan and Jean Kayira of the Environmental Science (ES) Department of Antioch University New England (AUNE), and Dr. Helen Greatrex of International Research Institute for Climate and Society, Columbia University, New York, to this final product. I would like to specially thank them for the guidance, support, and timeliness with feedback, even when I sometimes gave them only a short time to review voluminous chapters. I also acknowledge the wonderful blend of talents and expertise at my disposal, which covered climate variability and change, research methodology, and agricultural insurance, from both applied and theoretical lenses. I would like to thank them, especially for the promise to make their talents and expertise available to me even after my graduation.

I would also like to acknowledge the contribution and support of the Most High, my parents, managers of the University for Development Studies, friends, especially Yves Gakunde, relatives, and staff of the ES department and the larger Antioch and Keene community. AUNE is a great place to be and made such a great impression on me during my master's degree program that I returned there to pursue my Ph.D. studies.

My special thanks go to the Government of Ghana, represented by the Ghana Education Trust Fund (GETFUND) for sponsoring my Ph.D. studies. Without this sponsorship, I probably would have been nowhere to be called and recognized as a Ph.D. holder. I am proudly a Ghanaian.

Table of Contents

List of Figures

List of Tables

List of Appendices

List of Abbreviations

A&O	Administrative and Operational Cost
ACDEP	Association of Church Development Program
ADB	Agricultural Development Bank
ADF	Agricultural Development Fund
ADVANCE	Agricultural Development and Value Enhancement Project
AEZ	Agro-Ecological Zones
AEAs	Agricultural Extension Agents
AICs	Agricultural Insurance Companies
AIP	Agricultural Insurance Program
AIS	Agricultural Insurance Schemes
ARH	Actual Revenue History
ATR	African Traditional Religion
AUNE	Antioch University New England
AYI	Area Yield Index
BA	Brong Ahafo Region
CCAFS	Climate Change, Agriculture, and Food Security
CBs	Community Banks
CCU	Community Cooperative Credit Union
CF	Conceptual Framework/Christian Faith
CO_2	Carbon Dioxide
CRC	Crop Revenue Coverage
CRS	Christian Relief Supplies
CSA	Climate-Smart Agriculture
CSC	Climate-Smart Cocoa Crop Insurance
CSIR	Council for Scientific and Industrial Research
CF	Conceptual Framework
DII	Drought Index Insurance

DIDO	Dezendani Integrated Development Organization
EPA	Ghana's Environmental Protection Agency
ECOWAS	Economic Community of West African States
ES	Environmental Studies
FA	Field Associate
FAO	Food and Agricultural Organization
FAW	Fall Army Worm
FBOs	Farmer-Based Organizations
FCIP	Federal Crop Insurance Program
FASDEP	Food and Agricultural Policy Development Framework
FGD	Focus Group Discussion
FSC	Forestry Services Commission
GAIP	Ghana Agricultural Insurance Pool/Program
GDP	Gross Domestic Product
GETFUND	Ghana Education Trust Fund
GH¢	Ghana Cedis
GHG	Greenhouse Gas
GHGI	Greenhouse Gas Intensity
GIA	Ghana Insurers Association
GIRSAL	Ghana Incentive-Based Insurance for Risks Sharing and Agricultural
GIZ	Germany International Development Cooperation
GMA	Ghana Meteorological Agency
GSS	Ghana Statistical Service
IDA	International Development Agency
IFAD	International Fund for Agricultural Development
IIPACC	Innovative Insurance Product for Adaptation to Climate Change
IPA	Innovation for Poverty Action
IP	Income Protection

IPCC	Inter-Governmental Panel on Climate Change
IRB	Institutional Review Board
IRI	International Research Institute
JHS	Junior High School
KII	Key Informants
LEAP	Livelihood Empowerment Against Poverty
MDAs	Ministries, Departments, and Agencies
MESTI	Ministry of Environment, Science, Technology, and Innovation
MFIs	Micro-Finance Institutions
MIDA	Millennium Development Authority
MMDAs	Metropolitan, Municipal, and District Assemblies
MOFA	Ministry of Food and Agriculture
MPCI	Multi-Peril Crop Insurance/All-Risks Insurance
NADMO	National Disaster Management Organization
NG	Northern Ghana
NGO	Non-Governmental Organization/Non-Profit Organization
NGWP	Net Global Warming Potential
NHIA	Ghana National Health Insurance Authority
NIC	Ghana National Insurance Commission
NR	Northern Region
PFAG	Peasant Farmers Association of Ghana
PFJs	Planting for Food and Jobs
PGW	Potential Global Warming
PHC	Population and Housing Census
RA	Revenue Assurance
RAIMOs	Regional Agricultural Insurance Marketing Officers
RB	Rural Banks
RC	Regional Coordinator

REC	Research Ethics Committee
RMA	Risk Management Agency
SARI	Savannah Agricultural Research Institute
SHSS	Senior High Secondary School
SLP	Service-Learning Project
SMS	Short Message Service
SSA	Sub-Saharan Africa
SPSS	Statistical Package for the Social Sciences
TTFPTP	Third Trimester Field Practical Training Program
UER	Upper East Region
UNDP	United Nations Development Program
UDS	University for Development Studies
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations International Children Education Fund
USAID	United States Agency for International Development
USDA	US Department of Agriculture
UWR	Upper West Region
VSLAs	Village Savings and Loan Associations
WACCU	Wa Community Cooperative Credit Union
WASSCE	West African Secondary School Certificate Examinations
WC	WorldCover
WFP	World Food Program
WIBI	Weather Index-Based Insurance
WII	Weather Index Insurance
WTE	Willingness to Supple/engage in
WTP	Willingness to Pay

Chapter 1: General Introduction

1.1 Introduction

Smallholder farmers are those farmers growing a handful of crops cultivated almost entirely by family labor. In addition to subsistence farming, they may grow a small surplus of crops to sell on the market. They often struggle to succeed in a global agricultural system shaped by powerful agribusiness interests. Relatively little is known about the effects of agricultural insurance on the outcomes of smallholder farming operations. My research aims to explore perceptions of the potential and possibilities of agricultural insurance by answering the following overarching questions: What is the plight of poor and vulnerable smallholder farmers whose crops fail them? Can alternative livelihood options support smallholder farmers to ensure their food security? Do their existing adaptation strategies, coping measures, and safety nets support them to survive till the next farming season? Can smallholder crop insurance contracts supplement the current strategies farmers typically employ to manage their key agricultural risks? The answers to these questions could reveal whether Agricultural insurance is helping smallholder farmers in Northern Ghana (NG) to manage some of their key agricultural risks, especially crop risks.

1.2 The Agricultural Sector: Its Importance and Risks

Agriculture is the mainstay of most countries and constitutes the primary source of livelihood for the rural poor in developing countries (Lotze-Campen & Popp, 2012a). Over 70% of the world's poorest people live in rural areas and are mostly smallholder farmers who depend on agriculture for their sustenance (IFAD, 2011). Smallholder farmers produce over 80% of the food consumed in Sub-Saharan Africa (IFAD, 2011) and play a pivotal role in the socio-economic growth and development of their countries (Nnadi et al., 2013).

Despite the crucial role agriculture plays in the economies and lives of inhabitants of most developing countries, the sector has been threatened by various challenges. These include weather and climate-induced factors (Ward, Florax, & Flores-Lagunes, 2014), as well as other types of risks (Smit & Skinner, 2003; McLeman & Smit, 2006). Not only is the phenomenon of climate variability and change already affecting some farmers adversely, but also is predicted to worsen in the future (Edenhofer et al., 2012; Lotze-Campen, Müller, Popp, & Füssel, 2012; Stocker et al., 2013). This challenge has inflicted untold hardships and food insecurity conditions on some inhabitants of low-income countries, especially vulnerable farmers (Yap & Lotze-Campen, 2012). To address agricultural risks affecting smallholder farmers in low-income countries, some scholars and policymakers have recommended the introduction of various interventions, including Agric I, especially weather-based index insurance (WII), to assist farmers in reducing some of their climate-induced agricultural risks (Barnett & Mahul, 2007; Mahul & Stutley, 2010).

The contribution of agriculture to the growth and development of Ghana is similar to that of other African and tropical developing countries. For instance, the Ministry of Food and Agriculture (MOFA) revealed that the agricultural sector in Ghana employs about 51% of the total labor force, accounts for 75% of the country's foreign exchange, and is also the major contributor to GDP (39%), among other contributions (MOFA, 2007). About 90% of the inhabitants of Northern Ghana are smallholder farmers (Sumani, 2008), with most of them depending on rain-fed agriculture for their livelihoods (Acheampong et al., 2014). These statistics testify to the importance of Ghana's agricultural sector to its economy and residents. However, even though agriculture is still the largest contributor to the GDP (MOFA, 2007) with a marginal growth over time (Ghana Statistical Service (GSS)/MOFA, 2017), its share of the GDP has reportedly been declining over the years. The continuous reduction in the contribution of agriculture to GDP and other economic indices are mainly attributed to climate change and other problems confronting the sector.

Agricultural challenges in Ghana are mainly posed by weather-induced risks, even though non-weather-related risks also adversely affect some farmers. These challenges are more pronounced in Northern Ghana than in Southern Ghana (Adjei, Ahlers, & Andah, 2012; Sumani, 2008). This is due to the former's high dependence on rain-fed agriculture, as well as its peculiar geographic location within the Sudan and Guinean Savanna Ecological Zones, which experience a unimodal rainfall pattern (Ghana's Environmental Protection Agency, 2003.), both of which are exacerbated by a high incidence of poverty (Acheampong et al., 2014; Songsore & Denkabe, 1991). This study was, therefore, designed to identify the key agrarian risks smallholder farmers face in Northern Ghana and to explore how agricultural insurance can support smallholder farmers in managing some of these agricultural problems.

Agricultural insurance in general, and index-based insurance, in particular, can support smallholder farmers in low-income countries in coping with adverse effects from some of their key agricultural risks. For example, some researchers and policymakers report that weather index insurance can help smallholder farmers in low-income countries mitigate major agricultural risks (Barnet & Mahul, 2007; Clarke, Mahul, Rao, & Verma, 2012; Marr, Winkel, van Asseldonk, Lensink, & Bulte, 2016). Some of these scholars have recommended the piloting and up-scaling of AIPs and contracts to assist smallholder farmers in developing countries (Greatrex et al., 2015, Carter, de Janvry, Sadoulet, & Sarris, 2014). However, some post-piloting and implementation investigations into the performance of weather index insurance programs in some developing countries have reported mixed findings and reactions (Binswanger-Mkhize, 2012; Banerjee &

Berg, 2012; Hossain, 2013), indicating a need for further research into the prospects, feasibility, viability, and sustainability of agricultural insurance protocols.

Despite the promise of index-based insurance schemes and contracts as tools for agrarian risks management in low-income countries, some agricultural insurance programs have also been criticized for generating unintended adverse socio-ecological consequences. Some of the negative environmental impacts reported include ecological degradation (Müller & Kreuer, 2016; Phelan, Taplin, Henderson-Sellers, & Albrecht 2011) and maladaptation, i.e., the exacerbation of ecological degradation and further climate change (Klein & Maciver, 1999; McLeman & Smit, 2006; Müller, Johnson, & Kreuer, 2017; Panda, 2013). Some of these environmental risks may increase liability for agricultural insurance companies (Berz,1999; Mills, 2009), suggesting that the insurance industry, including the agricultural insurance companies (AICs) and their programs, need to take proactive measures to address these challenges (Dahlström, Skea & Stahel, 2003; Mills, 2009; Skee & Collier, 2012).

This dissertation project was undertaken in response to calls for further research into the potential of insurance as an agricultural risk management tool in low-income countries (Barnett & Mahul, 2007; Binswanger-Mkhize, 2012; Marr, Winkel, van Asseldonk, Lensink, & Bulte, 2016), especially in Northern Ghana (Stutley, 2010). This investigation was also timely because some AIPs in Northern Ghana were either about to be rolled out, were being piloted, or had recently been up-scaled. For instance, the Ghana Agricultural Insurance Pool (GAIP) is currently implementing and upscaling its AIP. The Government of Ghana has also initiated steps to implement an AIP called the Ghana Incentive-Based Risk Sharing and Agricultural Lending program (GIRSAL). An American company called WorldCover (WC) is also piloting a drought index insurance (DII) program in Northern Ghana and is currently going through the licensing process. The findings and recommendations of this dissertation research are therefore timely and will be useful to these AIPs.

My research employs a convergent mixed methods design to understand how agricultural insurance can assist smallholder farmers in managing their key agricultural risks. In the context of my dissertation project, convergent mixed methods design involves collecting qualitative and quantitative data concurrently, analyzing both sets of data separately, and then integrating these data for further analysis, interpretation, and discussion.

My goal for undertaking this dissertation research is not only to identify and understand the key agricultural risks confronting smallholder farmers in Northern Ghana, but also to assess how these risks are affecting these farmers. I further wish to understand how smallholders in Northern Ghana have been managing their agricultural problems so that I might explore the ways agricultural insurance can be employed to complement their existing agricultural risks management strategies.

My central research question is as follows: Does agricultural insurance have the potential to assist smallholder farmers in Northern Ghana in managing their key agricultural risks? To answer this question, my dissertation project explored the following component questions:

- What are smallholder farmers' major crop risks?
- What strategies have these farmers been employing to manage their key crop risks? How effective are these strategies?
- In what ways have AIPs and contracts been or can help (benefits) smallholder farmers to manage their key crop risks?

- Are agricultural stakeholders (i.e., insurers and insured smallholder farmers) willing to use agricultural insurance as a tool for promoting sustainable farming practices and climate change mitigation in Northern Ghana? If so, what ways can agricultural insurance programs and contracts help insurers and insured farmers to accomplish this goal?

1.3 The Motivation for This Research

My motivation for undertaking this dissertation research was informed by:

1. My personal and professional encounters and experiences with the vulnerability and exposure of smallholder farmers to agricultural risks,

2. Reports from the literature detailing how farming challenges adversely impact farmers, especially smallholder farmers in low-income countries, and

3. Recommendations by researchers, policymakers, international development agencies (IDAs), and agricultural practitioners for further research into agricultural insurance issues, not only to ensure the feasibility, viability, and sustainability of AIPs but also to avoid post-piloting and post-upscaling mortalities (e.g., Banerjee & Berg, 2012).

As a peasant farmer's son whose education was fully funded through proceeds from agriculture, it is sad to witness both climate-related and other challenges contributing to the declining fortunes of the Ghanian agricultural industry, especially as seen in declining agricultural productivity and the concomitant adverse impacts on smallholders. My interest in researching challenges confronting subsistence farmers was further heightened when I came face-to-face with this reality while coordinating the University for Development Studies' (UDS) Third Trimester Field Practical Training Program (TTFPTP) from 2011-2013. Under the TTFPTP, students are usually sent to live, experience, and study conditions in deprived farming communities to identify developmental challenges and the potentials within those communities. The encounters, experiences, and observations narrated above have also been abundantly documented in the literature. The adverse effect of increasing agricultural risks on smallholder farmers kept me wondering whether agricultural insurance could be a panacea for their agricultural challenges.

Touched by the plight of these rain-dependent smallholder farmers amid varying and changing climatic conditions, weather extremities, and other non-weather-related agricultural problems, I decided to do something about it. First, I reoriented my academic, professional, and community development efforts towards exploring and promoting concepts of how smallholder farmers can be assisted to cope with key agricultural risks, including ways for helping them adapt to adverse effects of climate variability and change while contributing to its mitigation in whatever way they as individual farmers can. In line with this vision, I also used my master's thesis research in 2008 to investigate the impact of climate variability and change on human migration in the Upper West Region (UWR) of Ghana. This enabled me to propose measures for reducing adverse effects on individuals forced into climate-induced migration as well as to consolidate the benefits of out-migration.

I also utilized my Environmental Studies Doctoral Service-learning Project (SLP) to conduct a pilot study in 2015 for my dissertation project, specifically focused on identifying the agricultural insurance implementation challenges in the Upper West region of Ghana in 2015. The SLP offered me the opportunity to learn more about the theoretical, practical, legal, policy-based, and other implementation dimensions of agricultural insurance. I equally used the SLP to make contacts and establish relationships with some key stakeholders in the agricultural and agricultural insurance industries in Ghana as a way of preparing the ground for my dissertation research fieldwork in 2016 and 2017. I have also challenged myself to focus my dissertation project on further understanding how AIPs and contracts can support smallholder farmers to cope with their key agricultural risks in developing countries, especially in Northern Ghana.

1.4 Significance of the Study

This dissertation research has the potential to contribute to the growth and development of the agricultural and agricultural insurance sectors in Ghana and other low-income countries with similar demographic, biophysical, and socio-economic characteristics. Smallholder farmers in Northern Ghana are confronted with a plethora of agricultural challenges. Even though these farmers have employed various strategies to manage their initial agricultural challenges, agricultural insurance may further support these farmers in coping with their residual agricultural risks.

The need for researchers to explore the potential of agricultural insurance for farm risks management in Northern Ghana is both timely and urgent. There are currently three AIPs either being up-scaled throughout Ghana (i.e., GAIP), piloted in Northern Ghana and the Brong Ahafo Region (i.e., WC), or planned for the 2018 crop season (i.e., GIRSAL). Refer to the section on the agricultural sector: its importance and risks for detailed information about these AIPs. The findings and recommendations of my research will be useful to these AIPs.

In addition to the gaps identified above (section 1.2), it is equally essential to identify existing adaptation strategies (both formal and informal), safety nets, and social welfare programs targeted at assisting smallholder farmers in coping with farm risks. I have not come across any single study in Northern Ghana that specifically identifies these agricultural risks management strategies or that assesses the effectiveness of such strategies in determining the potential for AIPs to complement existing agricultural risks management measures. This dissertation project responds to this gap.

For a study exploring perceptions of the potential of AIPs and contracts for crop risks management, it is essential to evaluate the efficacy level of existing agricultural risks management strategies to determine whether formal AIPs are needed. If existing safety nets and autonomous adaptation strategies are effectively assisting smallholders to manage their key agricultural risks, then rolling out AIPs and policies may amount to inefficient allocation of scarce resources, when such resources could be better used to address other urgent developmental challenges and needs of low-income countries, including poverty reduction and gender inequality issues. In this case, what may be required is enhancing the capacity of farmers to take advantage of existing safety nets, welfare programs, and other forms of informal and formal adaptation mechanisms. This dissertation project will, therefore, contribute insight for the efficient allocation of scarce resources to needy sectors of low-income countries and regions, specifically in Northern Ghana.

The research published by the few authors who have explored agricultural insurance issues in Northern Ghana differs from my own in limiting the research scope to the following topics:

1. The role of weather index insurance as a social safety net (Molini et al., 2008; Molini et al., 2010), 2. Weather index insurance as an adaptation to climate variability/change (Adiku, Debrah-Afanyede, Greatrex, Zougmoré, & MacCarthy, 2017), 3. Farmers' willingness to participate and pay for index insurance (Abugri, Amikuzuno, & Daadi, 2017; Afriyie, Zabel, & Damnyag, 2017; BalmaIssaka, Wumbei, Buckner, & Nartey, 2016; Danso-Abbeam, Addai, & Ehiakpor, 2014), 4. Farm investments, financial protection, and promotion of agro-input use (Haruna, 2015; Haruna, Sohngen, Yahaya, & Wiredu, 2017; Nunoo & Acheampong, 2014; Karlan, Osei-Akoto, Osie, & Udry, 2010), and 5. An assessment of the impact of agricultural insurance on gender (Greatrex & MaCarthy, 2016). Other studies only identify agricultural insurance as an agricultural risk management strategy (e.g., Bawakyillenuo, Yaro, & Teye, 2016). However, investigating the role

or determining the efficacy and potential of AIPs and contracts for crop risks management are grey areas in Northern Ghana. My dissertation research contributes to closing this knowledge gap by determining the potential of agricultural insurance and identifying a litany of ways it (i.e., AIPs and contracts) can support farming households in Northern Ghana to mitigate some agricultural risks.

One significant contribution of this dissertation project is its ability to link agricultural insurance with smallholder farmers' agrarian practices and climate change mitigation activities. Some researchers have expressed concerns that some index-based AIPs and contracts are creating unintended maladaptation and ecological degradation in some developing countries (McLeman & Smit, 2006; Nigus, Nillesen, & Mohnen, 2018; Panda, 2013). These authors and other scholars claimed that these environmental challenges would not only increase the liabilities of AICs but would also threaten their sustainability and profitability (Bergs, 1999; Mills, 2007). They, therefore, call on the insurance industry, including AICs, governments, agricultural insurance regulators, and other stakeholders to incentivize smallholder farmers in low-income countries to engage in sustainable agricultural practices and climate change mitigation (Dahlström, Skea, & Stahel, 2003; Müller, Johnson, & Kreuer, 2017; Skees & Collier, 2012). My dissertation research subscribed to this call since no such a study has been conducted in Northern Ghana. This research, therefore, explored the willingness of agricultural insurers to motivate insured farmers to engage in agro-ecology farming practices, climate-smart agricultural activities, and climate change mitigation undertakings. I also sought the willingness of farmers to participate in sustainable farming practices if they were motivated and supplied subsidized agricultural insurance contracts bundled with environmentally sound practices (Chapter 7 on Results). Employing insurance to address possible climate change, maladaptation, and ecological concerns in Ghana is timely since other new AIPs and companies are joining GAIP to provide insurance services to farmers, and are at various stages of development, i.e., intention to roll-out, piloting, and up-scaling AIPs and contracts. The findings and recommendations will be relevant for these AIPs and companies.

The findings, recommendations, and suggested research areas this study puts forward may also be useful to smallholder farmers, IDAs, potential researchers, GIA, NIC, and MOFA for purposes of agricultural risk management, product design, insurance industry regulation, and agricultural policy formulation and implementation.

1.5 Delineation of the Study

Specific delineation factors set the boundaries, scope, and focus of my dissertation research through the enlistment of the following strategies:

1. The research covers only the three Northern Regions of Ghana, comprising the Upper West, Upper East, and Northern Regions.
2. The study participants consisted of:
    i. Primary smallholder farmers in Northern Ghana
    ii. Secondary study participant groups composed of public and non-public officials working with smallholder farmers in Northern Ghana
    iii. Tertiary level participants comprising agricultural and agricultural insurance-related researchers, as well as agricultural insurance staff and regulators in Ghana (within and outside Northern Ghana)
3. The study covered the identification of:
    i. Smallholder farmers' key agricultural risks

ii. Smallholder farmers' adaptations, coping strategies, and social safety nets, as well as an assessment of the extent of their effectiveness

iii. Ways agricultural insurance enables farmers to manage key agricultural challenges, and

iv. Factors that can motivate agricultural risks insurers, as well as insured farmers, to promote and engage in sustainable farming practices and climate change mitigation efforts in Northern Ghana.

1.6 Assumptions

Before engaging in this research, I was aware that a plethora of factors and conditions could influence my study participants' responses. For instance, their motives, interests, and moods at the time in which they interacted with me could affect their responses, and ultimately, my research findings, conclusions, and recommendations. Unfortunately, I did not have any scientific or quantitative way of assessing these confounding factors. Based on these possible limitations, I assumed that:

1. The study participants were representative or nearly representative of their respective sub-populations, i.e., that focus group discussants, key informants, and survey respondents were representative of: (a) smallholder farmers, (b) officers and non-officers working with smallholder farmers, and (c) agricultural insurance-related researchers, regulators, practitioners, and policymakers, respectively.
2. As a multi-layered study with a primary focus on smallholder farmers, I assumed that key informants and survey respondents (who were not farmers themselves) provided honest and accurate answers that reflected not only their professional opinions but also the concerns and interests of smallholder farmers.

3. The study participants understood the interview and survey questions and provided honest and accurate responses to the best of their knowledge and abilities.

1.7 Dissertation Chapter Organization:

Chapter 2: Conceptual Framework and Literature Review

Chapter 3: Research Methodology and Design

Chapter 4: Results on Smallholder Farmers' Key Agricultural Risks

Chapter 5: Results on Smallholder Farmers' Agricultural Risks Management Strategies

Chapter 6: Results on the Role of Agricultural Insurance for Smallholder Farmers' Crop risk management

Chapter 7: Results on the Potential of Agricultural Insurance in Promoting Sustainable Farming Practices and Climate Change Mitigation

Chapter 8: Discussion of Results

Chapter 9: Summary of the Study, Conclusions, and Recommendations

1.8 Chapter Summary

Smallholder farmers in most African and other low-income countries depend on rain-fed agriculture for their livelihoods. Even though agriculture plays a crucial role in the lives of these farmers, the sector has been confronted with both climate-related and other agricultural risks. This increases the vulnerability of smallholder farmers to these agricultural challenges. These risks often result in poverty, food insecurity, famine, hunger, and malnutrition, thereby compelling affected farmers to employ a variety of interventions and strategies to adapt to and cope with key agricultural risks.

However, scholars do not concur on the extent of effectiveness of smallholder farmers' existing agricultural risks management mechanisms. Whereas some researchers argue that these agricultural risks adaptation strategies are effective, others conclude that they are only effective to some extent or are effective at all. Irrespective of the extent of effectiveness or ineffectiveness of the smallholder farmers' agricultural risk management strategies, the important point is that these adaptation strategies and coping measures may be inadequate, leaving a gap that yearns to be closed. Therefore, various agricultural risks management options have been recommended in the literature to assist smallholder farmers in low-income countries in addressing their residual agrarian risks, including the application of agricultural insurance, especially weather index insurance.

The picture painted by the preceding paragraph concerning the plight of smallholder farmers in low-income countries is similar to the case of smallholder farmers in Northern Ghana. Unfortunately, climate variability, climate change, and additional non-weather-induced challenges are making it impossible for these farmers to harvest the adequate yields needed to sustain themselves throughout the year and to also sell some farm produce to foot other household expenses and fulfill other commitments. These farmers have, therefore, relied on a combination of indigenous and scientific agricultural risk management strategies to reduce their vulnerabilities. However, I pause here to ask the following questions: What are those formal and informal adaptation strategies smallholder farmers have employed to manage their agricultural risks? Are these strategies efficiently helping them to manage their key agricultural risks? What are those key agricultural risks? How can agricultural insurance contracts help smallholder farmers to address their key agricultural risks? Are AICs willing to support and motivate insured farmers to engage in sustainable farming practices and climate change mitigation activities? If so, in what ways? Are smallholder farmers willing to engage in sustainable farming practices and climate change mitigation endeavors? If so, what are those sustainable farming practices and climate change mitigation activities? Moreover, what are their motivations for wanting to engage in these sustainable farming practices and climate change mitigation activities?

These questions challenged me me to determine the perceptions of the potential of agricultural insurance for crop risks management among smallholder farmers in Northern Ghana. Answers to these questions will not only expand the literature on the role of agricultural insurance based on information from the study participants but will also contribute as to how agricultural insurance can promote agro-ecological farming practices and climate mitigation, which is an emerging field in the agricultural insurance scholarship. My findings, conclusions, and recommendations will guide agricultural and agricultural insurance policy formulation and implementation, and will also guide the regulatory environment in Ghana, in addition to informing the re-design and design of existing and new AIPs and contracts, respectively. The conduct of this study is timely since various AIPs are either being introduced, test-run or expanded. For instance, GAIP is marketing its contracts in eight out of the ten regions in Ghana whereas WorldCover is also piloting its agricultural insurance model on DII products while going through its licensing process at the same time. The government of Ghana is also about to introduce a new agricultural insurance scheme (GIRSAL) during the 2018 farming season. Therefore, the information generated will be useful for these AICs, programs, and contracts.

The introductory chapter is followed by the conceptual framework that provides guidance, direction, structure, and boundaries for this study. The conceptual framework is presented alongside the literature review that informs this dissertation project.

Chapter 2: Conceptual Framework and Literature Review

2.1 Introduction

I undertook the literature review to gain insight into the operations of agricultural insurance in low-income countries, so that I could avoid previously discovered pitfalls and so that I could be aware of best lessons and practices harnessed going forward. The literature review enabled me to gain knowledge of the past and present debates, theories, conceptual and theoretical frameworks, and scholars in the agricultural insurance discourse in addition to identifying the relevant concepts, themes, and variables. It also offers me the opportunity to delve into the history and evolution of the field of agricultural insurance. A literature review based on the aforementioned issues afforded me the leverage to develop the appropriate conceptual framework, to focus and guide my research, and to link past and current research to my work to inform the discussion chapter and form the basis for a strong justification for my research with the potential for immense contribution to scholarship, policy, and practice in the agricultural insurance lanscape. This chapter is divided into two general sections: a conceptual framework and related literature review as presented below.

2.2 Conceptual Framework

My dissertation research focuses on: 1. The identification of smallholder farmers' key agricultural risks, 2. The identification of smallholder farmers' agricultural risk management strategies, such as adaptation strategies and coping measures, as well as social protection programs and safety nets, 3. The determination of benefits of agricultural insurance to smallholder farmers, and 4. An assessment of the willingness of agricultural insurance stakeholder (insurers and the insured) to engage in and promote sustainable farming practices and climate change mitigation.

These themes or variables constitute the pillars for conceptualizing my dissertation research and the subsequent literature review.

No single theoretical framework encompasses the scope of my research. I addressed this by synthesizing the relevant theories, concepts, models, and ideas that accommodate most of the dimensions into a single conceptual framework (Figure 1). This integrated conceptual framework draws on ideas from: 1. vulnerability assessment theories (e.g., Füssel & Klein, 2006; McLeman & Smit; 2006), 2. a complete agro-financial service framework for emerging economies (Goel, 2013), 3. autonomous and planned adaptation strategies in the agricultural sector (Smit and Pilifosova, 2003; Zahniser, Arriola, and Somwaru, 2010), and 4. willingness-to-pay i.e.,engage in and supply or promote theories (Liesivaara & Myyrä, 2014).

This integrated conceptual framework was informed by my personal knowledge, experience, and consultations with professional researchers and practitioners in the agricultural insurance field, coupled with information distilled from the aforementioned theories, models, and body of literature. This conceptual framework is compartmentalized into three segments: background information, statement of the primary focus of my dissertation project, and anticipated outcomes (Figure 1).

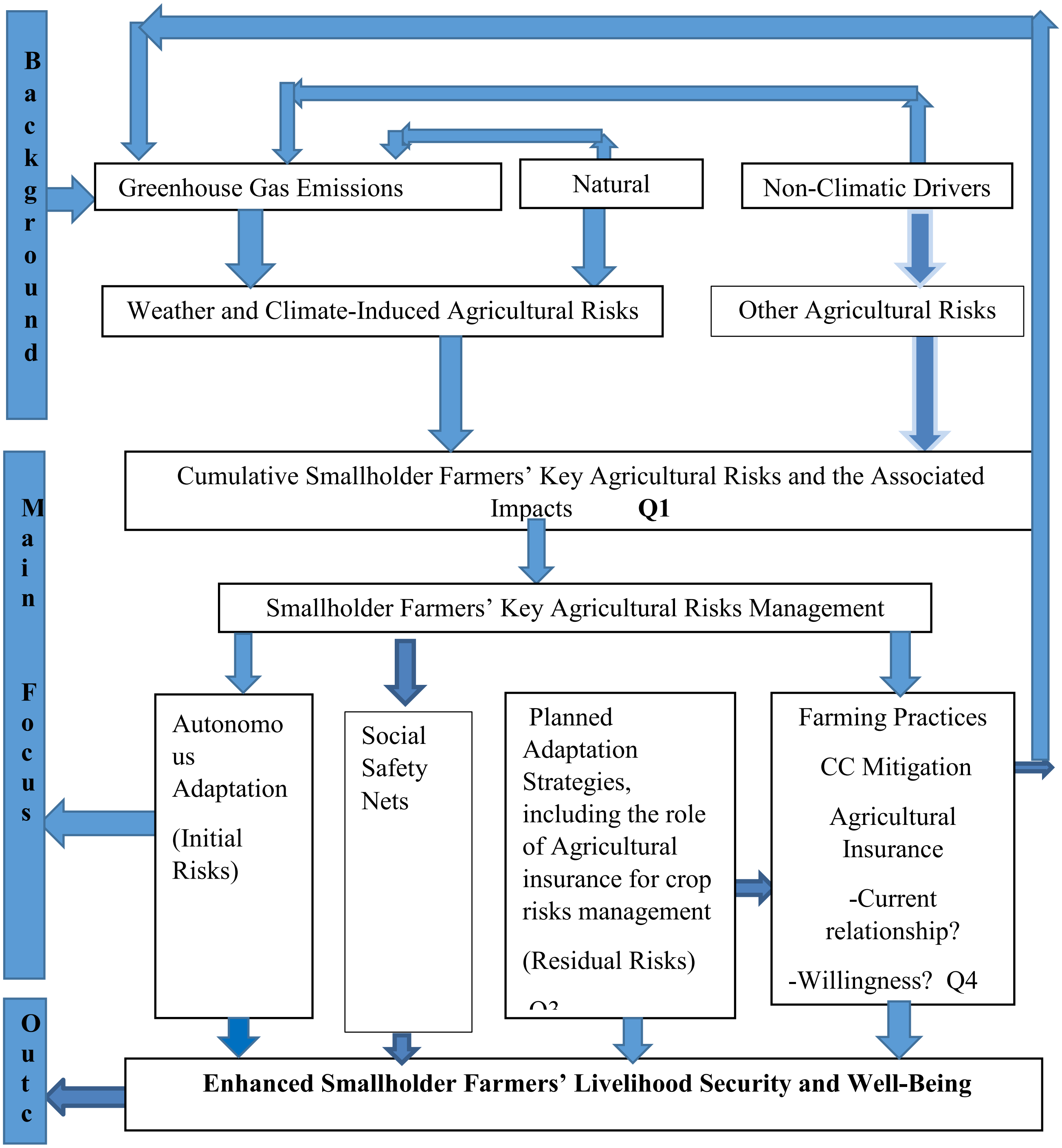


Figure 1: A conceptual framework guiding the role of agricultural insurance for crop risks management

2.3 Sources of Agricultural Risks and the Associated Theoretical Background of the Conceptual Framework

Anthropogenic climate variability/change adversely impacts agricultural productivity in both developed and developing countries (Parry, Rosenzweig, Iglesias, Livermore, & Fischer, 2004; Kurukulasuriya & Mendelsohn, 2008) and other non-climatic drivers (Füssel & Klein 2006; Smit & McLeman, 2002). This makes farmers vulnerable to these climatic and non-climatic agricultural challenges (Füssel & Klein 2006; McLeman & Smit; 2006).

McLeman and Smit (2006) identified climate change-related concepts and variables to inform the design of their vulnerability assessment study. They applied their conceptual framework to crop and flood insurance in the agricultural sectors in Canada, the US, and New Zealand. These authors reported that anthropogenic emission of greenhouse gases is the major cause of global warming, and ultimately climate change. They further indicated that climate variability/change is adversely impacting most systems, including socio-economic, biophysical, and agricultural systems through their exposure and sensitivity to climate change impacts. To reduce their exposure and sensitivity, and ultimately, their vulnerability; socio-economic systems, including farming and agricultural risks management measures need to be devised either reactively or proactively to adapt to the situation.

To McLeman & Smit (2006), vulnerability is a function of exposure/sensitivity and adaptive capacity of human, natural, and socio-economic systems, including agriculture at a given location and time in response to a given climatic stimulus (stimuli). This relationship they stated quantitatively as Vslit =f (Eslit, ACslit), where V= Vulnerability, E=Exposure, AC= Adaptive Capacity, s= a given human, socio-economic or natural system, l = a given location, i= a climatic stimulus (stimuli), and t = at a given time. This equation implies that vulnerability is directly related to the extent of exposure and is inversely related to the adaptive capacity of the actors (in this case, farmers). This also means that the vulnerability of any system to weather and climatic impacts is influenced by the type, and nature of the system, stimuli and the spatio-temporal characteristics of the system. McLeman & Smit's (2006) framework is relevant to my study because it offered the opportunity to discuss the factors making smallholder farmers vulnerable to weather/climate risks and can also be adapted to non-weather-induced agricultural threats. The adaptive capacity and the associated agricultural risks minimization strategies (adaptation strategies, coping measures, and social protection and safety nets) are also components of this framework.

Even though McLeman and Smit's (2006) theoretical framework provides useful guidance and direction for my work, the vulnerability assessment model mainly captured weather and climate-induced agricultural risks and is silence on the non-weather/climate-based challenges even though both categories of risks affect agricultural productivity. Despite this weakness i.e., its focus on weather and climate-related agricultural threats, the framework can be adapted to non-weather and climate-related agricultural risks and vulnerabilities, and I did just that. Füssel and Klein (2006) and Smit and Skinner (2002) also revealed that risks confronting farmers anywhere in the world are both weather/climate and non-weather/climate-related. For instance, Füssel & Klein (2006) argued that in addition to climate variability and change, non-climatic drivers and factors also contribute to the exposure, sensitivity, adaptive capacity, impacts, and ultimately, the vulnerability of biophysical and socio-economic regions and sectors, including agriculture. Smit and Skinner (2002) argued further that agricultural risk management measures should include both climate change adaptation and non-climate-based agricultural risks management mechanisms. According to these authors; economic, social, political, technological, and environmental decisions affect agricultural and adaptive activities and decisions and vice versa. These authors, therefore, included the climate and non-climate-based agricultural risks management strategies in their typology of adaptation options in their vulnerability study in the Canadian agricultural sector.

Farmers often employ a two-pronged approach to managing climate-induced agricultural risks: climate adaptation and mitigation (Rosenzweig & Tubiello; 2007). Smallholder farmers in low-income countries have been using their autonomous or informal adaptation strategies (Mobarak & Rosenzweig, 2012; Nyong, Adesina, & Elasha, 2007) to cope with their initial climate-induced agricultural risks (Molini et al., 2008). This often leaves residual agricultural risks (i.e., risk remaining after employment of initial coping strategies) unmitigated (Smit & Pilifosova, 2003; Füssel & Klein, 2006; Molini et al., 2008; Molini, 2010; Zahniser, Arriola, & Somwaru, 2010). This raises questions about the efficacy levels of these informal adaptation as agricultural risk management strategies.

To complement smallholder farmers' informal adaptation strategies, Goel (2013) proposed an agricultural insurance-based model called a complete agro-financial services framework for emerging economies. Goel (2013) proposed his agro-financial service framework in response to the need for an effective and efficient agricultural insurance to assist farmers to manage their key agricultural risks in emerging economies. Goel's (2013) model incorporated lessons learned from pros and cons of insurance programs and contracts provided earlier in the agricultural risks management and insurance literature. This informed my decision to adopt a modified version of Goel's (2013) model to guide the agricultural insurance component of my dissertation project.

Based on best practices from the literature, his intuition, and innovative ideas, Goel (2013) suggested to agricultural insurance companies to design their insurance programs to act as one-stop-shops by providing risk control functions such as yield, price, and demand protection through index-based insurance contracts. The model also incorporates risk financing roles such as the direct provision of agro-inputs or facilitate their supply to farmers (insurance companies' clients) by agro-inputs dealers or manufacturers. The model also recommends insurers facilitating farmers' access to credit facilities from financial institutions by using premiums paid to guarantee potential loan repayment defaults at very minimum interest rates. This enables risk-averse farmers to have access to financial resources to be able to purchase and adopt risky but productive technologies such as improved hybrid crop varieties, fertilizers, pesticides, and weedicides. The riskiness of these technologies is guaranteed or insured by the insurers (Goel, 2013).

Goel's (2013) complete agro-financial service framework employs an agribusiness and value chain approach which does not only link farmers to markets (both locally and internationally) but also markets insurance contracts through an innovative product delivery channel. To Goel (2013), this delivery channel involved the recruitment of agents or brokers (i.e., marketing officers) knowledgeable and experienced in agro-meteorological and extension service issues in order to provide advisory services to farmers in their respective locations in addition to the marketing of insurance policies at the local level. Goel (2013) supports his inclusion of advisory services in his model by reporting that Giné and Yang's (2009) weather index insurance field experiment in Malawi found an increase in the uptake of insurance contracts when these policies were bundled with the provision of additional services to farmers. Goel's (2013) model has practical application for agricultural risks management in emerging and low-income countries, especially its proposal to combine weather index and yield insurance to generate a composite index capable of addressing the intractable challenge of basis risk in addition to promoting demand for index insurance contracts.

Despite these innovative ideas espoused in designing agricultural insurance systems, the integrated agro-financial service framework may make the insurance companies lose sight of their core mandate of making agricultural insurance services available and accessible to smallholders who are mostly excluded from the financial markets in most low-income countries. Non-core services such as the supply of agricultural inputs and equipment, provision of advisory services which are not direct insurance- related can be offloaded to other agents or companies providing those services on contract basis. By this arrangement, AICs can concentrate on expanding and up-scaling their programs and products into other uncovered territories, primarily rural areas in low-income countries.

Formal or planned adaptation strategies, including AIPs and contracts have also been credited with having the potential to assist smallholder farmers to manage their key agricultural risks in low-income countries (Rao, 2010; Reinhard, 2012). As a result, some researchers and agricultural policymakers have recommended that farmers in low-income countries employ formal adaptation strategies (planned or proactive), including the use of agricultural insurance contracts to manage their residual agricultural risks (Barnett, & Mahul, 2007a; Goel, 2013)

Some authors have also reported that most farmers in Northern Ghana have been managing their agricultural risks using both agricultural insurance contracts and other informal and formal agricultural risks management strategies (Acheampong et al., 2014, Adiku et al., 2017; Bawakyillenuo et al., 2016). However, what are those smallholder farmers' agricultural risks in Northern Ghana? What adaptation strategies have smallholder farmers in Northern Ghana been employing to cope with their key agricultural risks? Are these strategies effective?

Since some agricultural insurance programs and contracts are potentially or demonstrably responsible for ecological degradation and maladaptation, AICs and programs must also be part of the solution (Mills, 2007; 2009). Dahlström et al. (2003a) and (Brahic, 2009) also suggested that the agricultural insurance industry could contribute toward creating carbon sinks, carbon sequestration, and reduction in greenhouse gas (GHGs) emissions. Skees and Collier (2012) and McKinley (2014) equally maintained that governments could connect vulnerable farmers to weather insurance and carbon markets through the provision of incentives and application of climate change adaptation and mitigation funds. A question one needs to ask is, what are smallholders' current agricultural systems and practices in low-income countries? Can or are some of these farming systems contributing to sustainable farming practices and climate mitigation? How can insurers and smallholder farmers be motivated to promote and engage in climate-friendly farming practices and climate change mitigation activities? This conceptual framework provided the direction, guidance, and the organizational and structural configuration within which these questions were explored.

2.4 Literature Review

agricultural insurance , especially weather index agricultural insurance has been widely acclaimed as one of the agricultural risk management strategies for smallholder farmers in low-income countries (Barnett & Mahul, 2007a; Carter, de Janvry, Sadoulet, & Sarris, 2014; Rao, 2010). On the contrary, some studies have reported mixed findings and reactions regarding its potential, and have, therefore, call for further piloting and research before upscaling existing AIPs and rolling out new schemes (Banerjee & Berg, 2012; Binswanger-Mkhize, 2012; Carter et al., 2014; Greatrex et al., 2015). This literature review evaluates the prospects and challenges of agricultural insurance to inform and anchor my dissertation project in the larger agricultural insurance scholarship.

The government of Ghana in collaboration with other development partners piloted an agricultural program called Innovative Insurance Products for the Adaptation to Climate Change (IIPACC) in Northern Ghana in 2009. This program has since been modified, up-scaled, and operated by Ghana Agricultural Insurance Program (GAIP). Even though some studies have been conducted on some aspects of agricultural insurance in Northern Ghana such as willingness to pay (WTP), farm and financial investment protection, social impact of agricultural insurance, none has explicitly investigated the potential of agricultural insurance for crop risks management among smallholder farmers in Northern Ghana. I, therefore, designed this study to explore the potential of agricultural insurance for crop risks management among smallholder farmers in Northern Ghana. The study also investigated the potential of agricultural insurance in promoting sustainable farming practices and climate change mitigation in Northern Ghana. This literature review was, therefore, undertaken to understand and acknowledge what existing scholarship has said about the potential of agricultural insurance for crop risks management, sustainable farming practices, and climate change mitigation in Northern Ghana and other low-income countries.

This dissertation research was conducted to understand the past and present nuances, debates, theoretical, and methodological underpinnings surrounding how agricultural insurance has been and can support smallholder farmers (henceforth, smallholders) to manage some of their key agricultural risks in low-income countries. I reviewed the relevant literature to gain insight into: 1. The different categories of agrarian risks and how they have been affecting smallholders, 2. How smallholder farmers have been managing their key agricultural risks, 3. The extent of effectiveness of these risks management strategies, and 4. Whether AIPs and contracts have been raising environmental concerns in the literature, and if so, what are those concerns and how are they being addressed?

The literature review is organized and discussed under the following headings: 1. Identification and description of smallholder farmers' key agricultural risks in low-income countries, 2. Smallholder holder farmers' agricultural risks management strategies in low-income countries, 3. The ways (role) agricultural insurance can or has been helping smallholders to manage their key agricultural risks, 4. An exploration of the role of agricultural insurance in promoting sustainable farming practices and climate change mitigation, and 5. Summary and conclusions.

Seminal resources were selected from peer-reviewed articles, dissertations and theses, published and unpublished articles, conference presentations, reports, magazines, textbooks, and newspaper feature articles. The literature review covers the evolution of agricultural insurance risks management strategies and captures ideas of Chakravarti as far back as 1920, who coined the concept "index insurance" and its subsequent development (Chakravarty, 1920). This notwithstanding, I used resources from the past ten years with only seminal resources being older than ten years.

2.5 Smallholder Farmers' Key Agricultural Risks in Low-income Countries

Agriculture is the backbone of most low-income countries in the world (Lotze-Campen & Popp, 2012a). IFAD (2011) reported that over 70% of the very poor in the world live in rural areas and who coincidentally are mostly smallholder farmers and are dependent on agriculture for their survival. The World Bank (2015) also revealed that, on the average, the agricultural sector in low-income countries accounts for 28% of the GDP. Smallholder farmers also produce over 80% of the food consumed in Sub-Saharan Africa (2015) and play a key role in the socio-economic and development spheres of their respective countries (Nnadi et al., 2013, WorldCover, n.d).

In the case of Ghana, agricultural land occupies about 57% of the total land area of the country (MOFA, 2010). The sector also employs 56.1% of the labor force, accounts for 21.5% of the GDP (World Bank, 2016), and generates 75% of the foreign exchange (MOFA, 2007). Over 90% of the farm holdings in Ghana are less than 2 hectares (ha), which are owned and managed by smallholders (MOFA, 2010; Sumani, 2008).

The above-mentioned statistics testify to the importance of Ghana's agricultural sector to its economy and residents. Even though agriculture is still the largest contributor to the national output (MOFA, 2007), with a marginal growth over the years (Ghana Statistical Service (GSS)/MOFA, 2017), its share of the GDP has reportedly been declining over the years. For instance, the growth of the sector has declined from 9.3%, 7.3%, 4.0%, 3.9%, and 3.6% in 2013, 2014, 2015, 2016, and 2017 respectively (GSS/MOFA, 2017).

Despite the importance of the agricultural sector to the socio-economic growth and development of low-income countries, the sector is beset with multiple challenges. Studies that discussed agricultural risks often employed different agricultural risks categorization criteria. For instance, some researchers and institutions categorized agricultural risks as physical, biological, biophysical, hydro-geological, and socio-economic challenges (IPCC, 2014b; Goel, 2013; Piao et al., 2010; Siebert, 2015). The different ways agricultural risks have been discussed in the literature can broadly be classified into two themes such as weather/climate-induced and non-weather/climate-related challenges for the convenience of analysis, synthesis, discussion, and presentation. Henceforth, climate/weather-induced and non-climate/weather will be used interchangeably with weather-induced (or climate-induced) and non-weather-induced (non-climate-induced), respectively.

A few vulnerability assessment theories discussed agricultural risks within weather-induced and non-climate-related frameworks. The theoretical frameworks of Füssel and Klein (2006), Smit, Burton, Klein, and Street (1999), and Smit and Skinner (2002) reveal that risks confronting farmers globally include both weather and non-weather/climate-related risks. For instance, Füssel & Klein (2006) in their second-generation vulnerability assessment theoretical framework, argued that in addition to climate variability and change, non-climatic drivers and factors also contribute to the exposure, sensitivity, adaptive capacity, impacts, and ultimately, the vulnerability of biophysical and socio-economic regions and sectors, including agriculture. While arguing for the classification of smallholder farmers' agricultural risks into weather-related and other agricultural risks themes, I acknowledge that there is no clear-cut demarcation between these risks categories as one can influence the other and the vice versa. For instance, desertification which is mainly climate-induced may influence out-migration, a non-weather socio-economic phenomenon. This makes it more compelling for both weather and non-weather-induced agricultural risks and the associated agrarian risks management strategies to be discussed concurrently or we run the risk of treating the symptoms rather than causes of the problems (Sumani, 2008).

2.6 Weather and Climate-induced Agricultural Risks.

The phenomenon of climate variability and climate change has been identified as a developmental challenge that adversely affects all sectors of global economies, including agriculture (Walther et al., 2002; Stern, 2007; Kalra et al., 2007). Climate impact studies, models, and simulations have predicted that climate variability and change will continue to impact various economic sectors in the world now and the foreseeable future (Parry et al., 2004; Solomon, 2009; Stocker et al., 2013). One of the severely affected sectors is agriculture, especially in tropical developing countries and arid regions (Rosenzweig et al., 1994; Kurukulasuriya & Mendelsohn, 2008). Some of the severely affected sub-sectors cited in the literature include crops, livestock, and aquaculture (Parry et al., 2004; Kurukulasuriya & Mendelsohn, 2008).

There is a consensus in the climate science research community that post-industrial revolution (post-1850) climate variability, climate change, and extreme weather hazards are caused by both natural and anthropogenic factors (Coe & Stern, 2011) with human causes weighing more than the natural causes (Santer, Wigley, Barnett, and Anyamba, 1996). Impacts of climate variability, climate change, and extreme weather events are transboundary, and as such, can affect agricultural productivity anywhere in the world.

Agriculture has been identified as one of the leading contributors to greenhouse gas emissions (GHGs), and ultimately, a significant source of the global warming and the climate change challenge (Pratibha et al., 2016). It is estimated that the sector's contribution to GHGs ranges from 10%-13.5% (Aggarwal & Sivakumar, 2010; IPCC, 2007), mainly emitted through the application of nitrogen-based chemical fertilizers and unsustainable farming practices, for instance, through intensive conventional tillage practices, the use of fossil-based fuels and indiscriminate bushfires, including burning of crop residues (Mosier, Halvorson, Reule, & Liu, 2006). Some farming practices also contribute to global warming and climate change through the destruction of biodiversity and land degradation (Foley et al., 2011). Cumulatively, these unsustainable practices have the potential to increase the net global warming potential (NGWP) and greenhouse gas intensity (GHGI). Snyder, Bruulsema, Jensen, and Fixen (2009) recommended that the global agricultural sector contributes to GHGs so must they also use innovative practices and technologies to be part of the solution, that is, play a role in mitigating global warming and climate change. The sector can use sustainable farming practices such as zero or minimum tillage, cover cropping, diversified crop rotation, and applying crop residue on farms (Mosier et al., 2006; Foley et al., 2011). Collectively, these sustainable farming practices may not only reduce the use of fossil fuels but also minimize soil erosion and disturbance, increase water retention, and soil carbon sequestration (Mosier et al., 2006).

The manifestations and adverse effects of weather/climate variability and change on agriculture can be classified under meteorological, hydro-geological, and biological risks. The specific manifestations and adverse effects of weather/climate-related risks include increasing temperatures, unpredictable rainfall patterns, pests and disease infestations, sea level rise, shortening farming season, and increasing frequency and magnitude of extreme weather events such as droughts, floods, hurricanes, and storms (Aggarwal & Sivakumar, 2010; Lotze-Campen, Müller, Popp, & Füssel, 2012; Parry et al., 2004; Piao et al., 2010; Rosenzweig et al., 1994; Stocker et al., 2013; Ward, Florax, & Flores-Lagunes, 2014). These risks collectively pose production risks to the agricultural sector.

Climate change and weather extremities have already reportedly caused food insecurity challenges in some low-income countries, especially in Sub-Saharan Africa (Lotze-Campen et al., 2012; Myjoyonline.com, March 2, 2016; Ward et al., 2014). Vulnerable smallholder farmers in these countries are often adversely affected by these weather/climate-induced risks and they (smallholders) may not have the adaptive capacity to cope with the adverse effects (Morton, 2007; Below, Artner et al., 2010). This is mainly attributed to the inability of farmers' informal adaptation strategies to assist them to sufficiently cope with extreme weather and climatic hazards (Adger et al., 2003; Barnett & Mahul, 2007; Füssel, 2007); Molini et al., 2010).

Most global, regional, and local climate change simulation models are predicting a further increase in global temperatures, unpredictable rainfall patterns, and changes in other climatic variables (Adger et al., 2003; Stocker et al., 2013). These weather and climatic trends have the potential to further increase the exposure and vulnerability of the agricultural sector to crop production risks (Smit & Skinner, 2002; McLeman & Smit, 2006). This calls for the simultaneous engagement of efficient climate change adaptation and mitigation strategies, including agricultural insurance. We now turn to non-climate-based agricultural challenges.

2.7 Non-weather and Climate-induced Agricultural Risks.

While there is no clear-cut distinction between weather-induced and non-climate-related agricultural risks, the non-weather/climate-related agricultural risks are mainly precipitated by socio-economic and environmental factors. As as a socio-economic venture, agricultural risks could emanate from a chain of activities, including crop production activities (Barnett & Mahul, 2007a), distributional networks, marketing, financial, and post-harvest related challenges (Simms et al., 2005; Mills, 2007; Patankar, 2011; Goel, 2013). The agricultural production risks have been mainly attributed to weather and climatic uncertainties (Smit & Skinner, 2002), pests and diseases (Ziska & Runion, 2007), and problems associated with the acquisition of farming inputs at the right time and in the right quantities (Goel, 2013). Fresco (2009) also reported agricultural produce being locked up in rural areas in some developing countries due to the deplorable nature of the road network and lack of proximity to urban markets.

Some farmers in developing countries are equally confronted with inadequate demand for their farm produce (Goel, 2013) and lack of access to agro-loans, mainly attributable to the risky nature of agricultural undertakings and lack of collateral security (Giné & Yang, 2009; Goel, 2013). These challenges are reportedly compounded by the adverse impacts of climate variability and change (Lotze-Campen et al., 2012; Stocker et al., 2013). This increases the exposure and vulnerability of farmers, especially smallholder farmers in low-income countries to the combined adverse effects of climate and non-weather-related risks and food insecurity conditions (Simms et al., 2005; McLeman & Smit, 2006; Füssel & Klein, 2006; Füssel, 2012). Agricultural risks often trap vulnerable farmers in a perpetual cycle of poverty if these challenges are repeated over an extended period or years (Barnett & Mahul, 2007a; Panda, 2013a). To assist farmers to escape from this vicious cycle of poverty requires supporting farmers with a wide range of agricultural risks management strategies, including, agricultural insurance, social protection programs, safety nets, and adaptation to weather extremities and climate variability and change. The next sub-section looks at how smallholder farmers have been managing their key agricultural risks over the years.

2.8 Evolution of Agricultural Risks Management Strategies in Low-income Countries

Even though adaptation, coping strategies, social protection measures, and safety nets connote different approaches to managing agricultural risks, these concepts and phrases will subsequently be used interchangeably. Farmers exposed to agricultural risks often employ either autonomous adaptation or planned adaptation strategies (Smit et al., 1999) or both to cope with adverse impacts of climate variability and change (Adger et al., 2003; Füssel, 2007; Zahniser et al., 2010). Autonomous risk management involves the employment of spontaneous and informal adaptation mechanisms to cope with initial climate-induced risks (Adger et al., 2003; Zahniser et al., 2010). These informal adaptation mechanisms may involve storing of grains and use of donations, remittances, and family network support systems to address initial agricultural risks (McLeman & Smit, 2006; Simms et al., 2005; Sumani, 2008, Sumani, 2015). Other informal agricultural risk management mechanisms include crop and farm diversification, livestock rearing, and mixed farming (Anik & Khan, 2012), crop rotation (Simms et al., 2005; Sumani, 2008);

cultivation of traditional drought and flood resistant crop varieties (Olubiyo, Hill, & Webster, 2009; Panda, 2013a), and sale of assets (Mahul & Stutley, 2010).

Formal adaptation techniques, also called planned adaptation strategies are often employed by farmers to manage climate-induced agricultural risks and other farming related threats. Formal adaptation strategies are mostly used to manage adverse effects of climate change and residual impacts remaining after the employment of autonomous adaptation measures to address initial risks (Adger et al., 2003; Füssel & Klein, 2006; Zahniser et al., 2010). Some of these techniques include scientifically produced improved crop varieties (such as drought resistant, short-maturing, and high yielding species), water efficient crops, savings and loan schemes, and micro-insurance for marginal farmers in rural settings (Barnett & Mahul, 2007a; Cell, 2009; Zahniser et al., 2010; Clarke, Mahul, Rao, & Verma, 2012; Ramirez, Colson, & others, 2013;Colson, Ramirez, & Fu, 2014).

Even though the classification of adaptation strategies into autonomous (reactive or ex-post) and planned (anticipatory or ex-ante) risks mitigation and management strategies provides a helpful guide to climate risks management, I identify two issues with the manner some climate change scholars have organized and explained these concepts. First, some researchers (e.g., Smit et al., 1999; Smit & Skinner 2002) envisaged planned adaptation coming from governments (and not the private sector and individuals) are meant to assist farmers to address their initial agricultural risks (reactive/ex-post) even though governments may also be involved in anticipatory adaptation activities (i.e., planned/ex-ante). This weakness has been pointed out subtly by other researchers (e.g., Zahniser et al., 2010) and needs to be re-echoed. The second weakness concerns some scholars' sequential arrangement of autonomous and planned adaptation strategies with the explanation that anticipatory or planned adaptations informed by public policy are usually employed to manage residual adverse effects (net effects), i.e., effects remaining after using reactive adaptation measures to cope with initial adverse effects (e.g., Smit et al., 1999; Smit & Pilifosova, 2003; Smit & Skinner, 2002; Zahniser et al., 2010). However, individual farmers may sometimes employ planned or ex-ante strategies to address both initial and residual impacts simultaneously and may not wait to deal with initial adverse effects before tackling negative net effects.

Even though informal and formal adaptation mechanisms have been applied to address climate-induced agricultural risks in the past and are still being used, concerns are raised about the efficacy of some of these strategies in managing weather and climate-related challenges, which may be co-variate in nature and extent (Molini, Keyzer, van den Boom, Zant, & others, 2008; Mills, 2007; Mahul & Stutley, 2010; Rao, 2010). This is because these risks are often spatially correlated that they can affect vast geographical areas, i.e., entire communities, countries or even regions (Meze-Hausken, Patt, & Fritz, 2009; Rao, 2010). Both informal and formal adaptation measures may, therefore, not be able to adequately support vulnerable farmers to be able to manage their key agricultural risks.

Conventional agricultural insurance schemes and contracts have been designed to address the weaknesses associated with the adaptation strategies described above (Shields, 2009; Smith, Goodwin, & Brown, 2010; Mahul & Stutley, 2010). Hossain (2013) in particular, argued that though a useful planned intervention, traditional insurance programs and contracts also come with their own set of challenges, thus, making them ineffective risk management mechanisms, especially for poor and marginal farmers in developing countries. Challenges associated with the smooth implementation of formal agricultural insurance programs in developing countries include problems of adverse selection, i.e., information asymmetry where insurers may not be privy to all the relevant information and facts about the insured; moral hazards, where the insured's irresponsible behavior may increase the liabilities of insurers; and high transaction costs due to monitoring, operational, and administrative cost (Barnett & Mahul, 2007; Hossain, 2013). These challenges have the cumulative effect of increasing costs of indemnified insurance, making traditional agricultural insurance contracts unattractive and unaffordable to poor farmers in lower-income countries (Mahul & Stutley, 2010; Hossain, 2013; Jensen & Barrett, 2015). This demands the design and introduction of innovative agricultural risk management strategies, including index-based agricultural insurance schemes and contracts. But what is index-based agricultural insurance? And how does it operate in low-income countries? The next section will explores these question.

2.9 Index-based Agricultural Insurance in Low-income Countries

Studies that explored the role of index-based agricultural insurance for crop risks management in both developed and developing countries have revealed mixed findings (Binswanger-Mkhize, 2012; Hossain, 2013). This situation generates an on-going debate about the efficacy of index-based insurance for agricultural risks management. Whereas some scholars are arguing for the adoption of alternative agrarian risk management strategies (Colson et al., 2014; Mobarak & Rosenzweig, 2012), other researchers, policymakers, and international development agencies still believe agricultural insurance, especially index-based insurance holds promise for smallholder farmers in low-income countries (Barnett & Mahul, 2007a; Cell, 2009). However, Greatrex et al. (2015) maintained that the argument is less about the lack of clarity on the role and efficacy of index-based insurance as an agricultural risks management tool but more about identifying best practices, addressing unintended adverse consequences and determining how index insurance can efficiently complement other agricultural risks management strategies. This is because index-based agricultural insurance programs are being up-scaled to reach thousands of farmers in countries embracing it as an agricultural risks management tool. This, therefore, calls for further research to identify best practices and unintended consequences of agricultural insurance programs and contracts if there are any, especially in Northern Ghana where index-based agricultural insurance has been piloted and currently been up-scaled (Nunoo & Acheampong, 2014; Sumani, 2015).

The few studies that examined agricultural risks management mechanisms in Northern Ghana, identified index-based agricultural insurance as one of the strategies that can help farmers to manage their climate-induced agricultural risks (Molini et al., 2010; Bawakyillenuo, Yaro & Teye, 2016; Stutley, 2010). Even though these studies identified agricultural insurance as a tool for climate change adaptation, they mostly explored its role in creating farmers' safety nets (Molini et al., 2010; Molini et al.,2008; Zant et al., 2008) and protection of financial investments (Haruna, 2015; Nunoo & Acheampong, 2014). Some studies have also identified the functions of agricultural insurance programs and contracts. For instance, some functions of index-based insurance programs reported in the literature include risk control i.e., yield, price, market, and demand protection (Goel, 2013; Rao, 2010), risk financing such as access to loans (Giné & Yang, 2009; Goel, 2013), and bundling index insurance contracts with agro-meteorological information (Hochrainer, Mechler, & Pflug, 2009; Makaudze, 2005).

2.10 The Role of Index-based Agricultural Insurance for Crop Risks Management in Low-income Countries

To address challenges associated with conventional insurance mentioned above, some scholars believe that index-based agricultural insurance programs and policies, especially weather index-based insurance (WIBI) and area-yield-based index insurance (AYI) contracts have the potential to aid smallolder farmers to manage their key agricultural risks (Chakravarti, 1920; Halcrow, 1948; Rao, 2010; Clarke et al., 2012; Hossain, 2013). According to proponents of index insurance, WIBI and AYI contracts usually reduce costs associated with adverse selection, moral hazards, fraud, and administrative and operational (A&O) costs. Index-based insurance does this through its design where insurers do not depend on actual losses of policyholders to determine indemnities (Rao, 2010). Only the relevant indices are used to estimate the extent of agricultural loss and the accompanying compensation. This index could be area-based (e.g., community, region, etc.), weather/climate-based (e.g., rainfall, temperature, distance to water body), vegetation condition or biomass index-based, livestock mortality rate-based (Mahul & Stutley, 2010; Makaudze, 2005; Rao, 2010; Patankar, 2011; Hossain, 2013).

Index-based AIPs and contracts have some advantages for both insured farmers and insurance companies. One advantage is the standardized, transparent, and objectively verifiable nature of the insurance contract and indices (Clarke et al., 2012; Patankar, 2011; Patt et al., 2009; Hossain, 2013). By the transparent nature of the contracts, both the insurer and insured may know the index, when a trigger event occurs, and an indication of how much loss or compensation is due in theory. However, this may not always be the case in practice, especially in low-income countries where farmers without formal education are involved and may not be able to conduct their own analysis. This weakness notwithstanding, index-based agricultural insurance is an improvement upon indemnity insurance where the insurance company may determine the losses and compensation and impose them on clients (Patt et al., 2009; Mahul & Stutley, 2010; Hossain, 2013; Panda, 2013a). This makes a strong argument for the introduction of index insurance, especially in low-income countries with both extensive and intensive sensitization of the farmers participating in the AIPs.

Goel (2013), Karlan, Kutsoati, McMillan, and Udry (2011), Karlan, Osei-Akoto, Osei, and Udry (2011) also revealed that index-based agricultural insurance contracts promote farmers' access to agricultural inputs such as loans, improved seeds, fertilizers, and other agro-meteorological advisory and extension services. Some studies have also reported similar findings (e.g. Giné & Yang, 2009; Hochrainer et al., 2009; Lotze-Campen & Popp, 2012). Cell (2009), Giné and Yang (2009), in particular, reported that bundling insurance contracts with other agro-related services motivates increased demand for index insurance policies.

Marr, Winkel, van Asseldonk, Lensink, and Bulte (2016) recently reviewed 110 papers on the topic "adoption and impact of agricultural insurance and credit for smallholder farmers for developing countries" found that most earlier researchers claim about some factors influencing demand for agricultural insurance in low-income countries could not be confirmed. In Marr et al.'s (2016) own words, "it is unknown to what extent credit suppliers would react to the insured status of farmers." (pg.94). Marr et al. (2016), therefore, recommended further research to clarify some of the earlier findings. Their findings are, however, not surprising because they corroborate results of some studies while contradicting others.

While I agree with Goel, (2013) and other scholars maintaining that index insurance schemes should act as one-stop-shop by promoting value-chain and agri-business linkages from farm gates to the final consumer, including linking farmers with agro-input dealers, care must be taken so that AICs will not be overloaded with non-core insurance functions. The concentration on core agricultural risks protection services may ensure that many farmers, especially smallholder farmers in rural areas in low-income countries who are mostly unprotected partly due to the non-availability of agricultural insurance services are covered (Chantarat, Mude, Barrett, & Carter, 2013). Even though index insurance programs and contracts are claimed to have the potential to protect small-scale farmers in developing countries (Mahul & Stutley, 2010; Panda, 2013a; Carter, Cheng, & Sarris 2016), there is concern about the issues of basis risk usually associated with these parametric insurance programs (Zant, 2008; Rao, 2010). Basis risk is the lack of correlation or mismatch between payouts and actual losses suffered (Rao, 2010). In this case, insured farmers may still suffer from the adverse effects of uncovered losses because the insured index may not perfectly reflect the actual loss incurred. This makes index agricultural insurance contracts unable to protect insured farmers fully. This calls for the application of additional coping measures to complement claim payments from AICs, possibly in the form of risks layering, i.e., sharing of the cost of risks between the insured farmers, insurer, and governments. Another strategy could be using all-risks policies, i.e., MPCI policies, revenue, income protection, and actual production revenue history policies. However, AICs suffering from problems such as adverse selection, moral hazards, fraud, and huge A&O cost informed their (AICs) decisions to abandon conventional agricultural insurance for index insurance and going back to indemnity insurance as a way of addressing basis risk may not be a smart move. I term this possible forward and backward movement as the cyclical nature of agricultural insurance, or agricultural insurance starting at one point and ending at the same point (i.e., dancing around this same point). How can index insurance programs and contracts address basis risks-related agro-production challenges without going back to the all-risks policies that influenced the decisions of agricultural insurance stakeholders to recommend and promote index-based AIPs and contracts for smallholder farmers in low-income countries? Goel (2013) possibly anticipated this question and proposed a proactive solution in his complete agro-financial service framework for emerging economies. He specifically recommended the development of an integrated index based on weather, yield, satellite-based vegetation biomass, and other relevant indices. Even though the inclusion of the yield and other parametric variables in the integrated index equation has the potential to capture all the farm-based production risks (i.e., the yield would probably have been affected by all the agro-production risks such as the elements of weather, soil moisture conditions, pest and diseases etc.), how this can be done is the challenge and Goel did not also show how it can be done. This inconclusive integrated index-based proposed solution generates further and more questions than answers. For instance, what are the range of weather and yield parametric variables necessary for the determination of an effective, efficient, and sustainable integrated indices? How does the integrated index also accommodate and address other non-weather and non-yield-based agricultural risks such as unfavorable market/demand conditions, post-harvest losses, value chain issues, price/revenue-related challenges, and the list goes on. Even though Goel (2013) did not provide answers, and possibly did not anticipated these questions in his proposed agro-financial model and integrated index, his proposed conceptual framework and ideas provoked scholarly discussions in the agro-financial inclusiveness literature, and I am happy to be part of this academic and scholarly dialogue and engagement.

There are other equally important challenges working against the welfare and full protection of farmers even if the insured index perfectly correlates with actual yield losses suffered (i.e., if all losses generated by the insured indices were 100% indemnified). For instance, most indices used in agricultural risks management are mostly weather and yield-based and not revenue or price-oriented (Cole & Gibson, 2010; Leblois, Quirion, & Sultan, 2014, Mahul, 2003; Mahul & Wright, 2003). In other words, most insurance programs in low-income countries, especially SSA, including Ghana do not incorporate revenue or price risks into their indices. This leaves a wide gap in the index insurance literature. This concern was realized in traditional agricultural insurance theory and practice in developed countries, especially in the US, Canada, Spain, and other countries, and has been appropriately addressed. Goodwin (2001), for instance, reported that the 1994 US Federal Crop Insurance Program (FCIP) Reform Act introduced revenue-based safety nets such as crop revenue coverage (CRC), revenue assurance (RA), income protection (IP), actual revenue history (ARH) with adjustments to future prices or crop prices projected to the time of harvest.

As an evolving risk management strategy, index-based AIPs and contracts are at different stages of development in developing countries, i.e., they are still being considered in some countries while being piloted, reviewed, and up-scaled in other areas. These programs can still amend their designs to integrate the revenue or price fluctuation safety nets. But studies like my need to be conducted to provide the requisite information to inform the design and redesign of existing and new AIPs and policies, respectively. We now transition to how agricultural insurance can promote sustainable agricultural practices and climate change mitigation.

2.11 The Role of Agricultural Insurance in Promoting Sustainable Farming Practices and Climate Change Mitigation

Climate change and unsustainable agricultural practices are threatening almost all segments of the global population, including the ecological and socio-economic sectors. All actors in the global development arena are, therefore, called upon to confront this challenge head-on (Solomon, 2007, Stopper, 2013), and agricultural insurance is considered to be part of the solution

(Mills, 2009). There are persuasive arguments for agricultural insurance in general, and index-based agricultural insurance, in particular, to actively engage in promoting CSA practices and climate change mitigation (Claassen, 2015; Mills, 2007, 2009, 2012) in addition to assisting farmers to address their key agricultural risks. Dahlström et al. (2003a) further reported that the agricultural insurance industry could contribute towards creating carbon sinks, carbon sequestration, and reduction in GHGs emissions proactively if the right political and regulatory environments were established. Skees and Collier (2012) maintained that governments and IDAs could connect vulnerable farmers to weather insurance and carbon markets through the provision of incentives and application of climate change adaptation and mitigation funds.

These views are grounded in ethical, moral, and environmental justice arguments. For instance, smallholder farmers in low-income countries contribute the least to global climate change and yet suffer the most from its adverse impacts with limited adaptive capacity (Below et al., 2010; Hassan, 2010; Morton, 2007). Edenhofer et al. (2012), Moellendorf (2015), the numerous UN's Conference of Party (COPs) sessions over the year, and the UNFCCC agencies are all calling on member countries, especially the developed (US in particular) and transitional industrial countries (China and Brazil) to provide the needed technical, financial, and infrastructural resources to support inhabitants of developing countries to adapt to adverse effects of climate variability/change and other agricultural risks. Other arguments for insurers to engage in climate change mitigation are framed around achieving socio-economic, sustainability, and profitability-related benefits of the insurance industry from the medium to term to long-term (Mills, 2007; Smith & Watts, 2009).

The insurance industry's current participation in climate change mitigation is mostly about general insurance issues and instruments (i.e., auto insurance, home insurance), strategic direction, organizational policy, and disclosure of climate risks information (Mills, 2009; Mills, 2012). However, some of the insurance industry responses to weather and climatic risks are directly relevant to climate mitigation (Mills, 2007, 2009; Mills, 2012). Some of these activities include engaging in climate change awareness creation, designing climate-friendly and climate-smart insurance products, promoting simultaneous climate mitigation and adaptation strategies, and incorporating climate risk reduction behaviors into insurance contract terms and conditions. However, this discussion is still at the general insurance industry level, and a case must be made regarding how conventional and index-based AIPs and contracts can contribute to climate change mitigation in the agricultural sector; particularly so when some agricultural insurance programs have been accused of causing climate change, ecological degradtion, and maladaptation (Galaz, Gars, Moberg, Nykvist, & Repinski, 2015; Klein & Maciver, 1999; Mills, 2007; Müller & Kreuer, 2016; Panda, 2013; Phelan, Taplin, Henderson-Sellers, & Albrecht, 2011). Skees and Collier (2012) gave some clues regarding how this can be done by suggesting that vulnerable farmers should be connected to weather insurance and carbon markets through the provision of incentives and application of climate change adaptation and mitigation funds. But are current agricultural insurance schemes and policies and smallholder farmers' agricultural systems promoting and contributing to climate change and sustainable farming practices? How can AICs and insured farmers contribute to agro-ecological farming practices and climate change mitigation?

Some detrimental practices associated with existing agricultural systems and insurance programs (i.e., AICs resulting in these harmful farming practices) include mono-cropping systems i.e., the cultivation of stand-alone crops, e.g. cotton, cocoa, rubber, mango etc. instead of indigenous crop varieties, especially millet and paddy rice which are known to be short-maturing, drought-resistant and well adapted to local environmental, weather, and climatic conditions

(Panda, 2013). Klein and Maciver (1999) stressed that **"**maladaptation may be encouraged by insurance and disaster-relief measures.**"** **(**p.193) Panda (2013) also found an index-based AIP inducing some Indian farmers to shift from the cultivation of millet and paddy rice which are well-adapted to the local Indian environment into growing a commercial cotton crop, a mono-crop. According to Panda (2013), the switch to the mono-cotton crop did not only lead to high indebtedness of the cotton farmers because of the loans contracted to meet the high inputs requirements but also resulted in ecological degradation and biodiversity loss, a situation he described as "maladaptive". These findings prompted some researchers to advise against governments' support and subsidization of crop insurance programs and premiums (McLeman & Smit, 2006, Nnadi et al., 2013; Shields, 2009). To these researchers, public support may mean governments are condoning and promoting these unsustainable practices. It may also mean governments are not incentivizing farmers to incorporate ex-ante risk management behaviors into their agricultural activities with the potential to preventing or reducing the occurrence of agricultural risks, these authors claimed.

Despite the concern that some agricultural insurance programs and contracts are causing maladaptation and ecological degradation, only a few studies link agricultural insurance to sustainable farming practices and climate change mitigation (Olmstead & Kleinschmit, 2011; Porrini & Schwarze, 2014; Skees & Collier, 2012). Some of these environmentally-friendly practices include the creation of carbon sinks, CO_2 sequestration, carbon credits, carbon markets, and prevention or reduction of emission of other GHGs. Phelan et al.'s (2011) research into "Ecological Viability or Liability? Insurance System Responses to Climate Risk" indicated that "insurance system responses to date are generally adaptive and weakly mitigative." (p.1)

However, the role of agricultural insurance in promoting agro-ecological farming systems and climate change mitigation is an emerging field (Dahlström et al., 2003a; Skees & Collier, 2012). McKinley, Asare, & Nalley (n.d.), for instance, investigated the potential of climate-smart cocoa (CSC) crop insurance for increased cocoa productivity and revenue generation in Ghana. The study also explored sustainable cocoa practices, the control of forest degradation and deforestation, and found a positive correlation between cocoa farmers' participation in CSC practices and the variables mentioned above, i.e., increased cocoa productivity and revenue and increased reversal of deforestation and forest degradation. The design of the experiment bundled the CSC crop contracts with loans and subsidized agro-inputs (e.g., fertilizers), and the authors found that farmers' patronage of CSC policies contributed to increase in gross revenue and decrease in forest degradation, i.e., reduction in the cultivation of forest area. Even though a novel study with useful results, the primary findings could further be enhanced if the authors had gone a step further to unpack the influence of possible compounding factors. In this case, the determination of net profit (e.g., total revenue minus total expenditure) could clarify the profitability or otherwise of CSC programs and contracts. Again, farmers' decision to engage in sustainable farming practices (i.e., CSA practices, agro-ecological farming systems, sustainable farming practices and climate change mitigation activities could be due to religious or socio-cultural motivations, traditional beliefs, fear of being sanctioned or based on some other reseasons or motivations rather than the influence of CSA practices. Byg and Salick, (2009), Goro and Yaro (2013), and Jarawura (2014) in their farmers' climate change and drought perception studies in Tibet and Ghana reported that smallholder farmers and other rural folks were using their socio-cultural and religious beliefs and faith to adapt to climate and weather-related hazards. In support of the use of socio-cultural factors and religious beliefs as adaptation strategies, Jarawura (2014) found that some farmers in the Savelugu District of the Northern region of Ghana have been engaging in environmentally sound agricultural practices (e.g., practice of on-farm and off-farm agro-forestry, non-bush burning, non-destruction of trees in and around culturally sensitive ecological sites-e.g., protection of sacred groves which are believed to be abodes of their gods/ancestral spirits). Ecological enhancement and reduced deforestation activities from these socio-cultural and religious beliefs and adaptation practices cannot be wholly attributed to farmers' participation in CSA as McKinley, Asare, and Nally are claiming as described above.

2.12 Summary and Conclusions

Smallholder farmers in low-income countries are vulnerable to adverse impacts of both weather-induced and non-climate-initiated agricultural risks. To address these risks, small farming households often employ adaptation strategies (both autonomous and planned) to cope with their agricultural risks, mainly caused by climate variability and change. With the projected increase in climate variability, climate change, extreme weather hazards, and other non-climatic agrarian risks, some scholars claim that smallholder farmers' existing adaptation strategies alone may not sufficiently help them to cope with the anticipated agricultural challenges. To support smallholder farmers in low-income countries to manage their existing and projected agricultural risks, agricultural insurance, especially index-based AIP and products have been proposed and promoted by some researchers, policymakers, and development partners. Index-based agricultural insurance schemes are currently being introduced (feasibility studies being conducted), piloted, reviewed, and up-scaled in some-low-income countries, especially in Sub-Saharan Africa (SSA). In the case of Ghana, the Ghana Agricultural Insurance Pool (GAIP) is currently up-scaling and expanding its AIP and contracts to cover many regions. The government of Ghana and WorldCover are also reportedly piloting new AIPs and products. Some agricultural insurance stakeholders believe the design and unique features of index-based agricultural insurance schemes and contracts do not only accommodate the special needs, circumstances, and peculiarities of smallholders in developing countries but also make the AIPs and contracts available, accessible, and affordable to this category of farmers.

Research into the functions, effectiveness, and viability of AIP and products reported mixed findings and reactions. Whereas some researchers claimed that agricultural insurance has been and can be a useful agrarian risks management tool, other scholars reported the contrary. Some studies also observed that some crop insurance programs and policies are not only promoting ecological degradation and maladaptation but are also attempting to insure the already insured, i.e., farmers already using informal agricultural risks management strategies. These claims make the role of agricultural insurance as an agrarian risks management strategy murky and uncertain, and, therefore, needs to be clarified based on country-specific circumstance, hence, this dissertation research.

The agricultural risks and agricultural insurance issues described above provide the background for critically-minded researchers to ask a couple of questions. Some of the questions that might have been provoked include: what are smallholder farmers' key agricultural risks? Are smallholders' existing adaptations capable of helping them to cope and manage their agricultural risks? If these agricultural risks management strategies are not effective, are there social protection programs and safety nets targeted at helping vulnerable small-scale farmers to manage their agricultural risks (i.e., for vulnerable farmers not to fall below the poverty level)? And if so, what are these measures and are they effective? Are crop insurance programs and contracts effective agricultural risk management strategies for smallholder farmers? Can AIPs and products promote sustainable farming practices and climate change mitigation? Can simultaneous climate change adaptation and mitigation enhance the sustainability and efficacy of crop insurance programs? Are crop insurance programs effective and sustainable climate change adaptation strategies? If so, what are the determinants and attributes of sustainable crop insurance programs and contracts? These questions and many others informed by the literature review are begging for answers. Further research is, therefore, needed to provide answers to these questions. These gaps in the agricultural insurance discourse create an entry point for my dissertation research to broadly explore the perceptions of the potential of agricultural insurance for crop risks management in Northern Ghana in an attempt to provide answers to some of the questions raised above.

I conducted the literature review to acquaint myself with what research work has been done in the field of agricultural insurance so far in order to identify the gaps and grey areas for my research. It also enables me to identify paradigm debates and methodological issues to inform and guide my research into the potential of agricultural insurance for crop risks management. In this literature review, I found three completed dissertation and thesis projects in Ghana, 14 published articles, and a feasibility report covering Ghana (15 in all). The three Dissertation and Thesis projects and eight articles were conducted in Northern Ghana (i.e., my study area) with the remaining four covering Southern Ghana. Irrespective of the study area and the type of research, i.e., whether a dissertation or an article, these studies focused on: 1. The role of agricultural insurance in protecting financial investments (1 article), 2. The role agricultural insurance in stimulating investments in the agricultural sector (2 articles), 3. Willingness to participate in AIPs or pay (WTP) for agricultural insurance services (hypothetical assessment) (4), 4. The role of agricultural insurance in promoting access to agro-loans or credit facilities (1), 5. The role of agricultural insurance for price protection (1), 6. Economic viability of climate-smart cocoa (CSC) crop insurance (1), 7. The role of agricultural insurance in promoting social adaptation and safety nets (4), and 8. An agricultural insurance feasibility study (1). Other research works I came across just mentioned agricultural insurance as an agricultural risk management tool in passing.

The next chapter presents the methodological and philosophical orientation of the research. It specifically details the sampling strategies, data collection instruments, study participants among other methodological-related phenomena.

Chapter 3: Research Methodology and Design

3.1 Introduction

My central research question is: What are agricultural stakeholders' perceptions of the potential of agricultural insurance for crop risks management among smallholder farmers in Northern Ghana? To answer this question, I further explored the following sub-questions:

1. What are smallholder farmers' major crop risks?

2. What strategies have these farmers been employing to manage their key crop risks? How effective are these strategies?

3. In what ways have agricultural insurance programs and contracts been helping, i.e.,benefiting smallholder farmers to manage their major crop risks?

4. Are agricultural stakeholders (i.e., insurers and insured smallholder farmers) willing to use agricultural insurance as a tool for promoting sustainable farming practices and climate change mitigation in Northern Ghana? If so, what ways can agricultural insurance programs and contracts help insurers and insured farmers to accomplish this? I employed the convergent mixed methods design to gather the requisite data and conduct the associated analysis to answer my research questions.

The goal of this chapter is to explain and justify the methodological procedures adopted in this research. This methodology section begins with brief information on the research phenomena and the philosophical orientation in which the study was grounded. Furthermore, it describes the research setting and scope, selection of the study participants, the study approach and design, and sources of data for the research. This chapter also outlines the sampling strategies, data collection methods, pre-testing of the sampling strategies and data collection methods, description of the study variables, data analysis, and results presentation techniques.

3.2 The Study Methodology and Paradigm

This study was guided by a mixed methods research approach that incorporated a combination of qualitative and quantitative strands. This approach allowed me to consolidate the strengths of both quantitative and qualitative research traditions as well as offset the weaknesses of each as recommended by mixed methods research experts (e.g., Bryman, 2006; Creswell and Plano Clark, 2011; Greene, Caracelli, and Graham,1989; Trochim, 2005). As multi-disciplinary research that aims at providing understanding and recommending practical solutions to address smallholder farmers' agricultural risks , this design is compatible with the pragmatic research philosophy and paradigm (Clark & Creswell, 2011). Even though the ontological, epistemological, and methodological orientations of this study seem more inclined to the constructivist paradigm, Creswell (2009), Clark and Creswell (2011), and Patton (2002) revealed that the pragmatic paradigm accommodates essential elements and features of other worldviews and philosophical orientations. Considering the practical nature and potential policy implications of this research, and the need to use participants' knowledge, perceptions, and experiences to answer my research questions, this requires a paradigm that is all-embracing and flexible enough to accommodate all these elements. The pragmatic worldview of issues offers this opportunity, hence, my decision to ground this research in this philosophical underpinning. The pragmatic approach specifically emphasizes among other things the need to use research to find practical solutions to societal problems (Patton, 2002), to which the application of agricultural insurance to managing agricultural risks among smallholder farmers is a part.

3.3 Study Design

The study design includes the selection of the study site, study participants, study approach, and sampling and data collection strategies as described below.

3.3.1 Study Site and Scope

My study covered Northern Ghana. Northern Ghana, also called the three Northern Regions or three regions of the North comprises three administrative regions (a region in Ghana is comparable to a state in the United States). These regions are the Upper West Region (UWR), the Upper East Region (UER), and the Northern Region (NR). Northern Ghana is bounded to the west by La Cote D'Ivoire (longitude 300′ 0″W), to the east by Togo (longitude 10 0′0″E), to the north by Burkina Faso (latitude 1100′ 0″N), and to the south by Brong Ahafo and Volta regions (latitude 80 0′ 0″N). Figure 2 below visually depicts Northern Ghana. Figure 2: Map of Northern Ghana showing study area.

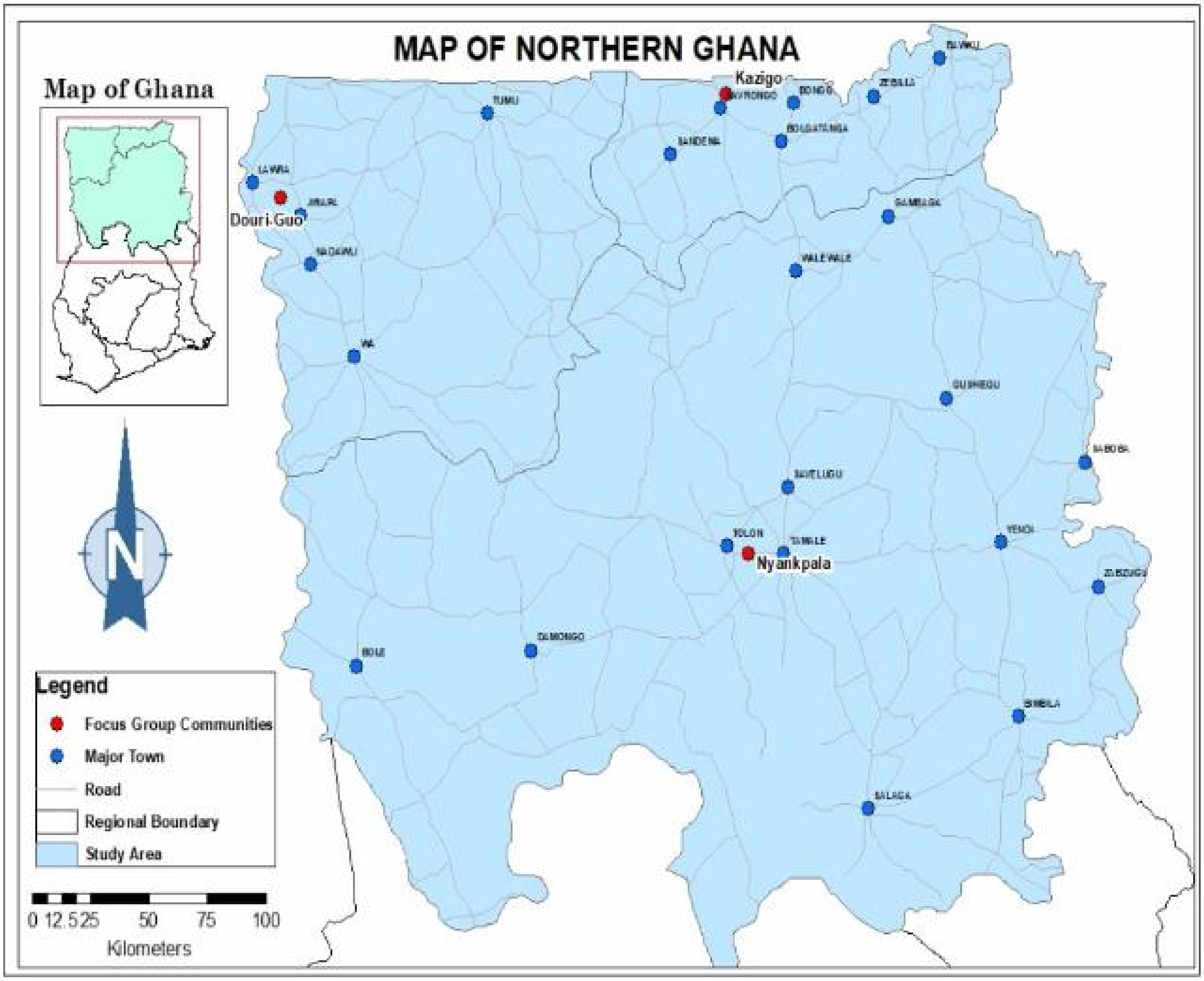


Figure 2: Map of Northern Ghana showing the study area.

Source: Contracted an expert to design this Map, 2018

Northern Ghana was selected for this study because of its high vulnerability to climate variability and change, extreme enviromental degradation, and the escalating agricultural risks (Acheampong et al., 2014; Christine Young Adjei, Rhodante Ahlers, & Kodwo Andah, 2012; EPA 2003; Molini et al., 2010); the weak adaptive capacity of its farmers (Acheampong et al., 2014); and the piloting and subsequent up-scaling of an AIPs in this part of Ghana. (Nunoo & Acheampong, 2014;

Stutley, 2010). Mmajority of Northern Ghana are subsistence farmers who mainly depend on rain-fed agriculture for their livelihood activities (Abdul-Korah, 2007; Acheampong et al., 2014; Sumani, 2008). Other researchers have indicated that climatic variables such as mean annual temperatures and rainfall will continue to vary and change in Northern Ghana, with possible increasing droughts, floods or storms (Acheampong et al., Adjei et al., 2012; 2014; Sumani, 2008).

The magnitude, frequency, and covariate nature of adverse weather and other agricultural-related challenges are making it difficult for small-scale farmers to use their informal adaptation strategies to cope with adverse impacts of their agricultural challenges in Northern Ghana (Acheampong et al., 2014; Bawakyillenuo et al., 2016; Adjei et al., 2012; Molini et al., 2010, 2010). This study was, therefore, designed to explore perceptions of the potential of agricultural insurance for crop risks management, sustainable farming practices, and possible climate change mitigation among smallholder farmers in Northern Ghana.

3.3.2 Selection of Study participants

My dissertation research is multi-stage and multi-layered in character, and as such, different categories of respondents were chosen to participate in the study. These participants included primary smallholder farmers, representatives of Peasant Farmers' Association of Ghana (PFAG), the staff of AIPs and companies i.e., GAIP and WorldCover, and representatives of the insurance industry regulator (i.e., the National Insurance Commission of Ghana-NIC). Other participants in the study were District and Regional Agricultural Extensions Agents (AEAs) of the Ministry of Food and Agriculture (MOFA), staff of the Ghana Meteorological Agency (GMA), projects, and other agencies involved in agrarian and agricultural insurance-related activities in Northern Ghana such as USAID/Agricultural Development and Value Change Enhancement project -ADVANCE, and some national and regional level agricultural insurance researchers.

These participants were selected because they had the requisite experience and knowledge to answer my research questions.

3.3.3 Study Approach, Design, and Justification

My research employed convergent parallel mixed methods design also called convergent design. Under this design, both qualitative and quantitative data were gathered concurrently but independently- collection of the quantitative data was not informed by the gathering of the qualitative data and vice versa. The qualitative and quantitative data were analyzed separately with their results merged at the end to enhance understanding and interpretation of the research outcomes (Clark & Creswell, 2011). However, the qualitative strand was given more priority than the quantitative aspects due to the nature of my main research questions and the sampling and data collection strategies and procedures employed. These attributes are more qualitative than quantitative.

This dissertation project employed the mixed methods research approach for a variety of reasons. Firstly, whereas some of my research questions demanded quantitative responses, others were also framed qualitatively. Therefore, one type of research approach, qualitative or quantitative is not enough to answer my research questions. Secondly, as an integrated study involving agricultural risks mitigation strategies and agricultural insurance with different categories of study participants, that is, smallholder farmers, insurers, and other non-insurer stakeholders who were either literates or illiterates regarding print-based literacy during my interaction with them, mixed methods research design is more appropriate for such integrated and complex studies (Clark & Creswell, 2011; Trochim, 2005). Thirdly, I engaged a mixed methods study to accommodate both probability and non-probability sampling strategies, as well as use the qualitative responses of the study participants to explain and expand some quantitative results - adding flesh to bone among other reasons.

3.3.4 Sampling Strategies

Northern Ghana was purposefully selected as justified above (see section 3.3.1 for detailed information about this). For instance, GAIP piloted agricultural insurance in Northern Ghana and is currently being upscaled to Southern Ghana as well. WorldCover, the second AIC was also experimenting drought index insurance in the three regions of the North and the Brong Ahafo region at the time of this fieldwork. To ensure that all the three Northern Regions were represented proportionally, Northern Ghana was stratified or clustered into three regional blocks, namely, UWR, UER, and NR. Multi-stage and stratified sampling was then used to select the community level study participants (i.e., smallholder farmers). UWR, UER, and NR each has 11, 13, and 26 Metropolitan, Municipal and District Assemblies (MMDAs), respectively. The original target was to cover approximately 10% of the MMDAs in each regional. In this case, 1, 1, and 2 MMDAs were to be purposefully selected from the UWR, UER, and NR, respectively. However, the field conditions changed, and the original sampling and the data collection plan was modified. Specifically, instead of sampling 2MMDAs from the 26 MMDAs in Northern region, one district and one community were chosen. This change was necessitated by lack of access to some farmers with extended experience of agricultural insurance practice, sponsored by a research agency in the Northern Region. However, the results, conclusions, and recommendations would still be relevant since the goal of the study was not to generalize the findings, conclusions, and recommendation.

All the MMDAs in each of the 3 Northern regions with some of their farmers holding agricultural insurance policies at the time of the fieldwork were identified, using information from the staff of GAIP, WorldCover, MOFA, and other agricultural insurance experts. Simple random sampling was then employed to select 1 MMDA each from the UER, UWR, and NR. One (1) community in each of the three chosen MMDAs with the highest number of insured farmers was purposefully picked, making three communities in all. By this criterion, Duori-Guo, Kazigo, and Nyankpala communities were purposefully selected from the Jirapa, Kasina-Nankana West, and Tolon Districts (randomly chosen earlier), respectively. In addition to the list of insured farmers from GAIP, WorldCover, and MOFA; Snowballing was also engaged to recruit some key informants such as nucleus farmers, AEAs, and some members of the PFAG.

The multi-stage stratified sampling involving the chosen regions, districts, and communities allowed possible comparison of results from these respective geographic scales i.e., regions, districts, and communities. For instance, this stratification revealed differences in agricultural risks and adaptation strategies at the regional, districts, and community levels. It further showed which gender, communities, districts, and regions were patronizing crop services more (hereby, referred to as innovators or adoptors) and which were the laggards or non-adoptors (those not willing or refusing to adopt the innovative insurance products), and the accompanying respective reasons in accordance with Rogers's (1995) diffusion theory of spreading and adopting innovative ideas.

Purposeful sampling was equally engaged to select respondents from non-farmer participants such as the insurers and other non-insurer stakeholders because these categories of participants were presumed to be able to answer questions on agricultural risks confronting smallholder farmers and the accompanying adaptation and mitigation strategies, including other issues on Agricultural insural insurance. In justifying the use of purposeful sampling for special case studies like mine, Patton (2002) said “the logic and power of purposeful sampling lie in selecting information-rich cases for study in-depth. Information rich-cases are those from which one can learn a great deal about issues of central importance to the purpose of the inquiry" (p.230).

These non-farmer participants are distributed as follows: representatives from each GAIP and WorldCover offices in each of the 3 regions and at the national office level, staff of NIC and PFAG in Northern Ghana or at the national level with oversight responsibility over Northern Ghana, and researchers from Universities and research institutions who conducted investigations into agricultural insurance issues in Northern Ghana. Other participants included representatives from GMA, Regional Coordinators of ADVANCE, and AEAs from the selected districts. This brings the total non-farmer participants to 44 as shown in table 1 below.

Table 1: Distribution of Non-Farmer Participants

Category of Participants	Total Number
Insurers (GAIP & WorldCover)	11
NIC	2
PFAG	3
Academics/Researchers/SARI	5
GMA	2
USAID/ADVANCE	2
AEAs	3
ACDEP	1
Nucleus Farmers	12
The staff of Rural Bank/Credit Union	3
Total	44

Note. Source: Constructed from field data, 2017/2018

3.4 Pre-Testing of Sampling Strategies and Data Collection Methods

A pilot phase was used to pre-test my sampling strategies and data collection instruments. This involved two separate FGD sessions with females and males, three key informant interviews, and five survey respondents (questionnaires administered). This preliminary study was undertaken to enable me to familiarize myself with the data gathering process to inform a better design of the sampling and data gathering instruments for the main fieldwork.

The pre-testing of the sampling strategies and data collection methods were conducted from 7th-14th December 2016. During this pilot phase, the Upper West region was selected for convenience and because I understand and speak the dialect i.e., Waale and Dagaari very well. Since all the 11 Municipal and District Assemblies had insured farmers, Nadowli-Kaleo District was purposefully selected. The Kaleo community was also purposefully chosen because the UWR GAIP sales list showed that Kaleo and its environs had the highest number of insured farmers in the region at the time of the pre-testing of the sampling and data collection instruments. The pilot study involved two separate FGD sessions for female and male discussants in Kaleo. This gender-disaggregation was incorporated so that female voices could reflect in the group discussions and not be subsumed under those of the males. In traditional northern settings i.e., in Northern Ghana, men and women are hardly brought together to discuss issues. In limited cases where both genders are brought together, women may only listen and are not allowed to contribute, and they may not even be comfortable talking in the presence of a single male when given the opportunity (Asitik, 2016). It is a traditional and socio-cultural practice in Northern Ghana that the husband is the head of the family and his voice represents those of his wife (wives). Asitik's Ph.D. thesis in "Entrepreneurship: A means to poverty reduction in rural Northern Ghana?" confirmed this hypothesis. Having separate FGD platforms for men and women was necessary because women may have unique agriculture risks and concerns different than those of men. Being aware of possible special gender needs, the pilot team organized separate FGD sessions to capture concerns of both genders.

The female group had nine discussants whereas the male discussion group recorded six participants. FGD sessions took place in Kaleo under a mango tree using the local language called Dagaare. Recruitment of discussants was done using information from the UWR GAIP office, AEAs, a nucleus farmer, and snowballing. The purpose of these FGDs was to allow discussants to identify their key agricultural risks, agricultural risks management strategies, and the current roles (benefits) of agricultural insurance among other variables. These sessions were facilitated and moderated by my two research assistants (RA) and I. There was difference in duration of the said FGD sessions. For instance, whereas the male FGD forum took $2^1/_2$ hours, that of the women lasted for about 3 hours.

In addition to the FGD sessions, three key informant interviews were conducted with 1 AEA, one nucleus farmer, and 1 GAIP marketing officer in the English language. These key informants were contacted to gather their key agricultural risks, adaptation and coping strategies, and how agricultural insurance contracts have been helping smallholder farmers to manage some of their farming problems. Whereas the interviews with the GAIP staff and AEA took place in their respective offices in Wa (the Region capital of the UWR), that of the nucleus farmer was conducted in Kaleo under a mango tree, also in English. The interview schedules that were used to guide the FGDs and key informant interviews were based on semi-structured questions to give discussants and informants the flexibility to tell their stories. The open-ended questions also offered the research team the opportunity to ask probing and follow-up questions. These interviews lasted between 45 minutes to 1hour, 15 minutes.

During this pilot phase, five self-administered questionnaires in the English language were personally distributed to non-farmer respondents, including 1 AEA, 1 GAIP staff, 1 GMA staff, 1 USAID/ADVANCE staff, and 1 SARI staff (a researcher). These participants were purposefully selected to participate in the survey. These respondents were chosen because they could answer some aspects of my research questions. Each respondent gave me time to come back for the completed questionnaire at his or her convenience (3 females versus two males). During this preliminary phase, responses were sought from subject areas of my research such as socio-economic and demographic characteristics of respondents, key agricultural risks, existing agricultural risks management strategies, and farmers' safety nets and welfare programs. Other areas covered included determining the effectiveness or otherwise of the adaptation strategies, existing roles of agricultural insurance, and existing farming systems and practices. (See Appendices VI, VII, and VIII on the data collection methods).

Based on the results of the pre-testing of the data collection instruments, some components of the study were scaled down, expunged, modified with new aspects introduced. For example, some key informant interviews and FGD sessions lasted between 45 minutes and 3 hours during the pre-testing phase to the extent that some participants were tired, yawning, and eventually became disinterested in the interviews and FGD sessions. I therefore, had to delete redundant questions as well as prune down some of the questions to prevent boredom and reduced interest in the interviews. I also learned from the pilot phase that pre-informing study participants with frequent reminders and interaction with potential participants builds trust and gives assurance of successful interviews and FGD sessions. These lessons and the appropriate modifications were built into the revised interview guides and questionnaires. Fortunately, the changes introduced were not so fundamental to warrant revision of the approved IRB and the immediate attention of my dissertation committee members. Aside from the modifications mentioned above, this preliminary study also offered me the opportunity to make the necessary contacts, arrangements as well as do the preparatory groundwork for the main fieldwork that took place between late 2016 and late 2017.

3.5 Qualitative Data Collection Methods and Variables

This research employed a combination of qualitative data collection methods to solicit responses from smallholder farmers, including focus group discussants and key informants.

3.5.1 Focus Group Discussions

Six FGD sessions were conducted in the three selected communities to elicit qualitative responses from farmers disaggregated into male and female groups (Refer to section 3.4). These gender-based community level FGD fora were undertaken to ensure that women voices were not buried under those of men.

Asitik (2016) advised that rural areas in Northern Ghana have unique and common cultural practices that need to be recognized and appropriately accommodated in any study in those areas to ensure successful fieldwork. This also requires engaging the culturally appropriate and sensitive community protocols, such as notifying chiefs and other opinion leaders of my mission to gain acceptance into the communities. Fortunately, I am from Northern Ghana and know the culturally sensitive issues and common community protocols to a greater extent. When introduced and accepted, I had no problem navigating my way through the cultural practices and local community protocols. For instance, a nucleus farmer (also my past student) introduced me to the regent of Kaleo, and I briefed him about my fieldwork in his jurisdiction. He, in turn, informed other community leaders about my presence in the community to conduct research. I also had adequate experience in the conduct of interviews and the use of community protocols in all the three Northern regions either directly or indirectly through translators. I worked for EPA and University for Development Studies (UDS) from 2002 to 2013, and during this period, I conducted a series of surveys and interviews in the Upper West and Northern regions-Northern Ghana. As a Coordinator of the UDS Third Trimester Fieldwork Practical Training Program (TTFPTP), I also conducted pre-community selection surveys throughout Northern Ghana before sending my students to selected communities. Under the TTFPTP, I again, conducted community entry protocols such as meeting with community leaders, asking to know about taboos in the communities and conducting supervisory and monitoring activities.

Kumekpor (1999) and Trochim (2005) indicated that FGD sessions are most effective when the discussants are not too many or too few,i.e., they recommended having 5 to 12 discussants per focus group. Despite this recommendation, field conditions made it impossible for all my FGD sessions to meet this suggestion. For instance, fourteen females showed up for the FGD at Duori-Guo -more than 12 discussants. Even though I was aware of the suggested number of discussants per session, it was ethically wrong to drive away the excess discussants. For instance, who was going to be asked to leave the FGD session? The remaining FGDs had discussants ranging from 5-8, i.e., Nyankpala female and male FGDs had 6 and 5, respectively, and Kazigo female and male focus groups also recorded 8 and 6 discussants, respectively.

The FGDs were undertaken to provide a group setting for interactive discussion of smallholder farmers agricultural risks, existing agricultural risks management strategies, and farmers' safety nets and welfare programs. The focus group interview schedule also captured the effectiveness or otherwise of these adaptation strategies, reasons for purchasing or wanting to purchase agricultural insurance policies, willingness to renew their subscriptions, and engage in sustainable farming practices. Other thematic areas covered included the willingness of farmers to engage in agro-ecological and the accompanying motivational reasons. The group setting was to enable a rich discussion of the complex subject of crop insurance.

Focus group discussion sessions were held either at the market square, (Duori-Guo), community meeting place (Kazigo), and a convenient location under a tree shade (Nyankpala). The Duori-Guo, Kazigo, and Nyankpala FGD platforms were held in the local dialect of the respective communities such as Dagaare, Kasim, and Dagbanli, respectively. Dakurah and I facilitated these sessions at (Duori-Guo), Adongo and Atinga at (Kazigo), and Mohammed and Issah at (Nyankpala). These FGDs fora lasted between 2-3 hours. Names of the RAs are pseudonyms.

Dakurah, Adongo, Atinga, Mohammed, and Issah except Atinga (a Kazigo community member) were graduate research assistants (RAs) proficient in their respective local languages and were recruited to facilitate and moderate FGD platforms in the UWR, UER, and NR. They were recruited from the Graduate School of UDS following an announcement for those interested to contact designated local language experts. Language experts in Dagaare, Kasim, and Dagbanli interacted with a pool of graduate students, and those most proficient and fluent in their respective dialects were chosen to form the research team. These RAs were paid, transported, and fed.

The RAs assisted in organizing, mobilizing, and facilitating the FGD sessions. In some instances, one facilitator ensured the smooth running of the sessions, and the other (note taker) recorded the salient points or responses. Even though I am only proficient in one of the dialects (Dagaare) used for the focus group discussions at Duori-Guo in the UWR, I was present at the other two FGD sessions. My presence was to give assistance to the RAs as well as supervise all the sessions for quality assurance and in compliance with all ethical and moral issues as contained in my approved IRB application and informed consent forms (See Appendices II-V). Responses emanating from all the six FGD sessions were audio recorded and some photographs taken with the permission of the discussants as required by the approved IRB letter.

Focus group discussions were facilitated using a schedule that contained semi-structured questions. The semi-structured nature of the questions gave discussants the flexibility to tell their stories. Nsowah-Nuamah (2005) explicitly encouraged the use of themes or question schedules to ensure consistency in the questions facilitators ask.

According to Asitik (2016), inappropriate use of a local language to gather qualitative data can compromise the quality of the information and the integrity, credibility, and trustworthiness of research results, conclusions, and the accompanying recommendations. To enhance the quality of data collection, I adopted a modified version of Asitik's Trans-MM model- Translation, Moderation, and Mediation Model. This model employs a three-tier process involving a translator, a moderator, and a possible mediator in the qualitative data collection process. Asitik developed this model in 2013 to guide his Ph.D. thesis data collection in Northern Ghana. This model is, therefore, directly relevant to the qualitative strand of my mixed methods research also conducted in Northern Ghana. The model requires the translator to be a tutor of the local language in question at the tertiary level or lower and the moderator and mediator to be examiners in the local language at the tertiary level i.e., Teacher Colleges of Education and Universities. In my research, it did not matter whether the translator, moderator or mediator was a tutor or examiner, what mattered was the cost of operationalizing the TMM model, competence, and proficiency in the local language. I recruited three mediators and three moderators in addition to my five RAs and myself as translators. In my study, it was only the mediators who were examiners in their respective dialects at the West African Secondary School Certificate Examinations (WASSCE) level and beyond (i.e., Universities and Colleges of Education). The translators were my RAs. The moderators were also tutors at the Junior High School (JHS) and Senior High Seconday Secondary (SHS) levels. All the moderators and mediators were paid except one who refused to accept the payment and said that was his contribution to my dissertation project.

As prescribed by the Trans-MM model, translators proficient in the local languages of my study area were recruited to translate the questions contained in the interview guide from English to the local languages as well as translate and record the responses from the local dialect into the English language for me, i.e., for purposes of capturing the fieldnotes. They also transcribed verbatim the audio recordings from the local language into English. The transcripts together with the audio recordings were then given to the moderators to compare the audio recordings with the transcripts so as to indicate any discrepancies and to suggest corrections (i.e., insertions, deletion or modification). The transcriptions and audio recordings never got to the desk of the mediators since there were no significant disagreements between the translators and the moderators. However, the moderators made minor suggestions and corrections to the translators which were readily accepted and inserted in the transcripts, hence, there was no need to involve the mediators in the data translation and transcription process.

3.5.2 Key Informant Interviews

Key informant interviews were conducted with insurers and some non-farmer participants who were working with smallholder farmers in the study communities, districts, and regions at the time of the fieldwork. Key informants were purposefully selected because they have been working with smallholder farmers and might also be knowledgeable in agricultural insurance and other agricultural risks-related issues. The inclusion of the knowledge, experience, and perceptions of these secondary or intermediary level study participants is necessary because they have been interfacing with the relevant national level organizations, agricultural insurance research scientists, and smallholder farmers at the community level. Therefore, their input into a research exploring the perceptives of agricultural stakeholders on the potential of insurance for agricultural risks management among smallholder farmers is relevant.

The key informants included GAIP marketing officers from two GAIP regional offices, a Regional Coordinator of WorldCover from each of the three Northern Regions, an AEA of MOFA from each Region, and a staff each from the two regional GMET offices. Other informants interviewed were focal persons from each of the three PFAG Regional Chapters, 1 USAID/ADVANCE staff, twelve nucleus farmers, and three staff of Rural Banks (Table 2). This brings the number of key informants to 29. These key informants were interviewed based on an interview guide with semi-structured interview questions (Appendix VII).

Table 2: Distribution of Key Informants

GAIP Marketing Officers	2
WorldCover Regional Coordinators	3
Agricultural extension agents (AEAs)	3
GMA Regional Coordinators	2
Regional presidents of PFAG	3
Regional Coordinator of ADVANCE	1
Nucleus Farmers	12
The staff of Rural Banks/Credit Union	3
Total	**29**

Note. Source: Constructed from field data, 2017/2018

3.6 Quantitative Research Methods and Variables

3.6.1 Self-administered questionnaires.

Questionnaires were the most appropriate method of data collection to answer some of my research questions, hence the mixed method design. Other questions were best answered through FGDs and key informant interviews. The questionnaires listed smallholder farmers' key agricultural risks, coping measures, safety nets, and other research variables. Respondents were expected to rank some of the variables. This, therefore, required quantitative responses such as frequency and ranking of responses, hence, the need to employ quantitative sampling strategies, data collection methods, and analytical frameworks to accommodate these responses.

Self-administered questionnaires (Appendix VIII) were employed to solicit responses from survey respondents, hereby referred to as tertiary level participants. Questionnaires were administered to these respondents who were proficient in the English language, and as such, could read and answer the questions posed in the questionnaires unaided or with minimum guidance or explanation. The questionnaires contained both closed-ended and open-ended questions to allow the respondents to answer the survey questions flexibly and conveniently. I included my cell phone numbers and email addresses so that respondents could reach me if there was the need to clarify or explain any issue.

I distributed the self-administered questionnaires to respondents at the regional, zonal, and national levels whose work or activities directly or indirectly related to agricultural risks mitigation and agricultural insurance issues. These respondents included: three GAIP staff, one staff of Association of Church Development Projects (ACDEP), one from MOFA regional Office, two Regional Directors of GMA, two academics from the University for Development Studies (UDS), two researchers from Savannah Agricultural Research Institute (SARI) in the Upper West and Northern regions, a Regional Coordinator of ADVANCE, and three AEAs. This yields 15 respondents. Whereas some questionnaires were personally distributed, others were emailed to respondents who agreed to this mode of distribution. Only five questionnaires emailed were completed and returned out of the ten distributed electronically. Seventeen (17) questionnaires were also manually distributed to targeted respondents, and ten were completed and returned. These together generated a response rate of 56%. These questionnaires captured attributes such as willingness to provide (WTP) crop insurance services and subsidies, willingness to provide or facilitate the provision of climate-friendly policies and institutional, infrastructural, technical, and administrative support to insurers, i.e., reinsurance, technical, and regulatory assistance as done in other jurisdictions such as the US, Canada, India, etc. (Appendix VIII) .

The non-farmer-participants, especially insurers, insurance regulators, and government represented by relevant agencies were also asked about their willingness to reward or motivate farmers undertaking climate-friendly and sustainable farming practices such as agro-forestry, agro-ecological, and CSA practices (i.e., climate adaptation, resilience, and mitigation activities).Other variables were premised on willingness to provide agro-meteorological advisory services (i.e., early warning systems, weather forecasting, when to plant, and when to harvest), willingness to supply farmers with agro-inputs directly or to link them (farmers) with agro-input dealers, agro-processors, and markets (agri-business value chain linkages), willingness to guarantee loans for farmers among other questions.

Table 3 below matches the various data collection methods with the specific research questions

Table 3: Data collection methods used for specific research questions			
Research Question/ Type of Data Collection Method	Focus Group Discussions FGDs	Key Informant Interviews KIIs	Questionnaires
Geographic scale of study participants	Community Level	District Regional National levels	Regional and National levels
What are smallholder farmers' key agricultural risks in Northern Ghana?	√**	√**	√**
What strategies have smallholder farmers in Northern Ghana been employing to manage their key crop risks? How effective are these strategies?	√**	√**	√**
In what ways have agricultural insurance contracts been helping (benefits) smallholder farmers to manage their major crop risks?	√*	√*	√**
Are agricultural stakeholders (i.e., insurers and insured smallholder farmers) willing to use agricultural insurance as a tool for promoting sustainable farming practices and climate change mitigation in Northern Ghana? If so, what ways can agricultural insurance programs and contracts help insurers and insured farmers to accomplish this?	√*	√*	√**

Note. Source: Constructed from field data, 2017/2018

Notes. √ Connotes the data collection method applied to a specific research question

* Collection of only qualitative data

** Collection of both qualitative and quantitative data

Table 3 portrays the type of data collection methods used to gather information for each research question. The table reveals that all the data collection methods, i.e., FGDs, KIIs, and questionnaires were used to generate data for all the research questions. The study was designed as a multi-layered study, involving insured farmers, KIIs, and survey respondents in order to obtain a wide range of perspectives from the different categories of agricultural insurance stakeholders. Focus group discussants (discussants) and key informants (informants) also answered questions from interview guides containing almost similar questions (Appendices VI and VII). In addition to most of the questions, discussants and informants answered, survey respondents completed other questions, mostly quantitatively (Appendix VIII).

3.7 Data Analysis

The data collected for this study included both qualitative and quantitative data. The qualitative data generated through FGDs and key informant interviews were focus group and interview transcripts. On the other hand, the quantitative data were the survey results.

I employed the general inductive approach, mainly informed by the qualitative data analytical framework. Trochim (2005) aptly defines the inductive analysis method as “bottom-up reasoning that begins with specific observations and measures and ends up as a general conclusion or theory.” (pg. 15). I employed the general inductive method of data analysis because it does not only offer me the opportunity to condense extensive qualitative data into manageable themes but also provides clear linkages between my research questions and the results.

Some researchers such as Patton (2002), Trochim (2005), and Thomas (2003) hinted that the inductive approach by its nature is more open-ended and exploratory, thus allowing categories and themes to emerge naturally from the raw qualitative data. These characteristics of the inductive approach made it a more appropriate data analytical framework for my research which is more exploratory with FGD sessions, key informant interviews, and questionnaire surveys. Under this general inductive approach, patterns, categories, and themes were identified, described, and the results presented textually and graphically, and conclusions drawn from these trends. The coding generated many themes, especially, smallholder farmers' key agricultural risks and the associated agricultural risks management strategies. For instance, the coding of smallholder farmers' adaptation strategies generated forty-five categories, which were condensed into nine themes.

As a mixed methods research, some elements of deductive analysis were also incorporated into my data analysis, organization, and presentation of the results. For example, I employed a modified version of Patton's, (2002) data analytical, organizational, and reporting framework. Leaning on Patton's data organizational and reporting framework, I analyzed the data thematically and by my research questions, that is, analysis on research question by question basis. My data analysis was also informed by recommended integrated data analysis and interpretation framework for convergent mixed methods research designs (Bazeley, 2009; Creswell & Plano Clark, 2011; Teddlie & Tashakkori, 2009). Based on these analytical data frameworks, the research data were broadly organized into smallholder farmers key agricultural risks, coping strategies, functions of Agricultural insurance, and the ways AIPs and contracts can contribute to agro-ecological farming and climate change mitigation. The themes and sub-themes were further generated from the question by question categories. My integrated conceptual framework also incorporated some theories which offered not only guidance for the entire dissertation project, data collection, data analysis, and discussion of the results but also provides the framework for data analysis. I specifically used McLeman and Smit's (2006) vulnerability to climate hazards: Crop and flood insurance, Smit and Skinner's (2002) typology of adaptation strategies in the Canadian agricultural sector, Zahniser et al.'s (2010) European Union's climate change adaptation framework in the agricultural sector, and Goel's (2013) complete agro-financial service framework for emerging economies. These theoretical and conceptual frameworks guided me to organize and analyze my research data based on weather and non-weather-induced agricultural risks and the subsequent adaptation strategies.

This combined deductive and inductive approach to data analysis in the social sciences, especially in mixed methods research is widely reported in the extant literature (Creswell & Plano Clark, 2011; Patton, 2002; Thomas, 2003). Wentz (2011), especially emphasized the need for combined deductive and inductive reasoning, including data analysis in scientific research when she reported that "In reality, scientific investigations rely on an iterative relationship between deductive and inductive reasoning. This serves to use existing theory to draw conclusions (typically a theoretical framework) and to use observations to develop (and verify) theory." (Pg. 84).

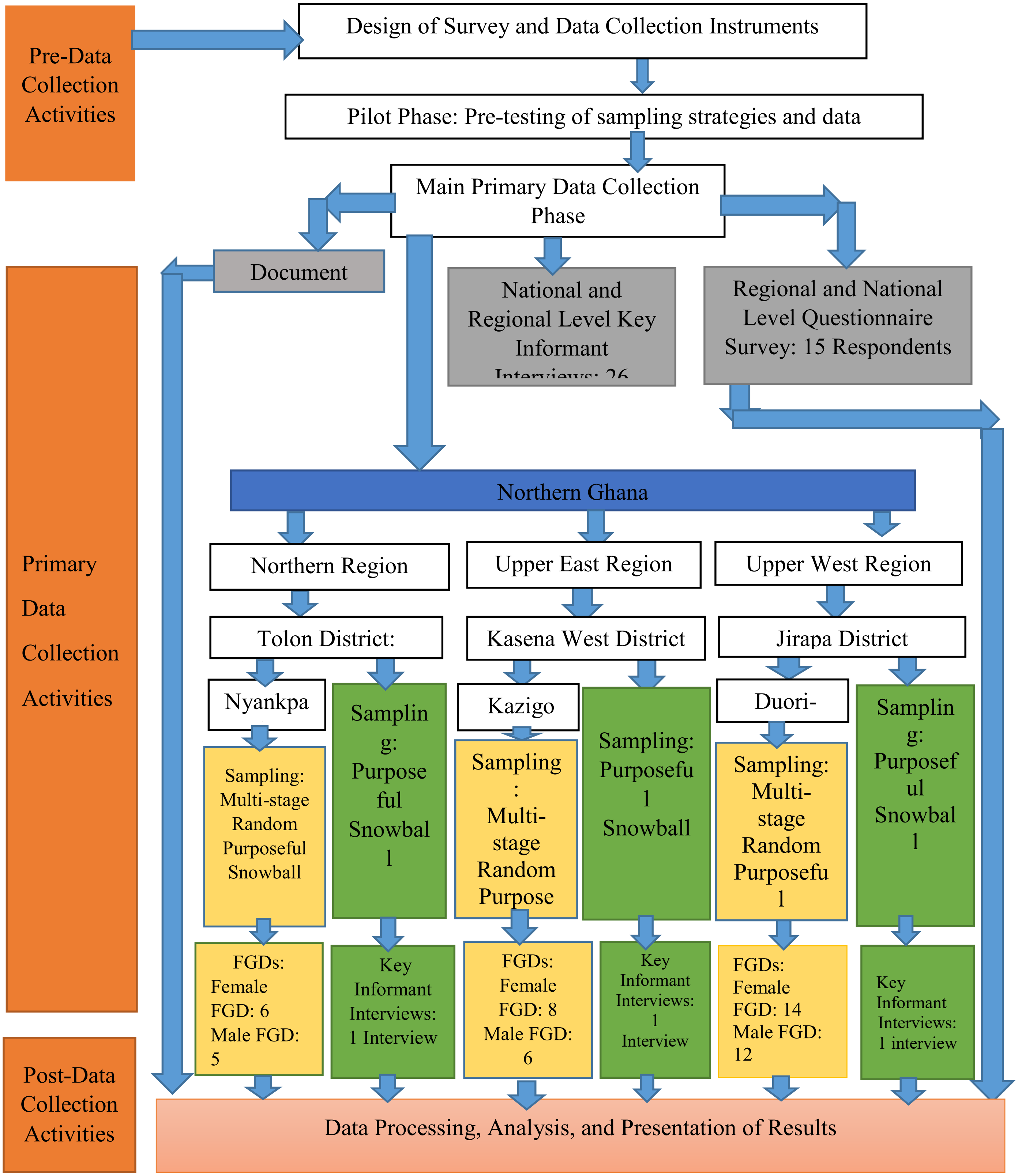
Results from the qualitative and quantitative analysis were synthesized to inform the interpretation of the integrated results. Data analysis based on the qualitative and quantitative strands did not only offer the opportunity to compare the qualitative findings between focus group discussants and key informants on the one hand, but also between the qualitative findings and quantitative results (from survey respondents) on the other hand. This integrated analysis also enabled me to transform qualitative data into quantitative data and vice versa to allow me to sum up the final output to arrive at a single quantitative score or index for comparison purposes (see section 5.5 for detailed operationalization of quantitizing and qualitizing data). Creswell and Plano Clark (2011) aptly describe this form of data transformation as "quantitizing qualitative data or qualitizing quantitative data." (p. 213). This value could determine the significance of the responses just like significance or p-value in quantitative research.

The study was initially designed to use Nvivo 11 software for Windows to analyze the qualitative data (narratives and nominal/categorical data) generated from FGD sessions, key informant interviews, and the qualitative responses from the questionnaires. Unfortunately, technology failed me while in Ghana, and I had to code the responses, categories, and themes manually and tortuously. This, however, enabled me to be deeply immersed in the qualitative data, an experience that was useful for the data analysis and discussion of the results.

Though my primary research question is qualitatively stated, some of the sub-questions demanded quantitative answers. Therefore, both qualitative and quantitative responses were recorded in an attempt to answer my research questions. The quantitative data were mainly obtained from the socio-economic and demographic characteristics of study participants, estimated participation rates of agricultural insurance, a ranking of key agricultural risks, adaptation strategies, the role of Agricultural insurance, and an indication of the importance value of some aspects of the study phenomena. The quantitative data generated were coded, organized, entered, cleaned, and run with SPSS and Microsoft Excel. Some qualitative data were also transformed into quantitative data (quantitized) and exported into excel for further analysis. The data transformation was performed to simplify the analysis, i.e., converting numerous responses, especially qualitative responses to a single or few indices and also to enable comparison between the quantitized qualitative and qualitized quantitative data. The quantitative analysis was conducted using descriptive statistics such as frequency distribution, ranking, weights, and indexes to describe the relevant attributes, patterns, and trends in the quantitative and quantitized qualitative data. Both quantitative and qualitative data were presented concurrently using frequency tables, graphs, pie charts, and narratives or texts.

However, upon a thorough review of my research questions prompted by my committee members, I realized that I could answer my research questions without engaging in statistical correlation and regressing analysis originally included in my data analysis techniques. For instance, I do not require correlation and regregression analysis to be able to identify smallholder farmers' key agricultural risks and adaptations strategies and also to determine the role of agricultural insurance for crop risks management and climate change mitigation. Because of the non-necessity of correlation and regressing analysis for addressing my research questions, this aspect was not included in my final data analysis. The methodology described above is summarized in Figure 3 below.

Figure 3: Flow Chart of the Research Methodology.



3.8 Validity and Reliability Considerations

As mixed method research involving myself, my research assistants and study participants, achieving very high valid, reliable, and objective results and conclusions were not possible since as human beings, we are value-laden and inherently bias to some extent. That said, a conscious attempt was made to enhance the credibility and trustworthiness of my research findings and conclusions through sound and rigorous methodological and procedural engagements. I enhanced the trustworthiness and creditbity of my research findings and conclusions by incorporating the following measures:

1. A mixed methods research design (qualitative + quantitative) to consolidate the strengths of both qualitative and quantitative approaches while offsetting the weaknesses associated with each. In addition to using some qualitative responses to explain quantitative answers, I also employed the mixed methods research design to triangulate information and elaborate responses from both farmer and non-farmer participants.
2. I equally engaged the appropriate sampling strategies, both probability and non-probability sampling strategies directly relevant to my research questions and participants. These strategies included stratified, multi-stage, random, purposeful, and snowball sampling to collect information from all segments of the study population. For instance, purposive sampling was employed to select regions and communities while snowballing was also used to choose key informants and the participating farmers at the household level. Insurers and other non-farmer participants were purposefully chosen since I assumed they were knowledgeable and experienced in crop risks and agricultural insurance issues.
3. The appropriate data collection methods were used to elicit responses from the relevant samples of the study population. For instance, semi-structured interview formats were used

to allow discussants and key informants the flexibility to give their full stories in response to questions asked without being restraint during the interview and FGD sessions. Open and closed-ended self-administered questionnaires, on the other hand, were distributed to insurers and other non-farmer respondents who could read and write their responses unaided or with minimal guidance. This also allowed study participants to respond to questions uninfluenced due to the absence of the researcher or his research assistants. I also included my cell phone numbers and email addresses in the introductory pages of the questionnaires so that I could be contacted for any question or clarification. Six FGD sessions were conducted at Kazigo, Duori-Guo, and Nyankpala where discussants were disaggregated into separate male and female groups. The gender-based disaggregation was done to ensure that relevant knowledge and experiences of both males and females were appropriately captured (Asitik, 2016; Madajewicz, Tsegay & Norton, 2014).

4. As a multi-dialect study, language barrier could compromise the credibility and trustworthines of the findings and conclusions. To address this challenge, I adopted a modified version of Asitik's 2016 Trans-MM model. This model recommends that experience and competent language experts be recruited to facilitate FGD sessions as well as translate the interview guide questions to discussants in local languages that are taught and examined at the tertiary level. By this approach, technical terms and jargons would have already been translated or can be translated into the applicable local languages. I leaned on the Trans-MM model to recruit translators, moderators, and mediators to assist in my data collection activities. The translators interpreted the focus group discussion questions from the English language into the local dialect and from the local dialect to the English language as well as transcribe the audio recordings into the English language

verbatim. Independent local language experts then moderated the transcripts by listening and comparing the audio recordings with the transcripts and giving their opinions on the accuracy or otherwise of the transcripts. In case there was a reasonable divergence between the transcripts and audio recordings, a mediator who is a competent and senior language expert was supposed to be called in to compare the recordings with the original and amended transcripts and give his/her opinion on the correct transcription of the audio recordings. Fortunately, there were no significant differences between the translators and moderators' transcriptions. However, the moderators suggested minor translations which were readily accepted by the translators. Therefore, translation-related discrepancies never went beyond the translators and moderators to involve mediators.

The modified version of Asitik's Trans-MM Model I adopted adhered to all the principles of the model with few modifications. In my research, for instance, it did not matter whether the translator, moderator or mediator was a tutor or examiner, what mattered was the cost of operationalizing the model, competence, and proficiency in the local language. In my research, it was only the mediators who were examiners in their respective dialects at the West African Secondary School Certificate Examinations (WASSCE) level. The translators were my RAs. The moderators were also tutors at the Junior High School (JHS) and Senior High School (SHS).

5. I ensured adherence to approved research protocols, processes, and procedures such as research design, sampling techniques, data collection methods, analysis, interpretation, and presentation of results. This adherence to approved research protocols ensured a reduction in personal influences and biases, thus, enhancing the validity and reliability of the study findings, conclusions, and recommendations. Despite my adherence to approved research

procedures, unexpected changes in the field conditions called for a change of the planned processes and procedures (Refer to section 3.4 on FGDs for more information on this). Fortunately, the modifications did not affect the research protocols much, and therefore, did not warrant revision of the approved IRB. However, my committee members were notified about these unexpected conditions and the associated modifications through my fieldwork progress reports through emails.

6. Reliability and validity of my study and its findings and conclusions were further strengthened through training of my research assistants as well as pre-testing the study's sampling and data collection techniques. Lessons and feedback from the pre-testing of the research procedures and protocols were used to improve and refine the research questions, sampling strategies, and data collection procedures, analytical techniques as well as a selection of the appropriate study participants.
7. Various categories of member-checking and triangulation strategies were used to improve the trustworthiness and credibility of my research findings, conclusions, and recommendations. These included the triangulation of information from FGD discussants, key informants, and survey respondents, and comparison of field notes with focus group transcripts. I also employed member-checking and triangulation of information by reframing questions in different ways and reading or repeating key responses to interviewees to seek their agreement with the responses recorded as well as comparing my findings and conclusions with those of earlier studies (chapter 8 on discussion of result), especially in Northern Ghana. I also cross-checked information with the relevant study participants during the data coding, processing, and analysis phases through phone calls.

3.9 Strategies to Address Ethical Concerns

Though my research was based on human subjects, I considered the potential risks to fall into the category of minimum risks which occurs when the research processes and procedures do not raise questions so disturbing to participants (Roberts, 2010). The AUNE IRB, UDS, and my dissertation committee reviewed my IRB application, informed consent forms, and data collection instruments- interview guides and questionnaires to ensure compliance with national and international research standards, ethics, and practice.

The key anticipated risks and ethical issues mainly concerned matters of confidentiality, especially, sensitive socio-cultural and economic information about respondents, possible interference with farming activities and non-farmer participants' official work schedules, required clearance before the release of confidential organizational information as well as having formal, appropriate, and consent access to study participants. Confidentiality is a crucial ethical and moral challenge usually associated with human participants in research undertakings. Addressing confidentiality issues, therefore, forms a key consideration in my research. I specifically took the necessary steps to ensure that participants' responses were treated confidentially and only used for purposes of my research. I also treated respondents and their responses anonymously using pseudonyms and assigning codes to answers during the data collection, analysis, and interpretation phases. The data, both hard copy and soft copy or electronic data have been stored in a secure location both in the field and after the fieldwork and will be destroyed after five years.

My research would have disrupted farming activities of smallholder farmers if the fieldwork had coincided with their farming season (April-December). Key informant interviews and FGD sessions were conducted on market days and Sundays, when most farmers do not usually go to the farm and during the off-farm/dry season (January- April) to avoid interfering with respondents' farming activities. Privacy and cultural sensitivity at the study settings and the individual level were also observed.

To avoid interferring with the official work and activities of non-farmer respondents such as insurers, the staff of GAIP, WorldCover, MOFA, and ADVANCE, I had to allow reasonable time for completion of the questionnaires either during break time or at home at their own convenience.

Most respondents were contacted to introduce my study to them before the fieldwork. This was achieved during my preliminary visits to the study communities, contacts with non-farmer participants directly or through community leaders, and email and phone communications. I also gave potential respondents about two weeks to decide whether they would participate in the study or not. I again made potential participants aware that I was going to be back to their communities with my research assistants in about 2-3 weeks if they agreed to participate in the FGD and key informant interviews. Non-farmer participants who agreed to participate in the survey were sent self-administered questionnaire in 2-3 weeks after the initial contacts and were given two weeks to return them or notify me to collect them. Provision was also made to continue to accept completed questionnaires until the end of March 2017. However, I continued to receive completed questionnaires until early November when I left Ghana for the US. Respondents had the option to email the completed questionnaires to me as attachments or draw my attention to collect them.

As a Ghanaian studying at a foreign University, I satisfied the requirements of all international and national laws regarding research ethics. I showed interested respondents, gatekeepers, and the relevant organizations a letter from my dissertation committee chair and evidence of approval of my AUNE's IRB application, indicating that I am a doctoral candidate who has satisfied all the academic and research ethical requirements to undertake this research in Ghana. I also sought approval from heads of organizations, chiefs, assembly members, and other appropriate opinion leaders before contacting study participants. I again sought the consent of all participants before recording their responses or taking their photographs. I also made each study participant aware that s/he had the right not to participate, avoid answering some questions or withdraw entirely at any point if s/he so desired since participation was voluntary. Participants were notified about this ethical requirement through the informed consent forms (Appendices IV and V) and that no respondent would also suffer any adverse consequences or be denied any benefits for non-participation or withdrawal from the survey, interviews or FGDs. I equally got IRB approval from Antioch University New England (Apendice II). As international research, i.e., research taking place outside the US, the conditionally approved IRB required that I obtain another ethical clearance from a research institution in Ghana before commencing my fieldwork. In adhering to this condition, I submitted my proposal and data collection instruments to the UDS Research Ethics Committee for review (REC). This was done, and I was accordingly cleared to commence my fieldwork (Appendix III).

Another ethical research consideration was dealing with power dynamics. In Northern Ghana, and possibly most other developing countries, one's standing in society is synonymous with his or level of power and influence. Such power dynamics situations can create ethical problems in a research setting when dealing with study participants of comparatively low social standing. I was confronted with similar ethical problems, especially at the FGD level where some discussants were afraid that their answers to my questions might not be up to my expectation and I would think they do not know anything or laugh at them.

These were ethical problems I anticipated based on my experience working with rural folks in Northern Ghana, and as such, had prepared strategies to address them as follows:

1. I used “positive” tribalism to reduce the effect of the power dynamics. As a Northerner myself, (i.e., a person from Northern Ghana), I played the positive tribal card and made the participants understand that we are brothers and sisters, and therefore, the same people. In my dialect, i.e., Dagaare, this is termed 'Te jaa bunyeni' which is directly translated as “We are all one.” or "we are the same people". In the UWR, the power dynamics element disappeared once I introduced myself as a Dagao (a person from the Dagaaba tribe) or te jaa bunyeni from Duong and started facilitating the FGD in Dagaari (i.e., the local dialect).
2. For the key informant interviews, I used traditional jokes to suppress any possible power dynamics-related ethical issue from playing out. Dagaabas (a dominant tribe in the UWR which I belong to) and Frafras (another major tribe from the UER where some of the key informants also belong to) are playmates, and once they meet, they are equal, i.e., neither is superior nor inferior to the other. This Dagaaba-Frafra playmate phenommenon has almost been extended to cover the entire Northern Ghana. As a Dagao, I also played that card with the Frafras and other key informants in the UER.
3. I equally used my familiarity with some of the study participants to play down some potential power dynamic-related and ethical issues. For example, aside from knowing some of the key informants, especially in the UWR where I come from and a few in the Northern Region where I also worked for many years, I used my earlier community entry, doctoral SLP, and pilot study contacts to address some power dynamics issues.

I am, however, aware that if some of the above mentioned power dynamic mitigation strategies are not well executed, they could affect the trustworthiness and credibility of the study findings and recommendations since participants could choose to share or not to share some information. I was, therefore, conscious of this fact and played the power dynamic mitigation games with tact and moderation.

4. Lastly, the posture and the way researchers and their field assistants carry themselves around can also create unethical and unequal power situations in research settings. To address this ethical challenge, I appreciated all responses (whether useful or not) and also used humility, respect, and a positive posture to assure discussants and key informants that we are all human beings despite the fact that I am a Ph.D. candidate and a University lecturer, and my RAs as master' students. This does not make us any special or different person, an impression my RAs and I created before the study participants by our conduct, approach to issues, and demeanor.

3.10 Limitations of the Study

I encountered some limitations and constraints which could have implications for the findings of the study and their generalizability. These limitations and contranints included:

1. Small sample size: my study covered only six FGDs in three communities (51 discussants in all), twenty-nine key informants, and fifteen survey respondents. This is a minute fraction of the thousands of agricultural insurance stakeholders who could have also participated in the study. I also missed responses from staff of Innovation for Poverty Action (IPA), and agricultural insurance-based research agency and their insured smallholder farmer, which could enrich my findings, conclusions, and recommendations. IPA and its sponsored farmers have a long history and experience of agricultural insurance in Northern region. My research missed this rich information because IPA did not allow my research team to interview its staff and sponsored insured farmers. The ultimate effect of this refusal is that I had to scale down the number of FGD communities and sessions from two and four to one and in the Northern region, respectively, even

though the region has twenty-six of the fifty MMDAs in Northern Ghana (i.e., 11 and 13 in the UWR and UER respectively). This may affect the study results to some extent.

2. Time and resource constraints: I did not also have adequate financial and material resources to cover a reasonable number of districts, communities, and study participants, especially through the used of a suffient number of paid graduate RAs. Even though I stayed longer in Ghana, the response rate (.e.g, survey respondents) was so slow that I needed more time to cover additional study participants. This was, however, not possible because I nneded to return to the US to continue with other compenents of the program.

3. Limitations associated with willingness to pay (i.e., willingness to promote or engage in): My fouth research question explored the willingness of AICs and farmers to promote and engage in sustainable farming practices and climate change mitigation activities. Staff of AICs and farmers overwhelmingly indicated their willingness to support and undertake agro-ecological and CSA practices with the potential for climate change mitigation. However, the willingness expressed was hypothetical, and they may renege when it comes to walking the talk. Also, sustainable funding mechanisms for AICs to motivate farmers to translate the willingness into tangible sustainable farming practices and climate change mitigation initiatives were not also explored.

4. Personal biases: As a peasant farmer's son whose educational journey up to the undergraduate level was totally financed with proceeds from farm produce, I am always bias in favor of smallholder farmers. Even though I tried as much as possible to adhere to scientific standards and research protocols, there could still be glimses or traces of personal predijuces that could minimally influence my results.

Even though efforts were made to address some of the these limitations as well as reduce the associated adverese effects, some of these constraints could still negatively affect the study findings and their generalizability.

The next four chapters, i.e., chapters four to seven present the results of the dissertation research as follows:

Chapter Four (4): Results on Perspectives of Smallholder Farmers' Key Agricultural Risks

Chapter Five (5): Results on Smallholder Farmers' Agricultural Risks Management Strategies

Chapter Six (6): Results on the Potential of Agricultural Insurance for Crop Risks Management

Chapter seven (7): Results on the Potential of Agricultural Insurance in Promoting Sustainable Farming

Chapter 4: Results on Perspectives of Smallholder Farmers' Key Agricultural Risks in Northern Ghana

4.1 Introduction

My first research question explored the perspectives of focus group discussants, key informants, and survey respondents on smallholder farmers' key agricultural risks in Northern Ghana. A detailed description of these risks are described below.

The key agricultural risks identified in this study have been organized into two broad categories: weather/climate-related and non-weather-induced agricultural challenges. However, there is no clear boundaries between weather-related and non-weather-related agricultural risks (henceforth, these themes will be referred to as weather and climate and non-weather and non-climate-induced or related agricultural risks) as one can influence the other and vice versa. For instance, droughts or floods can affect soil fertility. On the other hand, desertification, which is a climate-related phenomenon, can also affect rainfall patterns, soil fertility, and vice versa. Therefore, the categorization of agricultural risks into weather-based and non-weather-based is for analytical convenience and to facilitate an in-depth understanding of these agricultural challenges. The weather-induced and non-weather-induced agricultural risks were organized based on the data collection instruments, i.e., from FGDs, key informant interviews, and questionnaire surveys to understand the perspectives of each segment of the study participants.

4.2 Duori-Guo Community

Duori-Guo community is one of my focus group communities in the Jirapa district of the Upper West region. It is an active farming community with a total population of 739, disaggregated into 371 and 368 females and males, respectively, (Projected from Ghana's 2010 population and Housing Census -PHC, Ghana Statistical Service, 2018). The focus group discussants enumerated a litany of weather-related and non-weather/climate-induced agricultural risks as described below.

4.2.1 Weather/Climate-induced Agricultural Risks

Discussants mentioned different categories of weather-induced risks in the Duori-Guo community, such as erratic rainfall patterns, rainfall unreliability, lack of rainfall, droughts, occasional excess rains, and a long dry season. Both female and male focus groups ranked weather and climate-related agricultural problems as their most important agricultural risks. For example, both male and female discussants ranked unreliable rainfall patterns and droughts as their main agricultural challenges (Tables 5 and 6).

4.2.2 Non-weather-induced Agricultural Risk

Both male and female discussants identified lack of or inadequate agro-inputs as one of their key agricultural challenges. Agro-inputs mentioned included lack of improved seeds, chemical fertilizers, pesticides, and weedicides locally called "condemn" i.e., it destroys all the weeds without discrimination. The major concerns discussants' expressed regarding agro-inputs were either their non-availability or their availability at the wrong time. Another concern was that these inputs could be available but sold at prices beyond the reach of most smallholder farmers. There was, however, a gender difference in the ranking of agro-inputs, especially chemical fertilizer as a key agricultural challenge. For instance, whereas the male discussants identified lack of chemical fertilizer as a key agricultural challenge, the female discussants' main concern was their inability to buy it even if it is available. These female discussants revealed that their husbands and male household heads in general, usually control the family income such that they (i.e., females) cannot access it to buy agro-inputs for their separate farms whereas the men can use the family funds the way they want. In explaining women's lack of access to family resources, an elderly female discussant said:

> *N bidɔɔ, a ama za hong bang kye zin logro te noɔ. Ka te ning wa bore, a song tun a weɛ toma, a de a bondiree, a maali bing wa baare, te nu ba la kye be. A dɔbɔ pang soa. Sa nga ka nga gba, ba mang vɛnging kaa te pɔga gaa kuoɔre a boma a dea libie wa ko ba bang yi te bugro ba ba bang ka te meng dire boma gba. Ka vi zung gba naane, ba mengeng nang mang gaa a daa. Dɔ ba na nang ba zoro vi na, ba mengeng mang gaa a da. Kɔɔ yelee ho ba laara be bang ye kɔɔ de ho gulonson yiri gɛrɛ. Hoo, te mene ba ban angna poɔ teng be a te siri kuli poɔng.*

This quotation means:

> My son, you know all these things, and you want us to say it, and they will say we have said this and that (I interjected by reassuring the female discussants that that is why I am interviewing them separately from the men so that their identities will be hidden). After we have sowed, assisted with the farm work, harvested, and stored the farm produce, we have finished with our work. The stored grains are now for the men. Sometimes, they (the men) will instruct you to go and sell some of the farm produce and bring them the money to be boozing with, and they don't even know that we also need money or have needs. If not because they will be feeling shy, some of them (the men) will send the grains to the market themselves. Those who do not feel shy go to the market themselves. If you complain too, they will tell you to pack and go. Hmmmm! Some of us don't know what we are doing now or where we are now in our marriages.

As can be seen above, the quotation in the local dialect has been italicized to distinguish it from the direct translation into the English language. Subsequent quotations in the local languages have also been italicized to differentiate them from their English translations.

The Duori-Guo community members also identified inadequate fertile agricultural lands as one of their key agricultural challenges. According to these discussants, the problem is not the non-availability of farmlands, but the non-availability of fertile agricultural lands for all farmers. They also complained of the non-availability of tractor and bullock services at the beginning of the farming season. Some discussants explicitly indicated they often wait for weeks and months before accessing tractor and bullock services, by which time the rainy season would have been mid-way through the cropping season. Because of the late access to tractor and bullock services, some discussants reported that in some years in the past, the rains stopped before their crops were ready for harvesting, which led to crop failure.

The scarcity of fertile agricultural lands and tractor and bullock services also revealed a gender difference. Even though females were more concerned about inadequate access to fertile agricultural lands and tractor services, their male counterparts never listed these among their key agricultural risks. Men also mentioned soil infertility and stealing of their livestock as some of their key agricultural challenges while women discussants never reported these as part of their key concerns. However, both male and female discussants identified inadequate AEAs and poverty as some of their major agrarian challenges, with the latter leading to lack of money to buy agro-inputs (Tables 4 and 5).

Table 4: Female farmers' key agricultural risks identified through a focus group discussion session			
Duori-Guo Female FGD Session: Jirapa District: Upper West Region (UWR)			
Weather/climate-related risks		Non-weather/climate-related risks	Ranking
	Lack of rains/unreliable rainfall		1st
2	Droughts		2nd
3		Lack of farm labor	5th
4		Lack of tractors to plow their fields	3rd
5		Inability to buy fertilizer	6th
6	Long dry season		10th
7		Lack of agricultural extension agents	7th
8	Occasional excess rains		8th
9		Lack of access to agricultural lands	4th
10		Lack of capital/money to buy agro-inputs	9th

Note. Source: Constructed from field data, 2017/2018

Table 5: Male farmers' identification of their key agricultural risks through focus group discussion sessions			
Duori-Guo Male FGD Session: Jirapa District: Upper West Region (UWR)			
Weather/climate-related risks		Non-weather/climate-related risks	Ranking
1	Poor rainfall pattern		1st
2	Drought		2nd
3		Lack of chemical fertilizers	5th
4		Poverty	4th
5		Soil infertility	3rd
6		Lack of AEAs	6th
7		Stealing of livestock	7th

Note. Source: Constructed from field data, 2017/2018

4.3 Kazigo Community

Kazigo is the focus group community in the Kasina-Nankana West District, representing the Upper East region of Ghana. It is a farming community dominated by peasant farmers. GAIP's staff claimed Kazigo is one of the communities with active involvement in its agricultural insurance activities, with the full support and cooperation of its chief. According to the Kazigo "Pe" (chief), the community has 1,156 smallholder farmers (with more females than males) with some livelihood and environmental management initiatives such as a climate change adaptation project, dam, and VSLA (Village Savings and Loans Association) targeted at helping farmers address some of their agricultural challenges. The discussants revealed that these development projects were initiated by the Dezendani Integrated Development Organization (DIDO), an NGO owned and managed by the chief with support from UNICEF, CRS, and the Catholic Church. Focus group discussants expressed their appreciation for the for the Kazigo chief's initiating the development projects in the community, especially for inviting GAIP to enroll farmers in its agricultural insurance program to manage their residual farm-related challenges.

The Kazigo community focus group discussants enumerated a variety of their agricultural challenges during the FGD fora. The emergent themes from the FGD included weather/climate-related challenges, agro-inputs challenges, poverty, lack of tractors and bullocks, and inadequate agricultural extension agents (Tables 6 and 7).

Table 6: Female farmers' identification of their key agricultural risks through focus group discussions

Kazigo Female FGD Session: Kasina/Nankana West District: Upper East Region (UER)			
Weather/climate-related risks		Non-weather/climate-related risks	Ranking
1	Unreliable rainfall		1st
2	Flooding		5th

3		Poverty	6th
4		Lack of capital	2nd
5		Lack of tractor and bullock services	3rd
6		Poor quality seeds	4th

Note. Source: Constructed from field data, 2017/2018

Table 7: Kazigo male farmers' key agricultural risks identified through focus group discussions			
Kazigo Males FGD Session: Kasina/Nankana West District: Upper East Region (UER)			
Weather/climate-related risks		Non-weather/climate-related risks	Ranking
1	Late start and early stoppage of rains		1st
2		Lack of money/capital	2nd
3		Lack of fertilizer	3rd
4		Lack of tractor and bullock services	4th
5		Lack of agricultural extension officers	5th
6		Poor quality seeds	6th

Note. Constructed from field data, 2017/2018

4.3.1 Weather/Climate-related Agricultural Challenges

Discussants in the Kazigo community (both females and males) revealed that weather/climate-related risks were their most important agricultural challenges. The discussants identified unreliable rainfall patterns, flooding, and late start and early stoppage of rainfall as their key agricultural risks (Tables 6 and 7).

There was a gender angle to the weather-induced agricultural risks the discussants identified. For instance, whereas the female discussants ranked unreliable rainfall as their most important agricultural risk, their male counterparts ranked the erratic nature of the rainfall patterns, i.e., the late start and early stoppage of rainfall as their number one problem even though these phrases may mean the same thing technically. The women also identified flooding of their rice fields as one of their key agricultural challenges whereas their male counterparts never mentioned it among their main agricultural problems. A further probe to find out why the flooding was a key issue for women and not men revealed a feminization of rice cultivation, i.e., women are the main farmers of this crop.

4.3.2 Non-weather/Climate-based Agricultural Risks

Both female and male discussants also identified problems with agro-inputs as one of their key agricultural challenges in the Kazigo community. The specific agro-inputs discussants enumerated included lack of capital to buy other agro-inputs, lack of hybrid seeds, and lack of tractor and bullock services to plow their fields. In addition to these non-gender-based challenges, males added lack of fertilizers and AEAs as some of the key constraints on their farming activities (Tables 6 and 7).

4.4 Nyankpala Community

Nyankpala is the largest and most populous town in the Tolon District. It was chosen to represent the Northern region. Nyankpala has a total population of 8,670 disaggregated into 4,078 and 4592 females and males, respectively (projected from the 2010 Ghana PHC, Ghana Statistical Service, 2018). My study covered the traditional Nyankpala community i.e., the southern half which is made of indigenous Dagomba peasant farmers. The northern half of the Nyankpala community is cosmopolitan in character and hosts the Savannah Research Institute (SARI) with a weather station and agricultural demonstration sites and the Nyankpala Campus of the University for Development Studies (UDS). Both female and male discussants indicated the indigenous Nyankpala community members are benefitting socio-economically and technically from the presence of SARI and UDS through selling provisions and cooked food to scientists, faculty, staff, and students and diffusion of innovative research ideas and technologies to the indigenous

Nyankpala community members whereas their counterparts in Duori-Guo and Kazigo may lack these opportunities.

The main agricultural challenges affecting agricultural productivity in the Nyankpala community were identified as weather/climate-related risks, problems associated with agro-inputs acquisition and application, lack of agricultural and food procession equipment, marketing challenges, and weed infestation, especially striga (Tables 8 and 9).

Table 8: Female farmers' major agricultural risks identified through focus group discussions

Nyankpala Female FGD Session: Tolon District: Northern Region (NR)			
Weather/climate-related risks		Non-weather/climate-related risks	Ranking
1	Excess rains		1st
2	Droughts		2nd
3		Lack of tractor services	3rd
4		Lack of agro-inputs, especially fertilizers	4th
5		Weed infestation-especially striga	6th
6		Lack of market for farm produce, esp. rice	5th
7		Lack of rice processing equipment	7th

Note. Source: Constructed from field data, 2017/2018

Table 9: Male farmers' key agricultural risks identified through focus group discussion

Nyankpala Male FGD Session: Tolon District: NR			
Weather/climate-related risks		Non-weather/climate-related risks	Ranking
1	Drought		1st
2		Weeds, especially striga	2nd
3		Lack of fertilizers	5th
4	Excess rains		3rd
5		Lack of tractor services	4th

Source: Constructed from field data, 2017/2018

4.4.1 Weather/Climate-related Agricultural Risks

Both female and male discussants ranked weather/climate-related risks as their most significant agricultural challenges. Under this theme, both focus groups identified the occurrence of excess rains and droughts in some years as their key agricultural risks. For instance, the Nyankpala female discussants ranked excess rains and droughts as their number one and two key agricultural risks respectively while their male counterparts rated droughts and excess rains as their first and third most important agricultural challenges. This finding reveals a gender perspective on weather/climate-related agricultural risks. Women identified excess rains and the accompanying flooding of their rice fields as their most important agricultural challenge.

4.4.2 Non-weather-related Agricultural Risks

Focus group discussants in the Nyankpala community identified a wide range of non-weather/climate-induced agricultural risks as discussed below.

Lack of Agro-inputs.

Lack of agro-inputs was identified as one of the key agricultural challenges confronting smallholder farmers in the Nyankpala community and its environs. For example, both female and male discussants ranked lack of chemical fertilizers as their four and fifth most important agricultural risks, respectively (Tables 8 and 9). Lack of tractors to plow smallholder farmers' fields was also identified as one of the most important agricultural risks in the Nyankpala and its environs. They also complained of high plowing cost, making such services only accessible to fewer wealthy farmers. It was, therefore, not surprising that female and male discussants ranked it as their third and fourth key agricultural risks, respectively.

Weed Infestation.

In addition to the other agricultural risks already discussed above, weed infestation was identified by both male and female discussants. They specifically mentioned striga as a parasitic plant that does not only make agricultural lands less fertile but also strangles the roots of some crops, leading to crop plants mortality and reduction in crop yields. Weed infestation was not mentioned in any of the other two focus group communities as a key agricultural challenge except the Nyankpala community.

Market-related Challenges.

Challenges associated with marketing smallholder farmers' farm produce was mentioned as one of the key agricultural problems in the Nyankpala community. For example, the women discussants complained about lack of ready or guaranteed market for their rice. They further complained of low prices for their rice and other crops. These concerns were never raised by their male counterparts, making the marketing issue another gender-based challenge.

Challenges Associated with Value Addition to Agro-Produce

Focus group discussants in the Nyankpala community reported lack of opportunities and support to add value to or process indigeneous agro-produce as one of their problems. It emerged from the female FGD that ADVANCE has been promoting the concept of the value chain (value addition) among some smallholder farmers in other parts of Ghana cultivating maize, sorghum, soybeans, and rice by linking them with agro-input dealers, agro-processors, and markets. Even though women discussants were aware that value addition to their produce, especially rice, could earn them more income, the lack of food processing equipment, especially rice processing mills and packaging materials were their stumbling blocks. The women were unanimous that lack of rice processing equipment was adversely affecting their farm income (Tables 8 and 9).

4.5 Identification of Key Agricultural Risks by Key Informants

The key informants for this research were mostly farmers with formal education or officers working with smallholder farmers in Northern Ghana, i.e., the Upper West, Upper East, and Northern regions. They included AEAs, agricultural insurance marketing officers and field associates, nucleus farmers, some small-scale farmers with formal education, regional representatives of Peasant Farmers Association of Ghana (PFAG), and staff of some projects in the agricultural sector. Key informants who were not directly into agriculture but working with smallholder farmers at the time of the fieldwork were asked to enumerate key agricultural risks confronting these farmers, based on their working knowledge, observations, and experience. For those directly involved in small-scale farming, they were asked to describe their key agricultural challenges. In response, these key informants mentioned a range of agricultural risks confronting smallholder farmers in the three regions of the North. Since some of the non-climate-related agricultural risks are un-related in any meaningful way, this category of risks was further broken down into the appropriate sub-themes as discussed below.

4.5.1 Weather/climate-related Key Agricultural Risks

Key informants used rainfall and drought-related terms, concepts, and phrases to describe their weather-induced agricultural risks. In all their descriptions, inadequate or excessive amounts of rainfall and temperatures were the key denominators. These agricultural risks categories are presented diagrammatically below.

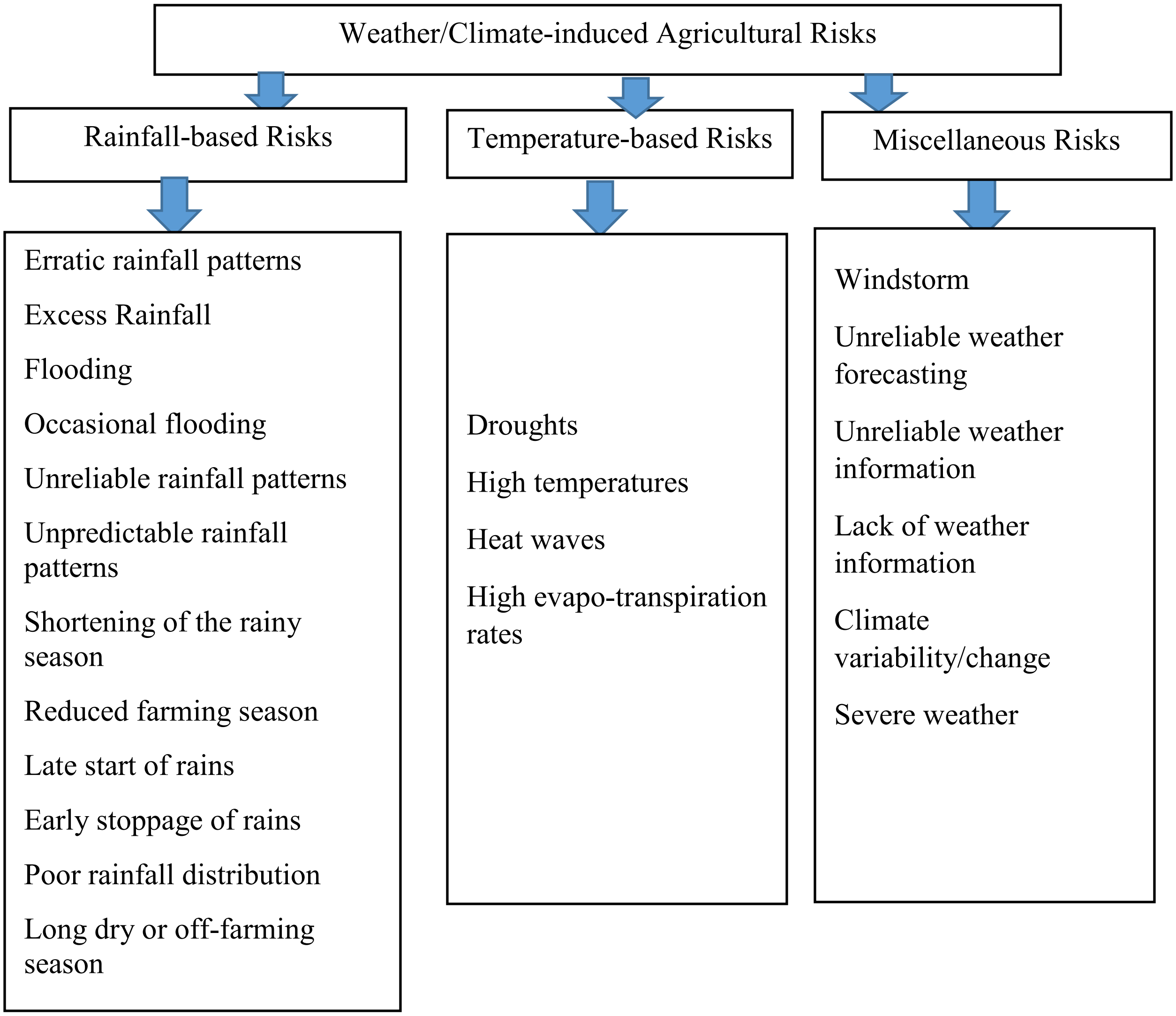


Figure 4: A flow diagram displaying key informants' description of their weather/climate-induced agricultural risks

Most key informants in the three Northern regions identified unusual weather conditions as some of their weath/climate-induced agricultural risks (Figure 4). For example, a male key informant in the UWR said:

> The immediate key agricultural challenge is the unpredictable weather. Yes, unpredictable weather. Most of our crops for many years, we know when to plant and expect a good harvest. And now, you wait and wait for the planting season, and it is not here, or you

plant, and you are waiting to weed and suddenly, the weather changes, the rains stop. Over a certain period, crops are supposed to have grown and matured … and when there is a disruption in the weather cycle, the crops [can be] negatively affected. Whether you apply all the inputs like fertilizer or what not… once the rain pattern suddenly changes, it affects everything. That is the first problem we face.

Even though flooding was identified as a key challenge in the Upper East and Northern regions, it was not the case in the Upper West region. Focus group discussants corroborated this in the Duori-Guo, Kazigo, and Nyankpala communities. The non-occurrence of floods in the UWR could be attributed to the non-proximity of the farms to streams, rivers, and other water bodies

4.5.2 Non-weather-related Agricultural Risks

In addition to the weather-induced agricultural risks, key informants also revealed a litany of non-weather-related problems affecting smallholder farmers in Northern Ghana. These risks ranged from agricultural production risks through marketing challenges to storage-related problems. These agricultural risks can be classified under the following general themes: marketing challenges, storage challenges, agro-inputs-related challenges, inadequate agricultural lands, lack of tractor and bullock services, and inadequate AEAs. The remaining themes included soil infertility, lack of farm labor, pest and disease infestation, negative attitude of some smallholder farmers, financial challenges, activities of alien and nomadic Fulani herdsmens and other livestock herders, and environmental degradation. The only regional differences in the patterns of agricultural risks were the occurrence of floods and weeds, especially striga in the Nyankpala community (i.e., Northern Region) which were not reported in the other regions. These themes are discussed in detail below.

Marketing-related Challenges

Key informants mentioned marketing-related challenges as some of the key agricultural risks in Northern Ghana. Almost all the key informants listed at least one aspect of a marketing challenge. Under the marketing challenges, informants mentioned market uncertainties and lack of grading systems for grains to make the crops internationally exportable. Some key informants also enumerated market glut, low prices, price fluctuations, lack of market, or low demand for farm produce as some market-related challenges confronting smallholder farmers in Northern Ghana. Other agricultural risks cited were activities of middlemen, i.e., market women and men who usually buy agro-produce from vulnerable farmers at take away prices during the harvesting season and sell back to the same farmers during the lean season at cut-throat prices, thus, taking advantage of smallholder farmers. One key informant summarized the market-related challenges when he said:

> Another challenge is [the] market [conditions]. You harvest, you get a good yield if you are fortunate but no market. Either there is no market, or the market is so poor in the sense that those who buy want to extort the farmer so much. Like I can remember in 2013, there was a bumper harvest of corn, and we had nowhere to sell it. That was the year I mentioned [earlier] that I had the weevil infection. I had to dry and re-dry and re-dry. Because there was that glut, they were not buying. I don't know whether everybody had food to eat, they didn’t need it. So, you have your corn, and you cannot sell [it]. The market women were exploiting the situation by offering unreasonable prices. For a bag of corn that was to be sold for let’s say GH¢ 80 [$16] those days, they would want it for GH¢ 40 [$8] or GH¢ 50 [$10]. Moreover, when you refuse, you have to keep your thing [corn] there until it gets

> rotten. So many farmers run at a very big loss. This discouraged some farmers from farming again. So, marketing is a big challenge to farmers.

Problems Associated with Agro-Inputs Acquisition and Application

All key informants also enumerated lack of one or other types of agro-inputs as their key agricultural challenges. According to these informants, most of their agricultural lands have lost their fertility, and most smallholder farmers are not in the position to purchase the various agro-inputs at the right time and in the right quantities. This often leads to low agricultural productivity and food insecurity, they claimed. The agro-inputs, informants named included certified seeds, chemical fertilizers, capital, tractor and bullock services, veterinary inputs and services, pesticides, and weedicides. Some key informants specifically complained about the non-availability or high cost of these agro-inputs. Most key informants also complained about lack of or inadequate AEAs to teach farmers how to apply these technologies. One key informant, for instance, revealed that:

> Others have their lands that are exhausted and need inputs like fertilizer to [add nutrients to] the soil. They don't get the fertilizer. Also, when they get the fertilizer, it may be a bit late in the day. Just this last farming season, you would see how some of them were very anxious to farm…they had planted, and after 2 weeks you are supposed to apply the first dose of fertilizer; and after 4 weeks, you will apply the second dose, that is, [in] 6 weeks [time], you are supposed to apply both the compound fertilizer and sulfate of ammonia. Now you have planted the thing [crop], and you are now looking for the fertilizer. (I probed further, so is it the question of inability to buy or non-availability?) …the immediate problem I am pointing out is non-availability or availability at the wrong time and the late arrival of inputs. I am talking about the late arrival of inputs. The second one will now be that the farmers who are ambitious but they are constrained by luck of funds…They are

> constrained by luck of funds. The example was, last year, I asked somebody whether he would farm corn and he said no [because] corn requires [much] fertilizer and he said he didn't have money to buy fertilizer. So, he said he would rather go for groundnuts or millet. And definitely, he has been constrained. He has been constrained because he had no money to buy the fertilizer and where do you turn [to]?

Another quotation from a nucleus farmer who supports a women farming group at Kaleo in the UWR reads:

> For crops to do well, the seeds must be improved or certified crop seeds. Unfortunately, the women that I am working with don't usually get these seeds and mostly used their traditional seeds like millet, groundnuts, and beans. The crops also require the right amount of fertilizer and pesticides at the right time and in the right quantities. The women also find it difficult to get these [fertilizers]. Even if they get them, they get them too late. They also lack access to timely tractor and bullock services and may farm late at the time the rains are about to stop. This normally contributes to reduced yields. Even though Ngmanu Enterprise [the organization working with the women] and other organizations are working hard to help the women address these challenges, it is not easy, and these problems persist. We need the government on board to help these poor women farmers.

Most key informants revealed that lack of tractors and bullocks to plow their farms at the beginning of the farming season is one of their key agricultural challenges. One female key informant complained that they often rely on tractors and bullocks because they (women) are weak and do not have farmhands to support them on their farms. In her own words: but to get a tractor or bullock to plow your farm, you need to join a long queue, and by the time it gets to you, it would have been late or the [planting season] would have been over.

Post-harvest Losses

Some smallholder farmers also indicated that they often suffer from post-harvest losses in addition to production and distributional challenges. During the interviews, some key informants indicated that storage-related difficulties formed part of their key agricultural challenges. Some informants revealed that post-harvest losses often occur both at home and on their farms. According to them, some crops are either left on the farm to dry or only harvested when they need it for any purpose. They also added that they usually store some grains, notably corn and sorghum in huts on their farms. To them, they have been experiencing post-harvest losses from bushfires, arsonists, termites, and rodents. In the words of a regional representative of PFAG:

> And then the storage facilities [also pose a challenge]. Most of the farmers will just give it out at take away prices simply because they don't have a way to store their produce. Some time ago, we [PFAG] advocated for national buffer stock to address this challenge, and as we speak now, I don't know whether they are in place or not.

Other farmers complained that they have been encountering post-harvest losses due to lack of standard storage facilities. According to them, they mostly store their grains or harvests in locally molded granaries, pots, and fertilizer and cocoa sacks. They further revealed that they usually protect their grains from weevil infestation by mixing the grains with ash before storing them since most farmers cannot find or buy standard chemicals to preserve their grains. In the absence of these storage facilities or when they are full, harvests or grains are usually kept on bare floors of their rooms, some key informants revealed. Again, these grains are at the mercy of the weather, termites, weevils, and rodents. In expressing his unhappiness about the storage-related challenges, a male key informant said:

> Now the 3rd challenge is the post-harvest losses… You know, you harvest your corn but where to store it to avoid [insect infestation]. Sometimes, some people lose almost [everything]. I remembered some time ago… I had to dry and re-dry and re-dry my corn as I told you earlier because it was so heavily infested with weevils.

According to some key informants, perishable crops and vegetables often suffer the most significant losses. This is because they do not have the appropriate storage facilities like cold stores and fridges, they revealed. A leader of peasant farmers (i.e., PFAG) who is a farmer himself said:

> For vegetables and fruits like tomatoes, watermelon, mangoes, garden eggs, cabbage..., and so on, we sell what we can sell, eat what we can eat, feed some with our pigs and poultry birds and the rest goes to waste. What can we do?

Problems Associated with Agricultural lands.

"You know, the land is among the most important factors of agricultural production that we farmers depend on for our farming activities." a key informant explained. "Therefore, availability of land is a necessary condition for successful farming activities," he added. This notwithstanding, some informants raised issues with difficulties associated with land acquisition for their farming activities. They specifically complained about soil infertility, land scarcity and degradation by illegal gold mining, negative land tenure systems, and difficulty in documenting agricultural lands acquired. Some informants across the three regions claimed that some smallholder farmers are treated as settlers and as such, are asked to pay huge rent to landlords and chiefs or contribute farm produce in lieu of the rent or both. Settler farmers are farmers who usually migrate from other areas to settle and farmers in other communities. They added that sometimes the settler farmers have to buy fowls, animals, and alcoholic drinks for traditional sacrifices to be made to the gods and ancestors of the destination communities. This concern was reported by a nucleus farmers when he complained in Dagaare that:

> *N dao, mee ban ka te yideme ne nang be a samuning soha kuorang wa. Ba na na N meng kuoheba. Te yeltuo kanaga la lisiri ne teng mang tu kyɛ bang ko te a tengbango teng kɔ. Sanga ka nga, a tendemee mang yen ka te ihi nuoɔhi, dunhi, libiri, daa, anaa taa mene ka ba tu lisiri seni kyɛ ka te tuoɔng kɔ. Kee nang ba e bla meng ba kong koe a gyie. Te kuori ba problɛm kpong la bla.*

This quotation translated verbatim means:

> My friend, you know that our people at samuni (samuni is a settler farming area) normally beg for land to farm. Some of these people are my out-grower farmers. Our major challenge is the traditional processes and protocols we have to go through before they allocate land to us to farm. Sometimes, the landlords will ask you to bring fowls, animals, specified amount, alcoholic drinks, and other things to be used to perform traditional sacrifices before we will be allowed to farm there. If you don't bring what you are told to bring, they won't give you the land to farm. That is one of our major challenges as farmers.

Another key informant complained that he wanted a parcel of land to undertake cashew plantation and to expand his farm but could not do so because of the uncertainty associated with the land tenure system. He, for instance, said, "It will take many years for it [i.e., the cashew trees] to fruit and mature, and I don't know when the landlords may need their land back." Even some farmers engaging in annual crop farming complained of similar challenges and added that this situation adversely affects their agricultural planning and production activities. The challenges described above are summed up by a nucleus farmer when he complained that:

> The society in which we [live in today], if eventually, you get the land, but you have challenges documenting it because the people will think you want to take their land away from them. They don't also allow you to enter into any contractual agreement with them so that you can be sure that you can farm on the land for a known period. This means they can take it [the land] away from you anytime that they want. This is adversely affecting our farming activities because [you] cannot grow some crops, especially perennial crops or tree crops which may have a relatively longer gestation period.

Lack of Agricultural Extension Agents (AEAs).

Most informants blamed lack of or inadequate agricultural extension officers for some smallholder farmers' agricultural challenges. To these informants, AEAs play a pivotal role in agricultural growth and development in Northern Ghana and the rest of the country. This is because modern agriculture is technology-driven and the role of AEAs cannot be discounted, especially among smallholder farmers who mostly lack formal education, they averred. Even educated educated still require guidance on agricultural extension services and some agronomic practices because agriculture is a specialized field like many other scientific disciplines, they added. They concluded that smallholder farmers need guidance to be able to effectively embrace new agricultural knowledge and technologies such as the cultivation of hybrid or certified crop varieties and application of agro-chemicals.

Agricultural Financing Challenges

Financial inclusion is essential to managing agricultural risks. Some key informants blamed their non-inclusion in formal agricultural financing mechanisms as one of their key agricultural challenges. They specifically blamed poverty, lack of capital and loans to be adversely affecting their agricultural activities. Some informants also claimed some smallholder farmers require money to buy agro-inputs such as certified seeds, fertilizers, and other agro-chemicals as well as pay for farm labor and plowing services. Unfortunately, they claimed most peasant farmers do not have the capital to purchase these agro-inputs and are also unable to access loans from formal financial institutions due to lack of collateral security. Most informants criticized the government of Ghana for not doing enough to support smallholder farmers to access financial services to address some of their agricultural challenges. In supporting the point of view that the government and financial institutions are not doing enough to support smallholder farmers, a leader of an organization that advocates for peasant farmers, i.e., PFAG said:

> We leaders of peasant farmers … have been advocating [for] government [to] consciously put in place agricultural development fund (ADF) by way of establishing a credit line for farmers. You know, before the early 1960s, Agricultural Development Bank (ADB) was a conscious effort by the then Nkrumah regime [Government] to boost agriculture. So, they set up that bank purposely to support farmers. Today as we are talking, Agricultural Development Bank (ADB) has lost its focus; it has lost its values of support [to the] agricultural [sector]. ADB has gone commercial now. So, we think we need agricultural development fund as an alternative funding strategy for peasant farmers. The government should set up a fund purposely for agriculture, and particularly for small-scale farmers where we will have access to loans.

Miscellaneous Agricultural Risks.

Other non-weather related agricultural risks key informants raised were the destruction of their crops by livestock and herds of nomadic and sedentary Fulani herdsmen, pest and disease infestations, negative attitude of some farmers, and environmental-related challenges. “As a Northerner yourself (referring to me as the interviewer), you know that it is a common practice to allow livestock to stray about (free range) or are being accompanied by herders," a key informant said. "These animals often destroy our crops," another key informant revealed. Some key informants specifically complained about the negative activities of alien Fulani herdsmen both nomadic and sedentary who usually control large herds of cattle. According to these informants, some herds can number up to 1000 plus. These Fulani men usually enter Ghana under the disguise the Economic Community of West Africa (ECOWAS) protocol which allows free movement of people, goods, and services between ECOWAS member countries, thus, making it difficult to control their activities, they reported.

These cattle herders mostly allow their cattle to enter smallholders' farms and graze on their crops, some key informants revealed. "To be fair to the Fulani herders, this could be done advertently or inadvertently," said another key informant. Some informants hinted that activities of the Fulani herdsmen in Ghana have now reached crisis and national security levels. This is because these herders are often fully armed when moving and even fighting with whole communities and sometimes exchanging gun fire with security personnel, they claimed.

Pests, diseases, and weed infestation were also identified as some of the key agricultural challenges. Almost all the key informants complained about the incident and effects of the fall armyworm (FAW). The FAW is a worm that devastated crops, especially maize during the 2017 farming season throughout Ghana (CSIR warns of a major resurgence of Fall Armyworm pests, September 30, 2017)

Some key informants again saw some negative attitudes and socio-cultural practices of some smallholder farmers as working against agricultural productivity in Northern Ghana. These informants reported that some farmers refused to adopt hybrid seeds and improved crop varieties which are not only drought-resistant and early maturing but also high-yielding. Their reason for the non-adoption is that these practices are alien and cannot be used to make traditional sacrifices to their gods and ancestors. For this reason, some farmers still cultivate a lot of the traditional crops, including millet, cowpea, groundnuts instead of maize which have qualities that can withstand current weather challenges, one informant revealed. It was also revealed during the key informant interviews that some farming practices also contribute to environmental degradation. Some of these harmful practices they enumerated as indiscriminate bushfires, charcoal burning, indiscriminate harvesting of firewood, deforestation, farming close to water bodies, wrong application of agro-pesticides, and monoculture plantations. To them, these practices lead to soil infertility, water siltation and pollution, and climate variability and change.

4.6 Identification of Smallholder Farmers' Key Agricultural Risks and the Associated Impacts on Smallholder Farmers in Northern Ghana from Questionnaire Survey

As a multi-layered study, questionnaires were distributed or personally administered to tertiary level respondents. Respondents were asked whether the climate and weather have been varying and changing over the years and to also describe and indicate the manifestations of the varying and changing climate if these changes were occurring (i.e., open-ended questions). Based on an earlier pilot survey that preceded the actual study in 2016, a doctoral service learning project conducted in 2015, and literature review, some relevant smallholder farmers' key agricultural risks and the associated impacts emerged. Respondents were then asked to rank these key agricultural risks and the associated adverse impacts (i.e., closed-ended questions).

4.6.1 The Occurrence of General Weather and Climate Variability/Change over the Years as Smallholder Farmers' Key Agricultural Risks

Eleven out of the fifteen respondents (73%) of the respondents indicated the weather and climate have been variability and change over the year, and also adversely affecting small-scale farmers. Again, 20% of the respondents said weather and climate variability and change have been occuring to some extent (Table 10). This means 93% of the respondents reported that climate variability and change have been occurring or occurring to some extent. The survey respondents revealed that weather/climate variability and change pose considerable risks to the agricultural sector (Table 10).

Table 10: Respondents' assessment of weather/climate variability and change

Weather/climate variability and change occurring	**Frequency**	**Percentage (%)**
Yes	11	73
To some extent	3	20
No	0	0
Missing figure	1	7
Others	0	0
Total	15	100

Note. Constructed from field data, 2017/2018

4.6.2 Manifestations of the Varying/Changing Weather/Climate

Once respondents indicated the weather and climatic phenomena have been varying and changing over the years, they were further asked to list and describe the manifestations of these weather/climate-based variables. The survey participants' responses have been organized into rainfall-related, temperature-related, pest and disease-related, yield-related, and miscellaneous manifestation categories (Table 11). It is important to add that some respondents mentioned some of these manifestations more than once (Table 11). For instance, erratic rainfall patterns, drought, and poor yields were listed by almost all the respondents. To capture the significance level of each risk, the associated response frequencies were recorded (Table 11).

Table 11: Respondents' description of the manifestations of the varying and changing weather and climate phenomena

Rainfall-related Manifestations	**Temperature-related Manifestations**	**Pest and Disease-related Manifestations**	**Yield-related Manifestations**	**Miscellaneous Manifestations**
Erratic rainfall patterns (6)	Increased Temperatures (1)	Pests invasion, esp. fall armyworm (FAW) (2)	Poor farm yields (2)	Reduction in vegetation cover (2)
Drought-related risks (4)	Slight changes in temperature (1)		Crop failure (1)	Dryness and bushfires (1)
Drying up of water bodies (1)	Excessive heat (1)			The threat of desertification (1)
	Scorching sunshine (2)			
Increasing dry spell days (1)	Harmattan season is no longer clearly defined (1)			
Excessive Downpour (1)				
Flooding-related risks (2)				

Decreased rainy days (1)				
Decreased rainfall amount (2)				
Low humidity (1)				
Rapid loss of surface water, i.e., dams and dug-outs, streams, and rivers (1)				
Reduced length of the cropping season (1)				
Light rain pours (1)				

Source: Constructed from field data, 2017/2018

From respondents' description of the manifestations of weather and climate variability and change based on the frequencies, rainfall-related risks posed the greatest challenge to smallholder farmers in Northern Ghana (Table 11). This was followed by temperature-induced agricultural risks, pests and disease-based risks, yield-related challenges, and the miscellaneous risks category. Even though weather/climate challenges can influence pest-related, yield-related, and the other agricultural risks, direct weather/climate-induced agricultural issues (e.g., rainfall and temperature-related risks) dominated smallholder farmers' key agricultural risks (Table 11).

4.6.3 Ranking of Key Agricultural Risks Affecting Smallholder Farmers in Northern Ghana

Respondents also ranked smallholder farmers' key agricultural risks, with 1st being the most important and 11th the least important agricultural risks. These agricultural risks were obtained from an earlier Environmental Studies Doctoral SLP, pilot study, and literature review. For visualisation, weights were applied to each ranking, i.e., 1.1, 1.0, 0.9, 0.8, 0.7, 0.6, 0.5, 0.4, 0.3, 0.2, and 0.1 to 1st, 2nd, 3rd, 4th, 5th, 6th, 7th, 8th, 9th, 10th, and 11th respectively to generate the resultant bar graph (Figure 5).

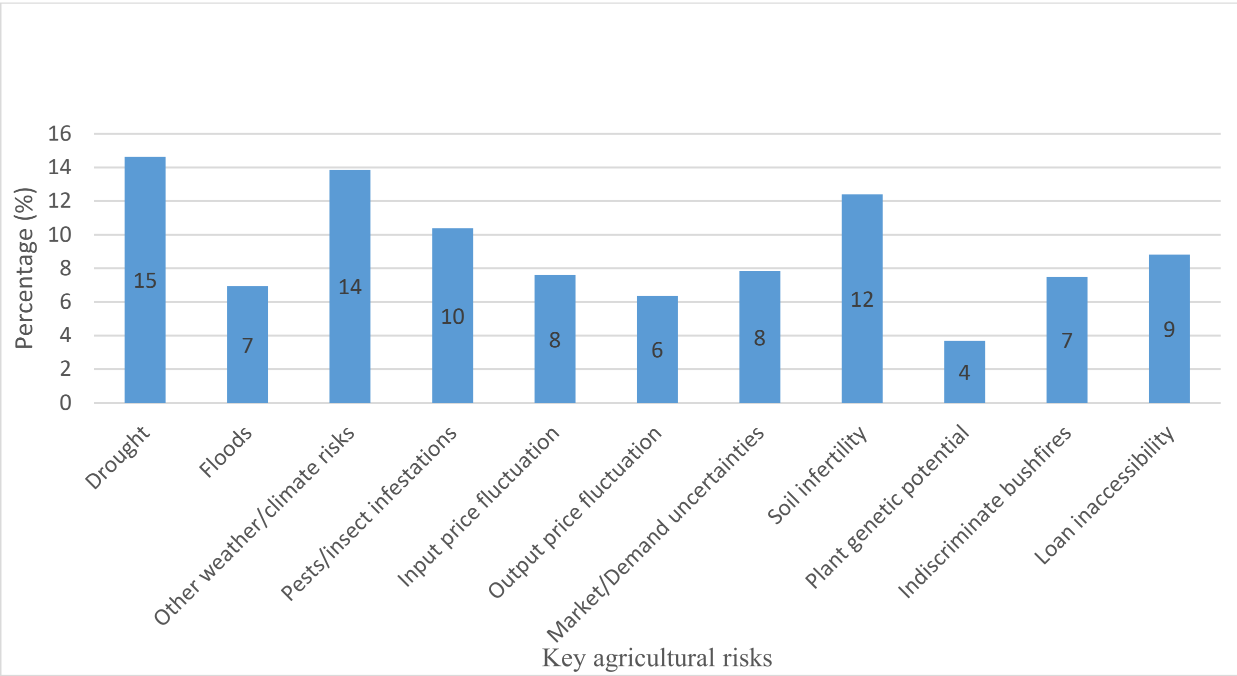


Figure 5: Bar graph displaying respondent's ranking of smallholder farmers agricultural risks

Respondents ranked drought as smallholder farmers' most important agricultural risk. This accounts for 15% of the 11 key agricultural risks they rated. This was followed by other weather and climate-related risks (14%), such as erratic rainfall patterns, shortening of the raining season, and increased temperatures as revealed by respondents' description of the manifestations of the varying and changing weather and climate (Table11). The weather/climate-related agricultural risks, including drought, cumulatively accounted for 29% of all the agricultural challenges respondents ranked.

4.6.4 Impacts of Key Agricultural Risks on Smallholder Farmers

The survey respondents equally ranked nine impacts of the key agricultural risks on smallholder farmers. I gathered these impacts from my pilot study, SLP, and literature review. Based on data analyzed from the questionnaires, respondents ranked loss of crop yields as their most important adverse impact (18%). This was followed by secondary losses such as farmers' inability to feed their families (13%) and to pay back loans (13%). The rest of the scores can be gleaned from Figure 6.

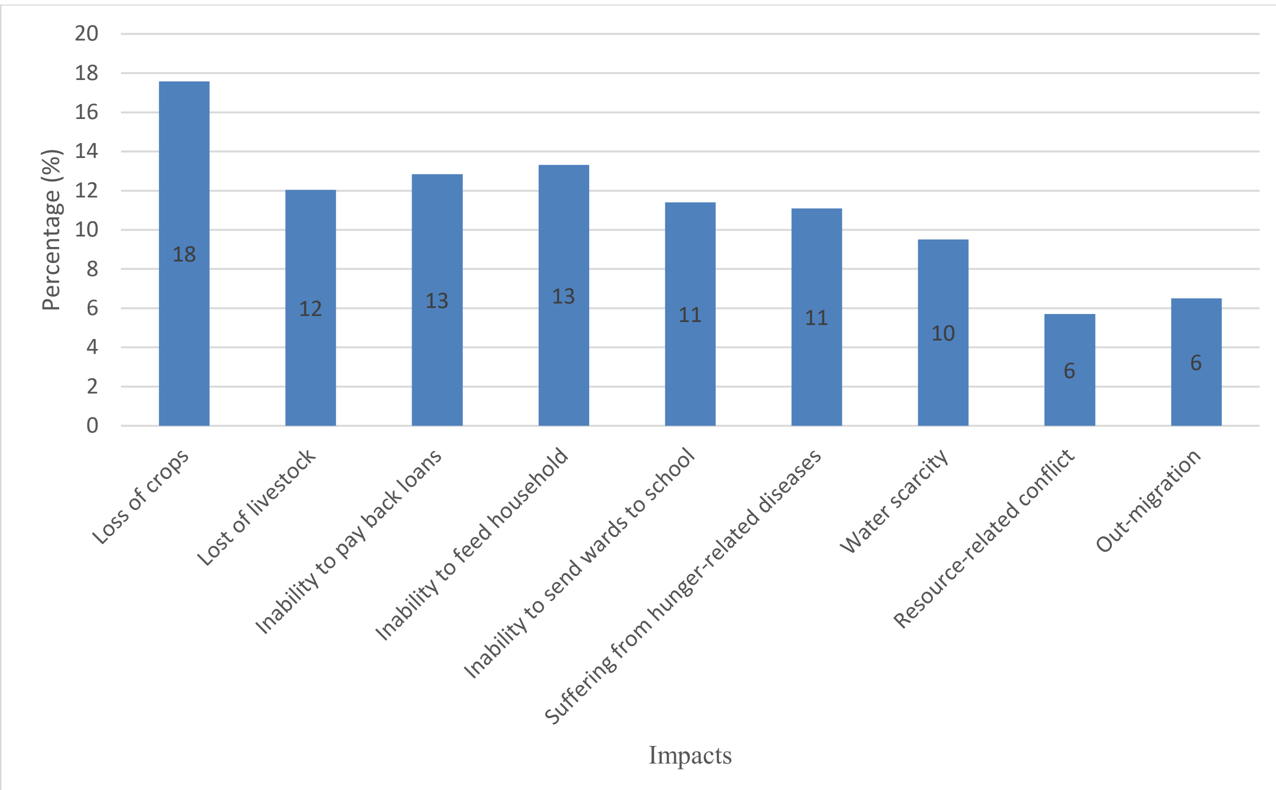


Figure 6: Bar graph showing respondents' ranking of impacts of agricultural risks on smallholder farmers

Chapter 5: Results on Smallholder Farmers' Agricultural Risks Management Strategies

5.1 Introduction

My second research question sought to identify and document smallholder farmers' existing agricultural risks management strategies. This is necessary because a study exploring perceptions of the potential of agricultural insurance for crop risks management needs to understand the efficacy level of existing agricultural risk mitigation strategies. In response to this need, focus group discussants, key informants, and survey respondents were asked to enumerate the strategies smallholder farmers have been employing to cope with their key agricultural risks. As a mixed methods research, adaptation strategies were identified using FGDs and KIIs. Survey respondents were also asked to rank pre-determined smallholder farmers' key agricultural risks (pre-determined from my Enviironmental Studies Doctoral SLP, pilot study, and the literature) to show their relative importance quantitatively through questionnaire surveys.

An analysis of smallholder farmers' agricultural risks management strategies was conducted at two levels based on the data collection methods. The first level measures were collated based on semi-structured interview guides with focus group discussants and key informants. The second level coping measures were also recorded from questionnaire administration - both personal and self-administered administered questionnaires. In this section, agricultural risks management strategies, adaptation strategies, coping strategies, social protection measures, and safety nets applicable to smallholder farmers will subsequently be used interchangeably.

Detailed Identification and Description of Smallholder Farmers' Agricultural Risks Management Strategies Through Focus Group Discussions and Key Informant Inteviews Smallholder farmers' agricultural risks management strategies discussants and infomants reported were analyzed concurrently. The analysis revealed that focus group discussants and key informants in Northern Ghana mentioned forty-five (45) different adaptation strategies to both weather/climate-induced and non-weather/climate-induced agricultural risks. Since smallholder farmers might employ the same or similar adaptation strategies, some coping measures recorded higher frequencies. For instance, food rationing, mixed farming, mixed cropping, praying to God, crying to gods, cultivation of improved crop varieties, and engaging in agro-forestry practices were stated severally by discussants and key informants.

The forty-five agricultural risks management strategies identified were condensed into nine broad themes. These themes included technology-based adaptation strategies, farm production and management systems, livelihood adaptation-related strategies, farm risks diversification strategies, financial inclusiveness adaptation strategies, socio-cultural and religious adaptation strategies, information-related adaptation mechanisms, flood-control adaptation measures, and social protection and safety net programs. Despite the categorization of the smallholder farmers agricultural risks management measures into the nine themes mentioned above, there are no clear boundaries between them as more than one adaptation strategy can be accommodated by more than one theme. This classification is, therefore, for ease of comprehension and analytical purposes.

5.1.1 Livelihood-related Agricultural Risks Management Strategies

The coded adaptation categories under the livelihood-related adaptation strategies included food rationing, engaging in small-scale trading, and reliance on foods from the wild. It was evident from most members in all the six focus group sessions and some key informants that dependence on wild foods was a prominent adaptation strategy some smallholder farmers often employ to cope with their food insecurity challenges, especially during bad years. Some foods from the wild discussants and informants mentioned were fruits and vegetables from shea, dawadawa, baobab, ebony, kapok, and yellow and blackberry trees. A male key informant in Kazigo community who is also GAIP's contact person claimed that God usually plans the fruiting and maturing of the wild foods to coincide with food deficit periods. This discussant stated :

> And the fruits... [you can also) depend on because If you can get enough [wild] fruits, you will not like food again. If you get plenty shea fruits, you will chop (eat) and drink water, [and] you will be okay. You may [also] have some fruits, [which] the children may depend on [to survive]. You may have shea, baobab, ebony and many types of fruits. When they come from school, they scatter [go in different directions] to look for these fruits. The children will eat and drink water. There is no time that there won't be fruits. This time is for baobab, ebony and different types of trees. You know kapok? (the discussant referred to me as the interviewer) Kapok is also there. Different types of fruits and vegetables from the wild [are there].

I saw a pile of harvested baobab fruits while having focus group discussions with Kazigo community members (Figure 7). The owner indicated that she was going to sell some and process the rest for household consumption. "I can use the income from the sales to buy foodstuff for the family in case our farm fails us", she revealed.

Figure 7: Stockpile of baobab fruits for consumption and sale to support the family

Note: Standing by baobab fruits are: Atinga, a discussant, and John Bosco: Researcher, **at** Kazigo.

Food rationing also emerged from my fieldwork as a key adaptation strategy among smallholder farmers in Northern Ghana. My fieldwork revealed that food rationing during bad years usually cover most parts of the year, especially from March/April (the beginning of the farming season when food is scarce) to September/October, a period before harvesting of crops begins. A key informant reported that due to food scarcity, matured male and female farmers usually eat a meal or two a day and the remaining meals catered for by relying on wild fruits and vegetables.

Some participants also identified income from small-scale businesses as an alternative livelihood strategy when their crops fail due to adverse weather and other non-weather-induced agricultural challenges. Two types of small-scale businesses were identified in the three focus group communities and some key informants (Appendix 1: on the socio-economic and demographic characteristics of the study participants). They included buying and selling goods and services (commerce) and indigenous agro-processing-related activities to support their families, especially during bad years. According to some study participants, those engaging in commerce mainly buy their goods and services from whole sellers in nearby cities and towns such as Tamale, Bolgatanga, Navrongo, Wa, Jirapa, etc. to retail to members of the focus group communities and their environs. They also usually buy agro-related produce from farmers for retail such as livestock, cereals, and legumes, they claimed. Some discussants and informants further maintained that those farmers processing agro-produce into foods, drinks, and other usable forms are mostly women. Discussants in the Duori-Guo, Kazigo, and Nyanpkala communities and informants mentioned preparation and sale of cakes, the sale of firewood and charcoal, and milling and packaging rice for sale. In the Duori-Guo and Kazigo communities, in particular, it was reported that most women normally engage in brewing and sale of a type of local beer called "pito." Income from these sources are mainly used to buy food to cope with adverse effects of bad years as well as satisfy other needs, some discussants and informants revealed.

5.1.2 Farm Risks Diversification Strategies

Farm risks diversification was also revealed among the measures smallholders have been employing to address some of their agricultural-related challenges. These diversification mechanisms have been sub-coded as farm-based, weather-based, and miscellaneous farm diversification strategies. Some study participants referred to these adaptation strategies as traditional or social insurance. A focus group discussant in the Duori-Guo community used a metaphor to describe farm diversification as an adaptation strategy in Dagaari (the local dialect) as:

> Baare ayi suongaa ba bɔrɔ. Ka hoong koɔrɔ a nang guolo noori aneng dunni meng, a mang son ho la. Ka hoong taa wɛraata bee kɔɔ kɔ kyi bee kamaana a bori bɛngɛ eng, ka ho zungnuma, a zaakun bang fieli ho. Ngaa teng meng mang erɛ a meng nang kyagli [be].

The direct translation of this quotation is that:

> A rabbit being chased by two dogs can never escape. If one is farming in addition to rearing livestock and poultry fowls, it helps him [or her]. If one has three farms at different locations or you farm millet or maize intercropped with cowpea, if you are lucky, [all] these [different] crops and practices cannot fail you. These are the strategies we have been employing to survive.

Some of the farm-based adaptation strategies some discussants and informant mentioned included mixed farming, farm diversification, and intercropping among other farming practices. All the study participants identified at least, one form of farm diversification strategies or the other such as mixed farming, mixed cropping, and having distant and backyard farms. According to the focus group discussants and key informants, mixed farming assures farmers of an alternative source of livelihood if crops fail and livestock blossoms and the vice versa.

Geographic farm diversification was reportedly widespread in Northern Ghana. Some focus group discussants and key informants revealed two types of farm diversifications, namely, distant farms and compound farms (backyard farms and gardens). An agricultural extension officer,i.e.. a key informant, reported that some farmers in the UWR mostly diversify even their distant and compound farms by cultivating more than one distant and backyard farms. To them, this approach further diversifies some of their agricultural risks.

Some of my study participants also claimed that farmers always reduce their production risks by practicing shifting cultivation, i.e., some households moving the farm and family from exhausted farmlands to new and fertile sites. Participants claimed that they usually return to the abandoned farmland after it had become productive again. A nucleus farmer in the UWR (a key informant) was, however, concern that the efficacy of this agricultural risk diversification mechanism may be reduced in future if nothing is done about current rates of population growth, urbanization, and general development trends. He cited urban sprawl around major towns and cities such as Wa, Nadowli, Jirapa, Lawra, and Tumu among other areas in the Upper West region. Similar concerns were re-echoed by the Upper East Regional President of the PFAG regarding high population density and urban sprawl around Bolgatanga, Navrongo, and Bawku in the UER.

It also emerged from the fieldwork that mixed cropping has been widely practiced in Northern Ghana. According to a nucleus farmer-key informant in the UWR, the philosophy behind the multiple cropping is that different crops have different soil and nutrient requirements, and as such, practicing intercropping means some plants may meet their nutrient requirements whereas others may not. An AEA also explained that mixed cropping is a special arrangement where leguminous crops replenish soil nutrients such as nitrogen and phosphate exhausted by cereal crops such as maize, millet, and sorghum. In the words of this key informant:

> Mono-cropping is lotto some farmers usually stake. If the farmland [soil] can satisfy [provide) all the requirements of the planted crop [mono-crop], then, the farmer has won lotto, and if the land does not meet [provide] the soil and nutrient requirements of the crop [mono-crop], then, the farmer has lost completely. Farming, in general, is lotto or game of

chance but undertaking mono-cultural agriculture is not a wise decision at all. [The wise decision is to grow many crops on the same field].

The weather-related farm diversification strategies the study participants reported were: studying the weather or rainfall patterns over the years and adjusting accordingly or waiting for the rains to establish before planting. Some study participants also explained that smallholder farmers usually diversify their crop production risks by splitting their planting dates. These discussants and informants explained that farmers normally plant their crops in two weeks or a month's interval so that if agricultural risks such as drought, flooding, pest and disease infestation occur, not all the crops will be affected. In corroborating this strategy, a WorldCover Regional Coordinator in the UWR said:

> Apart from early maturing varieties, I think because [the rainfall] is just not predictable, some [farmers] will also try to manage their risks for example, [by] splitting their planting periods or days. And if the farmer intends to do 3 acres of maize, he will choose to do the 1st acre in maybe the 1st month of the early rains and do another acre a month later and another a month later so at least his [risks are] distributed. If one fails completely, maybe two will do well, and if two fail, one may likely fall within the rainy period. Splitting the planting date is a potent agricultural risk diversification strategy. This potency was illustrated by the [adverse effect of] the fall armyworm, [also called FAW] that devoured maize [crops] tussling and beginning to mature throughout Ghana during the 2017 farming season. Farmers' maize crops were destroyed by the fall armyworm within the first three weeks of September before the situation was controlled by MOFA through the sensitization, provision of free pesticides, and deployment of AEAs, and closed monitoring of the situation. What this means is that the fall armyworm [adversely] affected farmers

who planted their maize within a particular time, and those who either planted earlier or later dodged it.

Another farm risk diversification strategy recorded from the field was studying the weather or rainfall patterns over the years and adjusting accordingly. Some key informants reported this form of adaptation in the Upper West and Northern Regions. Two key informants in the UWR said they have been studying the rainfall patterns over the years and adjusting accordingly. One specifically said he has studied the rainfall pattern and has concluded that sowing of crops, mainly maize has to be planted within a certain time frame. According to this key informant:

> If you are a farmer, you need to study the weather patterns over the years. For me, I have studied it in such a way that I am almost an expert now. If you go to Duong (the community the discussant comes from) now, the women say when they see me sowing my corn or any crop, they all prefer to go to plant the next day. Because invariably, when I sow, the next day or 2 or 3 or even the day of sowing, we get rain. Last year, they made a mockery of me that I sowed and for a week it didn't rain. They were all surprised and disappointed. And even the men say when they see me sowing corn, they also go to their farms [to sow corn]. Because I have studied the weather patterns to know that if you sow corn from 10th June, sorry 15th June to 10th July, you will never fail, you will never fail. If you sow corn in our area here, you will never fail. I am not trying to cover the whole of the District, in our area, Daffiamah, Duong area there and even Nadowli, Well I may dare say, the whole of the north-western part of the Upper West [region], if you sow [corn] between 15th June and 10th July, you will never fail.You will never fail. By not failing, I mean you will not suffer a drought that will make the corn fail totally because at the time that it will be tussling, you will have enough rains. At tussling periods of my farm, the

> rains are very frequent and heavy. I studied the weather over the years, I have studied the weather, and I know how to avoid these long droughts. Now if you sow your corn in May or early June, you are likely to face a drought because, by the end of June, it will be tussling and normally end of June to mid-July, you have a long spell of drought. But if you sow let's say 15th June, by the time the drought comes, the crop will still be very young, and it doesn't matter whether they are rains or not. So, you have to study it that way and try to avoid the long spell of drought.

I observed that this key informant's revelation about planting maize between June 15 and July 10 to coincide with the rains came through during the 2017 farming season when I was in Ghana. This observation has been confirmed by the Upper West Regional Office of the GMA. For instance, the Upper West Regional Office of the GMA recorded 53.8mm and 17.6mm of rainfall on June 15 and 16, 2017 respectively. From June 17-July 10, 2017 (the maize planting period the informant indicated), it also rained nine times on different days (GMA, UWR, 2017).

The female discussants in Nyankpala also recognized that using rainfall information generated by researchers and weather experts to guide their planting dates is one strategy they have been adapting to their weather-induced agricultural risks. These female discussants explained that they have been using weather information from SARI (Savannah Agricultural Research Institute located within Nyankpala) scientists as a signal to begin planting their crops. These women claimed they probably would have been incurring substantial yield losses without relying on weather information from SARI.

The study participants also mentioned farmers' waiting for the rains to stabilize before planting. According to these discussants and informants, the rainfall regime is so unpredictable that early rains around March, April, or May, may lure farmers into planting without follow-up rains or for droughts to occur later. To these farmers, the best strategy is to wait for the actual rainy season to set-in. These farmers were also concerned that waiting for the rains to establish could also lead to late farming which may risk their crops not maturing and ready for harvesting before the rains stop. A focus group discussant in the Kazigo community said this situation sometimes make them unable to decide when to plant, and further said: "farming involves staking lotto, sometimes you win and other times you lose."

A common farm risk diversification mechanism most study participants mentioned was reliance on grains stored from previous years. Some key informants and focus group discussants indicated they normally store their remaining millet, corn, sorghum, and cowpea in their granaries and sacks from good years against unforeseen contingencies like bad years as a result of droughts, pests and insects infestations, bushfires and any agricultural challenge that may result in low farm yields. At Duori-Guo, a female discussant boasts of millet and cowpea her family stored since 2015, that is, two years ago. A community leader (a focus group discussant) also said his family was still using grains stored from previous years to feed the family. This discussant was, however, concerned that consecutive bad years could force them to deplete the grians accumulated from previous good years and may have nothing to eat or store again. He, however, believes that his God would never allow this to happen to them and paraphrased the Holy Bible to support his belief by saying that God said we should forget about tomorrow for tomorrow will take care of itself. He went further to add that God says birds neither sow, reap, nor store grains and yet God feeds them and how much more valuable human beings he created in his own image."

Most focus group discussants and key informants mentioned migration from northern Ghana to southern Ghana or other agriculturally favorable parts of Northern Ghana as a common geographic farm risks diversification strategy being practiced by peasant farmers in Northern

Ghana. According to these discussants and informants, migration to other favorable weather and climate areas ensures that farmers do not put all their eggs in one basket so that, if the crops of those at home fail, those of the migrants may not fail and the vice versa. The migrants may also use income from farm produce to support family members back home during difficult times, some discussants and informants reported. This arrangement ensures food security for the household or family, they claimed.

Based on my interaction with some study participants, three types of migration patterns were distinguished. First, some members of the farming household usually migrate to southern Ghana (down-south) during the off-farming season to sell their labor for wages. This is seasonal migration, and the essence is for them to still be productive during the long dry season, they claimed. Secondly, other family members migrate voluntarily to agriculturally favorable areas to settle permanently. Thirdly, some families usually plan the migration arrangement were one or two members are sent down-south or to other favorable parts within Northern Ghana either to settle permanently or labor for wages. This planned migration could be temporary or permanent. No matter the type of migration pattern, the ultimate aim is for farmers to diversify their agricultural risks. This point was captured by a key informant when he said:

> Of late our people have also learned to let some members of their families [to] farm in different geographic zones. In case there is a failure here, you move to the other side. You hope to get something from the other side. The information I got from Papu [a farming community in the UWR] this morning was that a young man [because] the rain there [at Papu] was refusing to come and he decided to move down-south to do some farming there and then plant and go back [to Papu] so that when it starts raining there, he could farm there too because they had been waiting there and the rain was not coming. So, apparently,

if there is a failure here and there is something there, once vehicles are always moving across, food can be carried to any place after all food [harvested] here can be found in Makola market [a market in Accra, Ghana's capital city]. [In the same way], food [harvested] in Afraim plains (a farming area) can also come here, [that is, UWR].

5.1.3 Socio-cultural and Religious Adaptation Measures

Some focus group discussants and key informants reported that some smallholder farmers have been employing their faith and beliefs to manage their agricultural risks. These study participants identified two categories of socio-cultural and religious adaptation strategies: Christian Faith (CF) and African Traditional Religious (ATR) Believes and Practices. Some discussants and informants claimed that smallholder farmers who believe in the Christian faith usually pray to their God to intervene when they anticipate or encounter droughts, floods, and other agricultural challenges or to prevent their occurrence or moderate their adverse effects. They further claimed that during periods of famine and hunger, they usually pray to their God to touch the hearts of generous people and organizations to come to their aid. A male focus group discussant in Duori-Guo community said in the local dialect *"Te mang puoro sɔrɛɛ te daana Naangen koo ko te saamaarong ka te tuong kɔ a guoli te bibiiri aneng te pɔgba. A te daana Naangen meng mang song na te la a te koɔbo yeltariti puong"*

The translation of this quotation into English is "We normally pray to our God to gives us rains to be able to farm to feed our children and wives. Indeed, our God has actually been helping us with our agricultural undertakings."

Some focus group discussants and key informants also reported that farmers who believe in the African Traditional Religion (ATR) often invoke their gods and ancestors to intervene to prevent the occurrence of calamitous events or reduce some of the sufferings resulting from agricultural challenges like droughts and floods. "When there is prolong drought or lack of rains, our women usually go out to cry to our gods to grant us rains," a discussant reported. Men on the other hand, typically make traditional sacrifices to their gods and ancestors to plead with the rain gods to give them rains, they revealed. They also revealed that lack of rains or the occurence of droughts, other agricultural challenges, and low yields are usually punishments from their ancestors and gods for defying traditional conventions, norms, and rules, and as such, can only be reversed by performing traditional sacrifices to appease the gods and ancestors. Regarding the role of the ATR as an adaptation strategy, a discussant who is a traditional believer said: "*Te mang la maalɛɛ te bɔbɔ meng a sɔri a te saakum mine, a te tengama, a naa te ngimɛ kaa son te neng siimaa ka te toɔng dire ka yuoni la ta te."* This quotation also means "we also make traditional sacrifices to appease our ancestors and gods to grant us food to survive till the next farming cycle." There was, however, a strong disagreement between the Duori-Guo male focus group discussants who are traditional believers and the Christians regarding the potency of their respective faiths (belief in God or gods and ancestors) as an adaptation strategy. The Christians believe their God is more potent than the gods and ancestors of the traditional believers and vice versa. In all the three focus group communities (Duori-Guo,Kazigo, and Nyankpala), the discussants never mentioned the Islamic religion as an adaptation strategy unlike the case of Christianity and ATR.

Some focus group discussants and key informants also revealed that before the advent of technology-based adaptation strategies, some smallholder farmers were already employing traditional measures to cope with adverse effects of weather/climate variability and change and other non-weather-related agricultural risks. Even though some of these traditional adaptation strategies have already been discussed under earlier themes and sub-themes (e.g., socio-cultural and religious beliefs and practices), some of the study participants mentioned social or traditional insurance, the cultivation of crops which do not only have traditional significance (i.e., used to perform traditional sacrifices) but are also coincidentally drought-resistant. Such crops they mentioned were millet and other varieties of cowpea, groundnuts, sorghum, cassava, and yam. Even though these crops and other root tuber varieties may be low-yielding, some discussants and informants claimed that farmers are always sure of at least average harvest at the end of the farming season, as opposed to scientific crop varieties which could either lead to bumper harvest or total crop failure. Informants and discussants claimed that these middle level risks takers, also called risks-averse farmers are also still there in the face of scientific revolution in agricultural adaptation strategies.

5.1.4 Technology-based Adaptation Strategies

It was also revealed from my fieldwork that most smallholder farmers have been employing technology-based adaptation strategies to address some of their agricultural production risks. Some key informants and focus group discussants mentioned properties of this technology-based adaptation crop varieties as drought and flood-tolerant, high-yielding, early maturing, water efficient, pest and disease-resistant, and crops doing well on marginal soils among other features. They mentioned different crop varieties such as maize (e.g., pan3, pan13, pana, and 60, 85 and 90 days maize), groundnuts, sorghum (such as nara, naga, also called Madam Pricilla at Naro), cowpea, and rice. In the words of a key informant:

> The lobies (a tribe) even have 60-day maturing maize, and that corn if the soil is [fragile], but it will do [well], they will get something, and that corn is very sweet. If you chew it, you will finish everything. Johnny [referring to the researcher/interviewer] even MOFA (Ministry of Food and Agriculture) introduced a type of shorter maturing crop from the Upper East region, a type of guinea corn to us. In the Upper East region, they called it

Naga. Within three months, it is grown and matured. In Naro, a certain agric woman (female AEA) called madam Priscila… introduced it to us. In Naro, they called it Madam Pricilla because those who do not know the name of this corn call it Madam Pricilla. I knew it when I was in the Upper East region. They had to introduce it to us because of this weather unpredictability phenomenon. It grows very fast. It matures very fast. And the output is still the same as our guinea corn [i.e., guinea corn from the UWR) if not better. It is even whiter than our guinea corn.

5.1.5 Farm-based Production Management Systems and Practices

Key informants and focus group discussants listed a litany of farming systems and practices smallholder farmers have been employing to adapt to weather and climate-induced challenges and other general agricultural risks. The specific farm management and production-based adaptation practices discussants and informants reported included agro-forestry practices, irrigation agriculture, use of organic manure, and sustainable agrarian tillage systems. The remaining farm-based adaptations are crop and land rotation, contour plowing, cover cropping, and farming close to water bodies.

According to these key informants and focus group discussants, smallholder farmers have been engaging in agro-forestry practices to achieve food security. It was evident from the fieldwork that smallholder farmers normally nurture and protect naturally growing economic trees such as shea, dawadawa, baobab, and many others. They also sometimes develop mango and cashew plantations alongside their farms or inter-plant these economic and commercial tree crops with their cereal and leguminous crops. Fruits and leaves of such trees provide food during bad years and also serve as a source of income, mainly for women.

Discussants and informants revealed further that water deficit for crop production has been one of the key agricultural challenges confronting smallholder farmers in Northern Ghana. They revealed that smallholder farmers have been engaging some water conservation agrarian systems to adapt to the situation. Such water conservation-related adaptation strategies discussants and informants mentioned included irrigation agriculture, contour plowing, cover cropping, mulching, and farming close to water bodies. For instance, some discussants and informants in the Upper East and Northern regions revealed that some smallholder farmers have irrigated fields around the Vea, Tono, and Bontanga irrigation dams. In the Upper West Region, it was reported that some farmers have been watering their dry season gardens using water from the Sankana, Daffiama-Dakyie, Vieri, and Kamba dams. Other farmers either dig their own wells or use open water sources and streams such as the Wadie dam, Nyopulmo, Piiri kulaa to water their dry season vegetable gardens. According to some study participants, these irrigation opportunities do not only serve as a source of employment for some smallholder farmers during the long dry season but also provide them with food and income to enable them to cope with the long dry season.

Some discussants and informants also identified the preparation and utilization of organic manure and crop and land rotation as some of the farm management and production-based adaptation strategies some smallholder farmers have been using to enrich and recycle soil nutrients. It was reported that it is a norm for male farmers in Duori-Guo and Kazigo communities to choose fertile lands as their farm sites and give marginal agricultural lands to females. It was also revealed that some women in Kazigo who could not buy chemical fertilizers to enrich their farms devised a smart way of preparing compost/manure. The women said they usually use water, crop residue and farm stalks (practicing non-burning), livestock dung, and poultry birds' droppings to prepare organic manure for their farms.

Some sustainable farm production and management practices smallholder farmers have been undertaken have the potential to sequester carbon. Most smallholder farmers are now practicing minimum tillage and zero tillage practices. According to the Upper West Regional Director of ADVANCE, USAID/ADVANCE have been supporting smallholder farmers in various ways to cultivate maize, soybeans, sorghum, and rice. According to him, ADVANCE has been promoting sustainable farming practices by encouraging and training smallholder farmers to engage in minimum and zero tillage farming practices. Discussants and informants also reported widespread use of a type of weedicide popularly called "condemn" to clear the grass before planting their crops without tilling the land. This zero-tillage system also has the potential to sequester soil carbon and does not even disturb the top rich soil and soil micro-organisms, an AEA revealed. These sustainable agricultural practices have the potential not only to increase agricultural productivity but also to mitigate climate change and enhance the adaptive capacity of smallholder farmers in the long-run, another key informant indicated.

Some focus group discussants and key informants reported that studying the properties of the farmlands also provide farmers with adaptation information and opportunities. These study participants revealed that some smallholder farmers always select agricultural lands that can sustain some crops during droughts and flooding and also those that can do well on marginal lands. For instance, an informant explained that:

> Well, the first [adaptation strategy] is a selection of the land on which they [smallholder farmers] will plant. You don't go to a parcel of land which drought easily hits, and you will lose your crops… certain soils can sustain crops during drought. So, in as much as it is in your power, you look for such lands.

5.1.6 Flood Adaptation Measures

Flooding was also identified as an agricultural challenge among some smallholder farmers in Northern Ghana. It was, however, reported to have an unequal regional impact on farmers. For instance, some focus group discussants and key informants indicated that flooding was becoming an emerging agricultural risk for farmers growing crops in flood-prone areas and close to water bodies in the Northern and Upper East regions. Farms along the Saveligu-Diary stretch of the of the Tamale –Bolgatanga highway and those along the White Volta River running from Burkina Faso through the Upper East and Northern regions were explicitly mentioned as flood vulnerable areas. The study participants indicated two types of flooding, i.e., naturally occurring flooding due to excess rainfall and the spilled water (artificial flooding) from the Bagre Dam in Burkina Faso. The Bagre dam spilled water usually flows through the White Volta River, thus, inundating farms and sometimes carry away livestock and poultry products on the waterway, they revealed. This annual spillage sometimes kills some farmers because they (farmers) would not heed a warning from the Bagre Dam Management Authority and NADMO's early warning signals to relocate to higher grounds, some informants claimed. They added that NADMO and its collaborators have been sensitizing farmers every year through radio stations, community visits, announcements, and sometimes SMS about the need for farmers to relocate upland to avoid any possible disaster. In the case of the Upper West region, it was revealed that smallholder farmers usually experience occasional flooding, mainly caused by excess rains and those farming along the banks of the Black Volta River, its tributaries, and few other streams. On the whole, flooding is not a major challenge for farmers in the Upper West region, some discussants and informants asserted as discussed under identification of key agricultural risks by key informants.

Some smallholder farmers have, therefore, been deploying a variety of adaptation strategies to address challenges occurring due to both excess rainfall and rivers and streams overflowing their banks. One strategy most smallholder farmers and key informants mentioned was cultivating flood-friendly crops like rice and sorghum in flood-prone areas. To these participants, flood-friendly crops can withstand flooding, and as such, their yields may not be adversely affected. They also identified studying the flooding history of the farm and adjusting appropriately as an adaptation strategy to addressing flood-induced agricultural risks. According to these discussants and informants, farmers who have been cultivating the land over the years usually know which areas are flood-prone and which crops also do well in flood-vulnerable areas. They claimed that farmers do not only plant flood-friendly crops in flood-prone areas but also plant other crops in flood-prone areas early enough so that by the time the flood water comes in August/September, the crops would have been deeply rooted. Such well-established crops may not be adversely affected by flooding, they revealed.

Some discussants and informants also revealed that some smallholder farmers have been raising mounds and beds/ridges as traditional ways of dealing with flooding of farm crops. In their view, smallholder farmers usually cultivate mounds and beds to raise the crop and tuber plants above the flood water level. As one key informant put it:

> Some farmers have been able to raise mounds such that the roots of the cereals and [other crops] are above the flood level. So, you see the water flowing around the mounds, and the crops are standing above the water [level]. If you go to Nandom (a farming community)

> area, you even see them putting yams in valleys. What do they use? They are using the mounds. In our area here (referring to Nadowli-Kaleo district), we raise the mounds in valleys for corn and [sorghum] so that their roots are not submerged in water. In the case of corn, if the roots are submerged in water after some time, it will perish. Guinea corn [can] withstand [flooding].

It was also realized from the focus group discussions and key informant interviews that some smallholder farmers have been planting trees, placing sandbags across water channels, and constructing drainage channels as flood control strategies. Whereas the planted trees, especially macuna plants and bags with sand can reduce the speed of flood waters, the drainage channels conduct flooding water away from the farm, they reported. With controlled flooding and reduced erosion, the productivity of farm crops may not be severely affected, an AEA indicated.

5.1.7 Information-related Adaptation Measures

Some focus group discussants and key informants revealed that some smallholder farmers have been using agro-meteorological information as an adaptation measure. The information-related agro-meteorological adaptation strategies take several forms. First, it was revealed that some smallholder farmers have been picking signals from agro-meteorology-related researchers, AEAs, and informed farmers (e.g., nucleus farmers). For instance, it was reported during the Nyankpala female FGD that smallholder farmers have been picking weather signals from SARI to inform the timing of their planting activities. The discussants indicated that anytime SARI starts planting any crop, they also begin sowing it immediately as indicated earlier. A key informant in the Upper West region also reported a similar trend (Refer to 5.2.2 on farm risks diversification strategies).

Some farmers and key informants further revealed that they have been receiving and using weather information, especially rainfall information from other stakeholders to plan their farming activities. These sources they mentioned as GMA, ESOKO (a non-profit agro- marketing and information organization), and the Agricultural Insurance Companies (GAIP and WorldCover). They claimed they have been receiving weather information regarding the beginning of the farming season, rainfall amount, frequency and duration, drought, cessation of rainfall, type of crops to grow, the right use of agro-chemicals, and market and pricing information among others. This assertion was confirmed by some Regional Agricultural Insurance Marketing Officers (RAIMOs), GMA staff, ADVANCE, and some AEAs (as key informants).

Some smallholder farmers have also been using information from their participation in awareness and sensitization programs to manage some of their agricultural risks. It was also reported that some stakeholders in the agricultural sector have been creating awareness on adaptation strategies, agricultural extension services, and good agronomic practices. For instance, some discussants and informants indicated that AEAs and staff of GMA, PFAG, ADVANCE, ACDEP, and some agricultural-related projects and NGOs have been sensitizing smallholder farmers through various platforms on relevant adaptation practices, proper use of agro-chemicals, good agronomic practices, and sustainable farming systems. We now shift our attention to financial inclusiveness as an adaptation strategy

5.1.8 Financial Adaptation Strategies

Some discussants and informants reported that some smallholder farmers have been employing financial inclusive-based adaptation strategies to manage some of their agricultural risks. Some of these strategies included the purchase of agricultural insurance policies, taking loans from formal financial institutions and individuals, and membership of Village Savings and

Loans Associations (VSLA), Community Cooperative Credit Unions (CCUs), community banks (CB), Farmer-based Organizations (FBOs), and other farmer groups and associations.

These agricultural stakeholders revealed that the agricultural sector is vulnerable to a multiplicity of risks, both weather/climate-related and other general agricultural problems. They, therefore, claimed that they have been employing both ex-ante and ex-post adaptation strategies to manage their agricultural risks. Under the ex-ante agricultural risks management arrangement, some discussants and key informants revealed that some smallholder farmers have been insuring their farmers against defined perils, such as drought, floods or excess rains, bushfires, disease and insects infestations, depending on the type of policy purchased, i.e., whether drought index insurance (DDI) or multi-peril crop insurance policy. When the trigger event occurs, insured farmers are compensated or reimbursed depending on the type of plan procured, some of my study participants reported. Even though it was revealed that no discussant and informant that I interviewed ever received any compensation, some nucleus farmers, AEAs, and staff of Agricultural Insurance Companies (AICs) indicated that some insured maize and soybeans farmers in Northern Ghana received compensation in 2013 and 2015 for yield losses suffered due to the occurrence of droughts. GAIP Research Department (2017) confirmed the payment of compensation to insured farmers who suffered crop losses due to drought in 2013 and 2015 in Northern Ghana.

Some smallholder farmers have been employing ex-post adaptation strategies to manage some of the agricultural risks. These measures include their membership with VSLA (locally called “Susu") and Community Cooperative Credit Unions so that smallholder farmers could take "soft loans" (Interest-free or loans with low to moderate interest rates) at attractive interest rates from these micro-finance institutions (MFIs) both for consumption smoothening and addressing other needs. It was also revealed that smallholder farmers' membership with these MFIs offers them the opportunity to take consumer credit facilities such as food items, agro-inputs, and other goods and services on high purchase to address some of their farm-related challenges.

Most discussants and informants averred that some smallholder farmers require loans to buy agro-inputs at the beginning of the farming season and foodstuff during bad years. These study participants were not happy that financial institutions are always reluctant to grant loans to small-scale farmers because of the claim that agriculture, especially peasant farming is a risky venture and that most smallholder farmers do not have the requisite collateral security to provide the necessary guarantees. Some key informants, especially the agricultural insurance staff, asserted that smallholder farmers' participation in agricultural insurance programs provides them with the necessary collateral to access agricultural loans. My interview with the credit officer and manager of Bonzaali Rural Bank Branch in Tamale and its head office in Kumbungu, respectively, confirmed the view that insured farmers have access to agricultural loans than uninsured farmers. These Bonzaali Rural Bank staff claimed that they would grant agricultural loans to farmers without the traditional collateral security (e.g., leases of buildings, guarantors, and security deposits) only if they insure their farms or loans. They further revealed that Bonzaali Rural Bank has been collaborating with GAIP to provide insurance coverage for its (the Bank's) clients who are mostly peasant farmers. The staff of other financial institutions interviewed such as WACCU (for only UWR), Ghana Commercial Bank (GCB), and ADB across the three regions of the North were not even aware of the presence of AICs in Ghana except WACCU and were hesitant in using agricultural insurance contracts as collateral for granting agro-loans. These staff revealed that they would grant loans to farmers provided they insure the loans or provide the requisite collateral security like any other client.

5.1.9 The Extent of Effectiveness of Smallholder Farmers' Adaptation Strategies

As a study exploring perspectives of agricultural stakeholders on the potential of agricultural insurance for crop risks management, it is important first to determine the effectiveness or otherwise of existing adaptation strategies and social safety nets. In this regard, I sought the views of focus group discussants, key informants, and survey respondents on the extent of effectiveness of smallholder farmers' existing agricultural risks management strategies. Even though most participants revealed that smallholder farmers' adaptation measures and social safety nets were effective to some extent, a few indicated these strategies were either wholly effective or not effective at all. Further analysis of the effectiveness of the adaptation strategies was organized based on the different categories of respondents, i.e., discussants, informants, and respondents as discussed below.

5.2 Focus Group Discussants' Assessment of the Effectiveness of Smallholder Farmers' Adaptation Strategies

There were disagreements among discussants regarding the extent of effectiveness of smallholder farmers' adaptation strategies and social safety nets. As indicated earlier, adaptation strategies and agricultural risks management strategies are used interchangeably though there may be a technical distinction between the two.

From the FGD sessions and key informant interviews, over half of the discussants in the six (6) focus groups said their adaptation strategies were effective to some extent. For instance, 64%, 58%, and 69% of the female discussants at Duori-Guo, Kazigo, and Nyankpala ,respectively, indicated that their adaptation strategies were effective to some extent. This yields an average effective to some extent rate of 63.7%. On the other hand, 71%, 65%, and 57% of their male counterparts at Duori-Guo, Kazigo, and Nyankpala, respectively, also revealed that their adaptation strategies were effective to some extent, resulting in an average effective to some degree of 64.3%. This implies that about 63.7% and 64.3% of the female and male discussants, respectively, indicated their agrarian risks management measures were effective to some extent with 5% and 8% in the three (3) communities maintaining that their adaptation strategies were efficiently helping them (100% effective) to manage their key agricultural risks. Only 32% and 28% of the female and male discussants indicated that their adaptations strategies were not effective at all (Figure 8).

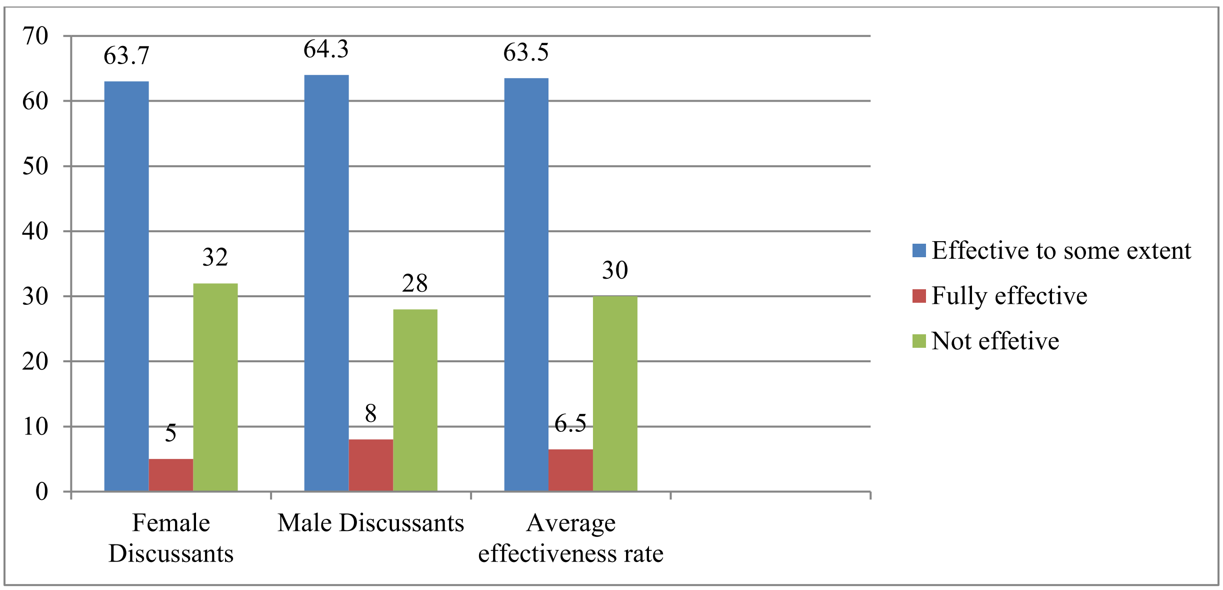


Figure 8: Group bar graph showing the extent of effectiveness of smallholder farmers' adaptation strategies

Discussants used numerous statements and proverbs to reveal their description of the degree of effectiveness of their adaptation strategies. For instance, a male focus group discussant at Duori-Guo said in the local dialect (Dagaari):

Yuomona wari nang mang ari bee ka saa ba wa ta, dunni bee Noori aneng kpeeni teng man kuori a di a libie gaa daa te da tesiimaa. Sanga kanga meng, a bi polikpieni hon mang *gaa la gyongo uonii sanga a te di paa a nyɛ bong kanga fii a song naa die diedeme. Amaa naa taa mine la teng hon mang erɛ a tuon song temenne bee a faa te menne". Kye ama yeng, tuoro nang mang bee te engeng fii*.

In direct translation, this quotation means:

> The years that we suffer from adverse effects of droughts or when the amount of rainfall received is not enough, we normally sell livestock or fowls and then use the money from the sales to buy foodstuff from the market to support ourselves. At times too, the young men normally go down-south during the dry season to labor for wages and use the money to buy foodstuff to support the family back home. These are the things we normally do to cope with the difficult times. However, these measures are not enough to solve all our problems.

The above quotation is attributed to those maintaining that their adaptation strategies are helpful or effective to some extent.

A few discussants also revealed that their adaptation strategies are very potent (i.e., 100% effective). In support of this position, another male discussant said in the local dialect (Dagaare):

> *Baari ayi suongaa ba bɔrɔ. Ka hoong kɔ dagorikakyo kamaana a legri kyarɛ bee ziɛ eng aneng bee kɔɔ kɔ dagoridakyo bɛngɛ a legri ziɛ bee kyare eng, ka kangang ba maale kye kanga hon namaaleng. Lenso mang yeli nyɛ baara ayi suongaaba bɔrɔ na. Ho wongaa paree? Sanga kanga meng to mang kɔɛ wɛ tɛɛ tɛɛ kyɛ bee hong kɔ ho weɛ a la kɔ ho yogo paali. Ka foongyɛri fo gbɛɛ, fo dang ba le zaa.*

This quotation also means:

> If two dogs a chasing a rabbit, it can never be missing. If you intercrop drought resistant or early maturing maize with millet or sorghum or you intercrop improved variety of beans with millet or sorghum, if one does not do well, the other may do well. That is why I said if two dogs are chasing a rabbit, it can never be missing. Do you understand? At times too, we diversify our farms by having distant farms and compound farms. If you diversify your farming activities, you will never lose completely.

There also emerged a third-minute group of discussants who said their adaptation strategies are not helping them at all. This group reported that smallholder farmers have been doing all they can to cope with their agricultural risks to no avail. They further claimed that farmers have been blaming their predicaments on lack of accurate weather information to guide them, lack of agricultural extension officers to teach them new ways of farming, and lack of money to buy improved crop varieties. In alluding to the presence of their so-called ineffective smallholder farmers' adaptation strategies, a female discussant said in Dagaare:

> *Te pang e wu la N bi dɔɔ? Te ba taa libie a hoon na da dagorikakyo bongbooro. La waana meng, a kuoriba karekyiri meng bala kye be a na wuli te a kuobo yeltari. Te dakurong kuobo yeltari meng ba la song no tetogtog ha. N bi dɔɔ te pang la e wulɔ? Teng maang de dɔgɔɔ haala. Ka te bi dɔbo meng la sigi a kong parii ka ba te bɔ bong kanga wa song te, kyɛ ba ba mang wa neng bon haa ka baalong yong naane bang mang lie te waneng kye ka* ba mene meng kpi gba. A bong fiin na teng taa na teng mang leɛ di a kaa ba bee a maali ba kuoriyelitarii.

This woman's views about the ineffectiveness of their adaptation strategies in her own words means:

What can we do my son? We don't have money to buy improved seeds. Also, there are not agricultural extension agents to teach us modern ways of farming. Our indigenous ways of farming too are no longer helping us. My son, what can we do again? We always labor throughout the year for nothing. When our sons also migrate down-south to find something to come and support us, they almost always either return empty handed or return with diseases, and some also even die there. The little resources that we have are what we usually use to take care of them or perform their funeral rites.

5.3 Key Informants Assessment of the Effectiveness of Smallholder Farmers' Adaptation Strategies

Key informants were also interviewed on the extent of effectiveness of smallholder farmers' adaptation strategies. These secondary level informants were either farmers themselves or officials working with smallholder farmers, and were, therefore in a position to tell the degree of effectiveness of smallholder farmers' adaptation strategies. Some of the informants interviewed included nucleus farmers, AEAs, agricultural insurance marketing officers, regional representatives of PFAG, ADVANCE, and some educated smallholder farmers.

Majority of the key informants (87%) revealed that smallholder farmers' adaptation measures were effective to some extent. They used different phrases, expressions, and adages to describe the level of effectiveness of smallholder farmers' adaptation strategies, including being "effective to some extent," "effective to a large extent," "effective to a greater extent," and "the adaptation strategies are helpful to farmers." Other phrases expressed included: "I will say they are helpful," "they work very well for them" (smallholder farmers), "the adaptation strategies are helping a lot," "they are not fully effective," and "some of these strategies are helpful." The phrase "effective to some extent" emerged as the most frequent theme. Only four (13%) out of the 29 informants maintained that smallholder farmers' adaptations were not effective at all with none indicating they were 100% effective. These discussants also used phrases such as "I think not," "they are not effective adaptation strategies," "they are not working," and "they are not sustainable" to describe the ineffectiveness of smallholder farmers' agricultural risks management mechanisms.

These two categories of informants adduced different reasons to support their description of smallholder farmers adaptation strategies either as useful to some extent or not being effective at all. Some key informants claimed that farmers' adaptation measures were effective to some extent because the existing adaptation strategies could only partially address a deficit in food security caused by weather/climate and non-climatic stresses. One key informant, for instance, said, "Even though these measures are helping farmers in one way or the other to cope with the adverse effects of bad years, they are not 100% effective". In the words of another informant:

> Yes, they [the adaptation strategies] are helpful to a large extent. Those who are serious, they gain a lot from that [adaptation strategies] like me except as I said earlier, I don't put all my eggs in one basket. Even though I don't farm much, I normally don't fail completely. I have never failed completely in my farming because the weather has never seriously hit me. The only time I failed was in 2013 because of the bad market. So, they [the adaptation strategies] are helpful to us to some extent.

These informants outlined ways their adaptation measures were effective to some extent, i.e., the beneficial and harmful effects. Some of the beneficial effects enumerated were: sale of livestock and poultry birds to buy foodstuff and pay their wards' school fees as well as foot other household expenses, income and foodstuff from migrants, improved yields from the cultivation of short-duration, high-yielding and drought-resistant crop varieties despite the occurrence of weather-related challenges, and agricultural insurance policies cushioning farmers a bit during bad years. One key informant responded that:

> Maybe the migration is helping because what I have noticed when they migrate to the south, they usually manage to get some small income and that income they bring it back and then use it to buy foodstuff and invest the rest [in] their land preparation to make up what they lost the previous year.

The role of migration as an adaptation mechanism revealed gender differences. Whereas male participants mainly reported the benefits of migration, their female counterparts mentioned its positive and negative impacts. Even though both male and female discussants and informants mentioned migrants sending foodstuff and money to support their families back home, female discussants at Duori-Guo added that the migrants sometimes return home sick, and some may even die there or at home and they would have to use the little resources they have accumulated over the years to treat them or perform their funeral rites. Some male participants also indicated that migration, whether seasonal or permanent, may be planned by the family whereas the female participants identified migration only as an adaptation strategy without indicating whether it is planned or not. The male participants were probably able to recognize that migration is a proactive adaptation strategy because males in Northern Ghana mostly make household decisions and may not involve or inform the females. Apart from the gender dimension to migration, the fieldwork also identified region-specific patterns of migration. In the Upper East and Northern regions, females (both married and young girls) mostly migrate to Southern Ghana, especially to Accra and Kumasi as head porters, popularly called "kayaye" in Ghanaian parlance and to also work in food joints and do other menial jobs to support themselves and their families back. This trend never came up in the Upper West region. Some possible hypotheses could be that Northern region is predominantly Muslims with polygamous families with the associated many offspring. The Upper East region is also densely populated (i.e., high population density) with less farmland per head in an agriculturally and climatically unfavorable land. The socio-economic and demographic characteristics of these two regions coupled with the harsh economic conditions mostly trigger migration to Southern Ghana which is economically and climatically more favorable than Northern Ghana. On the contrary, the Upper West region has a comparatively low population density and favorable agricultural lands which may hold back females to assist on the farms with young girls having better opportunities to attend school.

Adaptation strategies being helpful or effective to some extent also implies that they may not be 100% effective or may even be destructive in some ways. For instance, some key informants blamed the partial effectiveness of some of their adaptation strategies on poor seeds, adverse effects of out-migration, and some challenges associated with the drought index insurance being implemented. It became evident from some key informants that agricultural insurance policies are not sufficiently effective. For instance, a nucleus farmer said:

> Sometimes a farmer may encounter poor yields yet will not be compensated. Other times too, the farmer may want the insurance but cannot find the insurance people to cover their farms, unlike the health insurance where the officers always come to us, and we know their offices too. Look, last year like this, I could not insure my farm. The insurance people need to do more than what they are currently doing. There is the need to let farmers know more about the insurance and where we can find them.
>
> Regarding the ineffectiveness of smallholder farmers' agricultural risks management strategies, a key informant said:

> For the galamsey…and migrating down-south thing is not helping them at all. Most of them go there and come with illnesses and all sort of things. That one is not helping them. The animals [livestock] I will say would have helped but now is also turning to fail them because of the thieves.

These quotations demonstrate the ineffectiveness of smallholder farmers' coping mechanisms.

5.4 Determination of the Extent of Effectiveness of Smallholder Farmers' Adaptation Strategies from Questionnaire surveys

A questionnaire survey was also employed to determine the effectiveness of smallholder adaptation strategies. In this regard, respondents were given the option to tick (pre-determined response categories) whether farmers' adaptation strategies were effective, not effective, or effective to some extent (Appendix VIII). Analysis of responses from the administered questionnaires revealed 44% of the respondents indicating smallholder farmers' adaptation strategies were effective to some extent with 19% and 25% saying the coping mechanisms were ineffective and effective respectively. About 12% of the respondents did not indicate whether the adaptation strategies were effective or not (Figure 9).

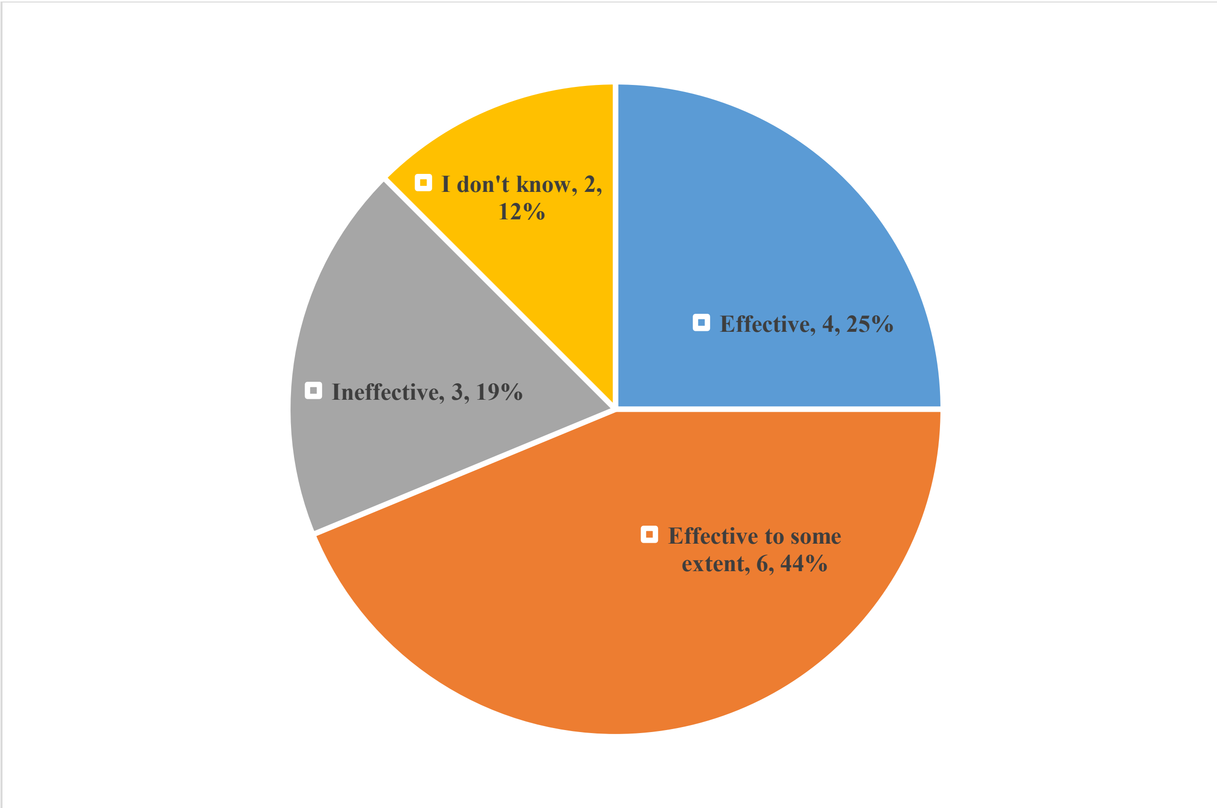


Figure 9: Extent of the effectiveness of smallholder farmers' adaptation strategies

Reasons some respondents cited for the effectiveness of smallholders adaptation strategies included: increased yields from the cultivation of improved crop breeds (i.e., drought-resistant and early maturing crops), income used to buy foodstuff as well as pay for other household expenses from the sale of livestock and poultry products, off-farm jobs, migration, remittances from relatives, secured yields from mixed farming, and crops and farm diversifications.

Some respondents also revealed that smallholder farmers' adaptation strategies were helpful to some extent, especially during difficult years. Some respondents in this category, for instance, mentioned that income from remittances, off-farm jobs, and migrants might not be enough to buy sufficient foodstuff to feed large families, characteristic of most Northern farming households because of their peculiar extended family ties. Some respondents also stated that measures such as improved crop breeds and crop and farm diversifications might be rendered ineffective if there is a catastrophic drought like the one in 1982, 1983, and 2007. To this group of respondents, these adaptation measures can only be useful to some extent.

A few of the respondents revealed that smallholder farmers' adaptation strategies were not effective at all. This category of respondents based their reasons mainly on lack of access to financial services as adaptation measures. They specifically said almost all smallholder farmers lack access to loans from financial institutions as adaptation mechanisms due to the collateral security requirements. A nucleus farmer who had over 30 women out-growers under him said:

> I even used my agricultural insurance policy as a guarantee for a loan and yet was denied and was asked to be making weekly payments as the collateral security. This is the plight of a leader of a group of smallholder farmers, and one can imagine the fate of the women out-grower farmers under me [and other smallholder farmers] once it comes to access to agro-loans.

Even though agricultural insurance has been widely acclaimed as a financial adaptation strategy for farmers, some respondents said most smallholder farmers do not have money to buy agro-inputs and also purchase agricultural insurance policies to cover their farms. In the event of a drought, flood or any natural disaster, such farmers may be unprotected, and could, therefore, suffer yield losses without any form of compensation. Apart from the inability to buy foodstuff and pay other household expenses, such a situation may also affect their farming activities in the following farming season, some respondents explained.

5.5 The Extent of the Effectiveness of Social Safety Nets and Welfare Programs Targeted at Helping Smallholder Farmers in Northern Ghana to Manage their Key Agricultural Risks

The study participants had different views about how effective these social intervention measures are. Majority of the focus group discussants, key informants, and questionnaire respondents maintained that the social safety nets were not effective coping measures with a minute fraction reporting that these safety nets were effective to some extent. Only one respondent (7%) and one key informant (4%) out of the 15 and 29, respectively, claimed that the social safety nets and welfare programs were effective. Those who claimed these safety nets were not effective maintained that these measures and organizations which provided them exist in theory. They cited several instances to buttress their claims. A good number of the study participants maintained that successive governments have established and expanded institutional activities, such as NADMO, LEAP, Fertilizer subsidization programs, and the NPP-led Planting for Food and Jobs (PFJs) and One-District-One-Factory (1-D-1-F), One-Village-One-Dam (1-V-1-D to provide safety nets to affected Ghanaians, especially vulnerable smallholder farmers but whether these institutions and programs are functional or not is another matter.

Using NADMO as an example, most discussants, key informants, and respondents revealed that NADMO only comes in when there are floods and bushfires to the neglect of some direct weather and climate-induced disasters like droughts and crop failures due to pests and disease infestations like the recent (i.e., 2017) fall armyworm (FAW) infestation throughout Ghana. Even with the floods and bushfires, NADMO's intervention in the provision of ex-post support is not covering all farmers' losses, some discussants and key informants asserted. For instance, one key informant said:

> I don't think there is any support. There is no support. The farmer is left to his fate. NADMO doesn't come in when there is drought. NADMO doesn't come in when there is a bad market. NADMO may come in if there is a disaster like you harvest and fire burns everything. But even then, I know of a case in Daffiamah [Daffiamah is a farming community] where someone heaped his very large [pile] of corn and somebody set fire to it, but NADMO never went to his rescue. So, NADMO is just there as a political organ that wants to win votes by going to some few individuals. It doesn't help the farmers at all

The above quotation re-echoes the views most participants held about NADMO. Most discussants, informants, and respondents claimed that NADMO is a political organization and lacks resources and logistics to execute its statutory functions.

Focus group discussants at Duori-Guo and Kazigo and some nucleus and educated key informants believed that other non-profits, projects, and development partners are more efficient and effective than NADMO. In answer to the extent of effectiveness of smallholder farmers' social protection and safety nets, a male discussant at Kazigo said:

> Yes, it has happened [i.e., we have received support] from Catholic Social Center at Navrongo. [We] went there for some food [and other forms of support, including] beans, corn, oil, flour, and zinc. It has helped us a lot. After we got [the] food, …we used it to feed ourselves and families. That very day and the rest of the days, we had food to eat. We also preserved our assets [did not sell our assets] which we would have [sold] to buy zinc.

The same question was posed to focus group discussants at Duori-Guo, and in response, a female discussant reported that:

> No, we [have never had] any form of support from NADMO here [in Duori-Guo]. We only heard about it, but we have never seen [them] …in this community. Sometimes [ago], I heard they were giving six hundred Cedis [Gh₵ 600.00, i.e., $140] to each household in the next community down there, but we have never received it.

From the above quotations, NADMO was not mentioned at all by the Kazigi focus group discussants. In the second case, NADMO was mentioned, but it never assisted the Duori-Guo community members in any way. However, the Navrongo Catholic Social Center was mentioned as one of the non-governmental sector agencies supporting vulnerable farmers to cope with adverse effects of bad years. Even then, cushioning from non-profits and projects is not very effective because of a large number of farmers that may be affected in the event of a covariate disaster, some study participants claimed. Because of the ineffectiveness of the existing social safety nets, many key informants and discussants are recommending the re-visit of the indigenous safety nets that have been abandoned to complement the limited efforts of NADMO, non-profits, projects, and other development partners.

Chapter 6: Results on the Role of Agricultural Insurance for Crop Risks Management in Northern Ghana

6.1 Introduction

My third research question was formulated to explore agricultural stakeholders' perspectives on how agricultural insurance has been or can support smallholder farmers to management some of their key crop risks. As a three-layered study; involving focus group discussants, key informants, and questionnaire respondents, these participants were asked to either enumerate or rank the ways AIPs and policies have been or can assist smallholder farmers to address some of their key agricultural risks. By this arrangement, focus group discussants and key informants were contacted to enumerate the ways agricultural insurance has or can support smallholder farmers to manage their major agrarian risks. Survey respondents were also requested to rank the roles and potential of agricultural insurance contracts and programs for crop risks management. Because of the ranking and exploratory nature of this part of the research, views of discussants and key informants on the role of agricultural insurance were discussed together, and rankings of survey respondents analyzed as a stand-alone section. The rest of the chapter is organized into general agricultural insurance issues and the specific roles of agricultural insurance for crop risks management as presented below.

6.2 General Agricultural Insurance Issues Captured from the Fieldwork

An exploration of the role of agricultural insurance for smallholder farmers' crop risks mitigation yielded interesting, unexpected, and surprising findings. In addition to my formal data collecting methods such as FGDs, KIIs, and questionnaire surveys, I also had meetings with some key stakeholders in the financial and agricultural sectors. I was also invited to participate in a WC's Open House Event in the UWR where WC staff delivered presentations on their agricultural insurance progracts and activities. I was also allocated a slot to talk about my research in Northern Ghana and agricultural insurance in general (Figure 10).

Figure 10: John Bosco, the Researcher briefing the audience about his research and contributing to the discussion at a WorldCover's Open House Event in the UWR, Wa

These interactions afforded me the opportunity to deepen my understanding of agricultural insurance issues in Ghana. For instance, I got to know about WC (the second agricultural insurance company in Ghana-AIC) the first time through snowballing when I was pre-testing my sampling strategies and data collection instruments. Before commencing my fieldwork, I was aware of only GAIP as the sole AIC operating in Ghana. I found that WC was actively piloting DII with smallholder farmers in Northern Ghana, using a variety of awareness creation and service delivery channels such as community visits, mobile telephony technology (i.e., SMS), radio discussion programs, jingles, and Open House Events. I also observed that WC uses a very efficient agricultural insurance service delivery model that links its national/zonal office in Tamale to the three Northern Regional Capitals- Wa, Bolgatanga, and Tamale where the offices are located, Districts and business communities through Field Associates (FAs), and community focal/contact persons. The model has a strong collaborative arrangement and works from the Regional Coordinator (RC) through the Regional and District MOFA offices (working with MOFA Directors and AEAs), FAs, and community contact persons to insurable smallholder farmers. The spatio-organizational structure of the WC model shows a strong decentralized service presence at the grassroots or community level.

GAIP is also a collaborative arrangement between nineteen members of the GIA and the government of Ghana. This AIP is a baby of the erstwhile IIPACC which first piloted weather index insurance in Ghana. This agricultural insurance scheme started marketing insurance products in 2011 in Northern Ghana. GAIP has now up-scaled to cover the entire country with visibility mostly in urban areas. This agricultural insurance program first marketed AYII products and subsequently added DII, MPCI, poultry products, plantation/tree crop protection, and livestock insurance. This insurance scheme also has a spatio-organizational configuration from its National Office through the three Regional Marketing Offices to other agricultural stakeholders, mostly in the private and informal sectors. GAIP's marketing strategy relies heavily on riding on the backs of farmer-based and related organizations (FBOs) such as ADVANCE, ESOKO, MIDA, AGRE-CARE, nucleus and out-grower farmer arrangements. MOFA, which is the statutory body responsible for managing Ghana's agricultural sector does not feature prominently in GAIPs collaborative arrangements with stakeholders in the agricultural sector, whether at the National, Regional, District, or Community levels. This casts clouds on GAIP's visibility and presence at these levels. Some GAIP staff attributed the situation described above to inadequate funding, lack of the requisite human capital, high attrition rate, and logistical constraints among other factors.

Discussants, informants, and other agricultural insurance stakeholders were unanimous that the intention of the AICs are good but expressed concerns that some challenges were militating against the realization of these goals. Some of these challenges they mentioned as limited geographic coverage, limited awareness creation programs, poor understanding of agricultural insurance issues (espeically index-based insurance), lack of coverage for many crops, lack of frequent monitoring visits by the insurers, and the effect of basis risk and other downstream challenges among other constraints. Some holders of DII policies in the focus group communities whose crop yields fell below their expectations (e.g., Duori-Guo and Kazigo) wished they had been compensated. They were, however, honest to admit that their losses were due to other perils such as fire, crop pests and diseases (e.g., the fall armyworm), soil infertility, and destruction of their crops by livestock rather than drought or inadequate rainfall, which they insured against. Some discussants at the Duori-Guo and Kazigo FGD sessions, however, said they were not happy that the agricultural insurance staff did not come to sympathize with them about their yield losses as people working together. Despite these challenges, most discussants and key informants who were farmers themselves indicated their readiness to continue to subscribe to the insurance policies in order to observe the insurers for some time to see whether they are there to protect farmers' risks on a win-win arrangement or "they are like other insurance schemes which like collecting premiums but begin to drag their feet, quoting big laws, and engaging in litigation antics when it is time to pay compensation," one key informant concluded. A male discussant during the Duori-Guo community FGD said in Dagaare that :

> *Ka ba nang wa, te hon naa da la. Te ba mene wuli teng ka ba ba ngeɛɛrɛ dɔɔ da yeni onzoro. Ka hong e dɔɔ yɛng, ho mang aring wulee ho dɔɔlong fee kyɛ ka ba nang wa toɔbo, hong pang zo. A gbɛre bonaare soba engɛng hong man zo. A le zuing, ka ba nang la wa., te naa da la.*

This quotation directly translated means:

> If they [the insurers] come, we will buy again. Our fathers taught us that a man does not run away if he is beaten the first three times. As a man, he stands to fight back until he is defeated the third time before you can then run away. Because of what our fathers told us, if they come, we will buy again.

A Regional Director of ADVANCE who is collaborating with GAIP to provide coverage for his farmer-clients said he has been explaining to his farmers to understand that the problems associated with agricultural insurance programs and contracts are common with every new program and that they should understand that and continue to insure with GAIP. On the contrary, another Regional Director of ADVANCE disclosed that he relaxed his collaboration with GAIP because when insured farmers experience losses, GAIP does not compensate them. He further revealed that his client-farmers are losing trust in him because they claimed he has been deceiving them to throw away their monies because when they pay the premiums, and it is their turn to be paid compensation, GAIP reneges. However, this may be due to the effect of basis risk.

The only exception in the UWR was a female key informant whose groundnuts failed, and she did not receive any payout from GAIP because of basis risk. In my interview with her, she was virtually crying and swearing never to purchase any insurance contract again. She also said she would discourage any person who wants to buy agricultural insurance policies. I cross-checked this finding with a RAIMO of GAIP in the UWR, and he confirmed it. These preliminary findings are relevant for a study exploring agro-stakeholder views on the potential of agricultural insurance for crop risks managementcrop risk management.

6.3 Determining the Role of Agricultural Insurance for Crop Risks Management among Smallholder farmers in Northern Ghana by Focus Group Discussants and Key Informants

Discussants and key informants revealed an array of ways agricultural insurance companies operating in Northern Ghana have been assisting smallholder farmers to manage some of their agricultural risks. Generally, discussants and informants claimed agricultural insurance policies have been protecting insured farmers' crop production risks. The specific ways agricultural insurance has been helping smallholder farmers to address their agricultural production uncertainties are discussed in detail below.

Focus group discussants and key informants identified eight broad ways or themes agricultural insurance can or has been assisting smallholder farmers to manage some of their crop risks. These are: 1. Motivation to increase crop production, 2. Protection of farm investments, 3. Provision of agricultural insurance and agricultural-related information, 4. Promoting food security, 5. Promoting access to financial services, 6. Revenue mobilization for national development, 7. Ensuring stability and sustainability in farming undertakings, and 8. Enhancing agricultural planning.

6.3.1 Motivation to Increase Crop Production

Most focus group discussants and key informants revealed that protection by drought index insurance (DII) and multi-peril crop insurance policies (MPCI) motivates smallholder farmers to increase their agricultural production. These participants reported that their motivation to increase crop production was premised on the fact that they would be reimbursed in the event of a drought or an insured peril occurring. They, therefore, claimed they do not fear increasing production. Other participants indicated the agricultural insurance policies boosted their confidence to expand their farm sizes because if the trigger event occurs, they would be compensated. This assurance, therefore, makes them comfortable and confident in their farming undertakings. Many statements discussants and key informants made attest to this fact. For instance, a male focus group discussant from the Kazigo community said:

> Having insurance policy motivates insured farmers to increase productivity and production. You know if people are sure that in case of disaster, help will come from somewhere, they will even do more. They will produce more. It motivates them to do more.

In the words of a key informant from the UWR:

> agricultural insurance has risks protection function and also provides comfort**.** Also, there is this thing [that is, comfort], I don't know the word to use. There is a comfort that your life is not gone forever in case a disaster strikes [because] you are aware that there is insurance like we have our vehicles [insured], knowing that if you have money to do a full insurance, [i.e., comprehensive insurance] and if something happens, the insurance company will replace the vehicle for you. There is that comfort.

6.3.2 Protection of Farm Investment

Some study participants also maintained that their goal for participating in agricultural programs is to protect their farm investments. According to them, they usually purchase agro-inputs such as hybrid seeds, chemical fertilizers, and weedicides among other inputs. Sinking all these resources into agriculture is a hefty risk to take, they claimed. In describing the seriousness of their agricultural risks and the need to protect their farm investments, a male discussant from the NR said:

> Just imagine preparing the farmland, tilling it yourself or with hired labor, taking a loan to buy expensive hybrid seeds, fertilizer, condemn [a type of weedicide] and not knowing whether it will rain or not. Is it not a high risk the farmer is taking? There is, therefore, [the] need to protect the investment

This quotation implies that buying agricultural insurance policies to cover farming activities constitutes secure protection for farmers' investments. Other discussants and key informants expressed similar views in the Upper East and West regions.

6.3.3 Provision of Agricultural Insurance and Agricultural-related Information and Education

Most focus group discussants and key informants revealed that GAIP and WorldCover have been providing them with information and education on agronomic practices and agricultural extension in general and agricultural insurance in particular. To these participants, these educational messages are sent to insured farmers through community outreach activities, workshops, short message services (SMS), voice messages, jingles, and radio discussion programs. Discussants at Duori-Guo, Kazigo, Nyankpala, and some AEAs and insured informants claimed they have been receiving information on weather patterns, good agronomic practices, types of agricultural insurance policies, the importance of agricultural insurance, and marketing opportunities. The study participants mentioned ESOKO, GMA, AEAs, FM stations, the newspapers, nucleus farmers, and some agro-input dealers as some of the organizations GAIP and

WC have been collaborating with to provide education on agricultural insurance and agro-meteorological, extension, and agronomic issues among smallholder farmers. For example, the Upper West Regional Director of ADVANCE who is supporting smallholder farmer with agricultural value chain activities and linkages said:

> I agree with what Jayden and Jaylen (pseudonyms) with GAIP have been telling the farmers. What [insured farmers] have to expect is that they have to do the right thing before they can be paid [receive payout) by GAIP. You see, the insurance companies should continue to sensitize the farmers to know that what they [GAIP] pay them [farmers] is just compensation [for a specific risk]. So, it cannot meet all [their] expenses and [maybe] expected yields. So, it is better for the farmer to make sure that all the best practices are adhered to than to focus all his [or her] mind on insurance to come and pay in case there is a failure.

They also claimed that the agricultural insurance marketing officers often use the community outreach window to explain models of agricultural insurance, their operational activities, and premium and claims payment procedures. Some RAIMOs interviewed confirmed the discussants' and informants' assertion by saying that they (the RAIMOs) normally use their education and information sharing platforms to educate farmers on issues of basis risks and the strategies they have instituted to overcome them. For instance, WorldCover (WC) organized an Open House Event (OHE) in Wa, the Upper West regional capital to sensitize current and potential clients on its products, operational model, customer journey, and to let stakeholders know where to locate WC staff and office. This OHE coincided with my fieldwork in Ghana, and I was invited to participate and share some thoughts on agricultural insurance from the academic perspective (Figure 11).

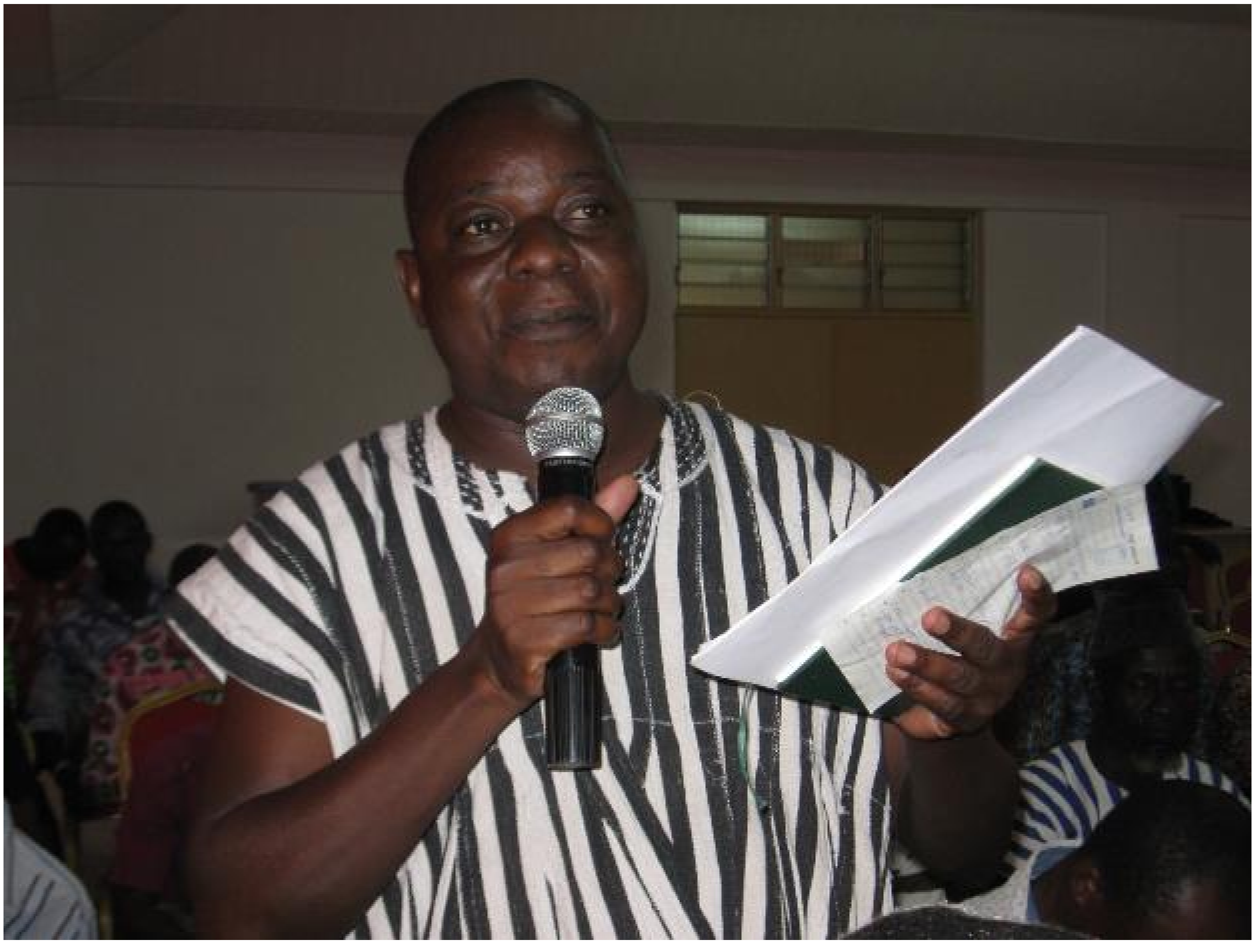


Figure 11: WorldCover Open House Event with John Bosco (The Researcher asking a question)

Despite efforts to educate smallholder farmers on agricultural insurance, key informants and discussants were unanimous that much is not being done to reach out to many smallholder farmers. For instance, when discussants and key informants were asked about the percentage of farmers who were aware of agricultural insurance at the time of the fieldwork, a lot of them estimated between 0.2%- 5%.

6.3.4 Ensuring Food Security

Some of the study participants mentioned that their decision to purchase agricultural insurance policies was to ensure food security for their families. For them, making sure that food is always available for the family is more important done other considerations. A key informant, for instance, said:

> The agricultural insurance [companies] gave us the opportunity to insure our farms against drought. You have your peace of mind when you insure your farm because when your crops fail…, you will be compensated so that you can buy foodstuff for your family.

In the words of another key informant:

> I think in the event of drought, farmers can get compensation that can help them [to] pay their wards' school fees, yes, and it can help them feed [their] families too. It can [also] help them put some money back into their pockets.

6.3.5 Financial Risk Protection and Provision of Other Services

It was revealed from my fieldwork that some farmers who cannot finance their agricultural activities upfront and cannot also get help from other sources usually require loans to procure agro-inputs such as hybrid seeds, chemical fertilizers, farming implements, and other agro-chemicals. As a risky investment, financial institutions often need adequate collateral to be sure that they can recoup their monies in the event of crop failure, some study participants revealed. Unfortunately, most smallholders do not have the necessary landed property to pose as collateral for loans, they claimed. Some informants indicated that agricultural insurance policies could be used as collateral for agrarian loans from financial institutions. In the event of insured crop failure, farmers will either utilize compensation received from the insurance companies to settle their indebtedness to the financial institutions, or the insurance companies may pay the financial institutions on behalf of their insured farmers, depending on the arrangements entered into in the contract, some discussants and informants averred. For example, an agricultural insurance staff revealed that:

> I know with insurance, banks will be willing to give loans to farmers since they may no longer be afraid because if anything happens, they know the insurance companies will pay them, or the insurance companies will pay the farmers for them to also pay the banks. Apart from providing a guarantee for you, I know it also enhances your ability to repay credit in years of bad yield and provide additional security for the banks too.

In addition to acting as collateral, some focus group discussants and key informants claimed that their participation in agricultural insurance programs also promotes access to financial and other agro-related services such as cash grants, agro-inputs, and tractor services. For example, it was revealed that some smallholder farmers needed to purchase drought index insurance before they could access cash grants from some NGOs and projects. Some nucleus farmers also require out-growers under them to hold agricultural insurance policies before they could grant them agro-inputs such as improved seeds, tractor services, and chemical fertilizers on credit. It also came out that some nucleus farmers are prepared to pay the premiums on behalf of their out-growers with the agreement that the latter pays back in-kind with farm produce after harvest. According to one key informant:

> [Agricultural] insurance can enable [smallholder farmers] … to qualify for specific benefits. Because there are some organizations that provide services on credit …[including] agro-inputs and tractor services, but they also fear that if they do so and the crops fail, they might not be able to get their monies back. So, they prefer to work with only people who have insured their crops [farms].

Regarding responses as to how agricultural insurance can be used as collateral for agro-loans, my study participants can be categorized into two groups; those claiming agricultural insurance can facilitate financial inclusiveness (i.e., access to loans) and those saying the contrary.

The former mainly comprised agricultural insurance staff and some aggregators (e.g., financial institutions GAIP is working with (e.g., the Bonzaali Rural Banks in Kumbungu and Tamale) and the latter represents insured farmers. For example, a nucleus farmer in the UWR who wanted to use his insurance contract as collateral for an agro-loan was denied the credit facility by the financial institution and demanded weekly cash deposits as the acceptable collateral security. Even though there could be other reasons beyond the collateral requirements such as the type of financial institution involved, and the amount of loan requested which I did not probe further due to time and other constraints. Similar concerns were expressed hypothetically and not backed by any evidence like the case of the nucleus farmer just mentioned. Therefore, the role of agricultural insurance in providing access to agro-loans may be theoretical, especially among smallholder farmers in Northern Ghana.

6.3.6 Revenue Mobilization for National Development

Some benefits of agricultural insurance are external to the insured farmers (indirect benefits) with the potential to promoting national growth and development. In this regard, some discussants and key informants said agricultural insurance mobilizes resources for national development. According to this group of participants, agricultural insurance companies mobilize funds through the collection of premiums which they normally (AICs) use to compensate farmers when the trigger events occur. During good years, there may not be the need for insurance companies to pay compensation, they asserted. Therefore, the premiums generated could be channeled into other investment potfolios, programs, and projects within the national economy, they claimed. Apart from contributing to economic growth and GDP, such development projects and programs could also provide employment avenues and payment of taxes which could feed into the country’s development process or cycle, a key informant revealed.

For instance, one key informant in the UWR reported that:

> There is also the other good path to the nation that the insurance monies will be [used] to develop the nation. Is just insurance but it is not definitely that everything must be destroyed and the insurance will pay. [Therefore], agricultural insurance is also a revenue mobilization window for national development.

Some staff of GAIP and WC also confirmed the role of AICs in mobilizing resources for national development. Apart from building a pool for possible future claim payments, part of premiums accumulated could be invested in other projects, which some key informs referred to as national development.

6.3.7 Providing Stability and Sustainability in Farming Undertakings

Agriculture, as practiced by smallholder farmers, is highly risky and can easily be destabilized by calamitous events, including covariate weather and climate-induced hazards, an AEA claimed. For instance, this AEA maintained that "a drought or flooding event at a critical period in the farming season or critical plant growth period could destabilize farmers." Based on this submission, agricultural insurance may act as a bridge between bad years and good years, thus, providing stability in the agricultural continuum or cycle, some of the study participants averred. According to them, during periods of drought or crop loss, farmers usually find it difficult to survive through the lean season till the next farming cycle. To these discussants and key informants, even though there are usually adaptation strategies such as support from relatives, the reliance on wilds fruits and vegetation, food rationing, the sale of livestock, and out-migration as a last resort; such coping mechanisms are not sustainable in the long-term. Some participants were, therefore, of the view that agricultural insurance does not only offer sustainable solutions to agricultural problems but also provides stability in the agricultural industry year after year, hence, their decision to purchase agricultural insurance policies. To them, income from compensation has been and can be used to prepare the agricultural land, purchase agro-inputs, and pay for farm labor in preparation towards the next farming season. Without agricultural insurance, farmers own savings, and other adaptation strategies, farmers may not have the needed resources to continue with their farming activities in the next farming cycle, they averred. This situation often results in a mass exodus of farmers to southern Ghana in search of non-existent greener pastures with the attendant consequences, they claimed. Some focus group discussants at Duori-Guo said the 2007 drought forced most of their active young men to emigrate to B.A. (Brong Ahafo region) to labor for wages.

6.3.8 Enhancing Agricultural Planning

Some focus group discussants and key informants also said their participation in agricultural insurance programs can enable them to plan for the next farming season. For drought index insurance, the GAIP marketing officers interviewed revealed that the deactivation period usually starts at the end of August. In the case of WorldCover, the staff (key informants) explained that the deactivation period varies from community to community depending on when the activation period starts and the types of crops grown. Following the end of the activation period, insurance marketing officers usually receive satellite rainfall data from their head offices in Accra and Tamale to share with insured farmers. From the data, insured farmers will be informed whether they met the threshold for compensation or not, they revealed. Educated and informed insured farmers can also interpret the data to determine whether the trigger has been reached or not, an agricultural insurance staff (informant) revealed, thus, ensuring transparency, accountability, and building trust, another key informant claimed.

I gathered from both GAIP and WorldCover staff that they normally hold their concluding meetings with insured farmers before November and those qualified for compensation paid immediately, especially if the policies were weather index-based. The timely payment of compensation was corroborated by some key informants in the Upper West region. With the assurance and prompt payment of claims, insured farmers can plan on how to use the claims received, including preparing for the next farming season, some key informants maintained.

6.4 Determining the Role of Agricultural Insurance from Survey Respondents

The ways agricultural insurance can support or enable farmers to cope with their agricultural risks have been documented in the literature (as discussed in chapter 8). I also used my service learning project and pre-testing of my data collection methods to gather some roles of insurance for crop risks management in Northern Ghana. Survey respondents were then asked to rank these pre-determined roles of agricultural insurance in the light of how they can help smallholder farmers to cope with their key agricultural risks in Northern Ghana (Figure 12).

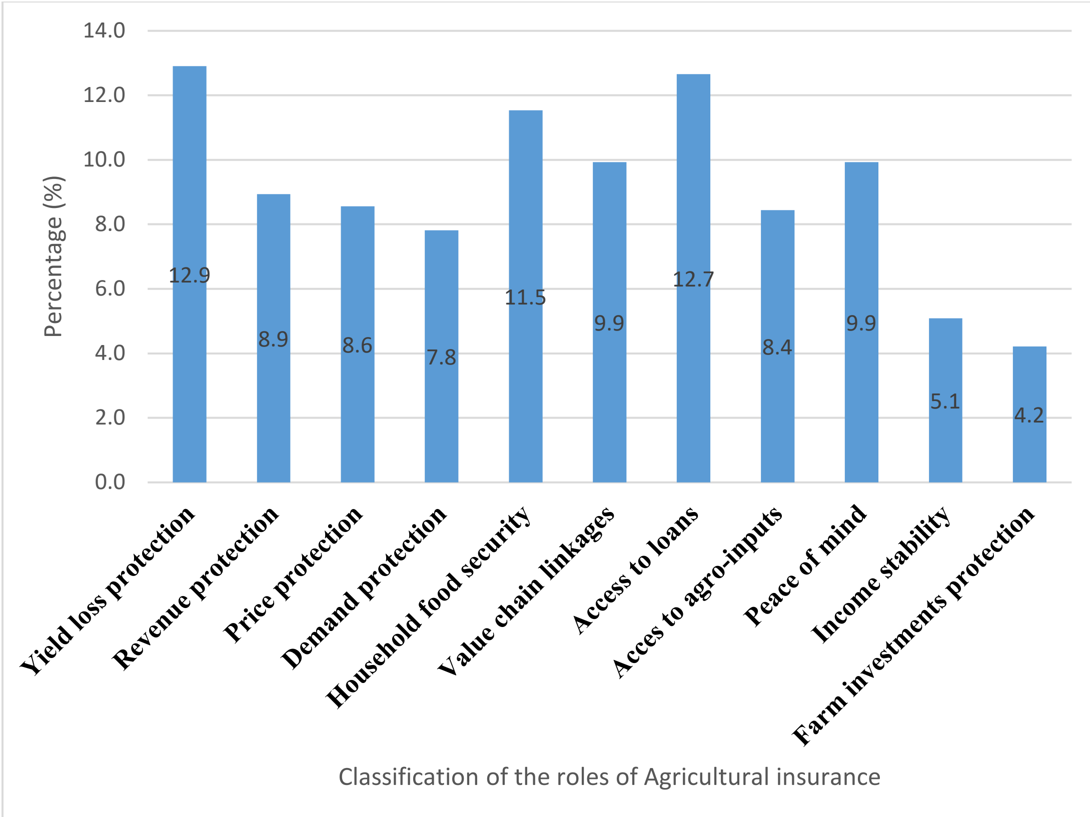


Figure 12: Bar graph showing respondents' ranking of the roles of agricultural insurance in Northern Ghana

To ensure convenient analysis and comparison of the scores, frequencies or the rankings for each crop insurance function (role) was multiplied by an appropriate weight to arrive a quantifiable value or index. These values were summed up and the proportionate percentages or scores established for each role. The role of agricultural insurance in protecting farm yield loss(es), access to agro-loans, and food security were ranked 12.9%, 12.7%, and 11.5%, thus, attracting the highest rankings. (Figure 12).

Chapter 7: Exploring Stakeholder Perceptions on the Potential of Agricultural Insurance for Promoting Sustainable Farming Practices and Climate Change Mitigation in Northern Ghana

7.1 Introduction

My fourth and last research question investigated the potential of agricultural insurance for promoting sustainable agricultural practices and climate change mitigation. It specifically explored the willingness of AICs and smallholders to promote and engage in agro-ecological farming practices and climate change mitigation. This chapter has been organized into two sections, namely, how agricultural insurance can promote sustainable farming practices and climate change mitigation in Northern Ghana from the perspectives of focus group discussants and key informants on the one hand, and those of survey respondents on the other hand.

Apart from agricultural insurance being employed to manage direct agricultural challenges world over, including climate-induced agrarian risks, it also has the potential for promoting climate change mitigation and sustainable farming practices. Sustainable farming systems and methods as used here include agro-ecological farming systems, agro-forestry, climate-smart agriculture (CSA), and conservation agricultural practices. There is, however, an intersection in meaning between these concepts, and as such, will subsequently be used interchangeably in this section.

7.2 Perspectives of Focus Group Discussants and Key Informants on how Agricultural Insurance Can Promote Sustainable Farming Practices and Climate Change Mitigation among Smallholder Farmers in Northern Ghana

To determine the potential of crop insurance in promoting climate change mitigation and sustainable farming systems, I asked focus group discussants and key informants' three separate questions. First, they were asked to indicate smallholder farmers 'willingness to engage in agro-ecological farming practices if provided with subsidized crop insurance policies. Secondly, the discussants and key informants were asked about their willingness to patronize crop insurance services if the agricultural insurance policies were bundled with agro-ecological farming systems and practices (i.e., without subsidies). Thirdly, they were further asked to indicate their motivations or reasons for promoting and engaging in agro-ecological farming systems and climate change mitigation. Responses to these questions were then used to determine the study participants willingness to promote and engage in sustainable farming practices with the potential for climate change mitigation. The ways smallholder farmers and AICs can contribute to sustainable agriculture and climate change mitigation are categorized into the themes analyzed below.

7.2.1 Engaging in Sustainable Farming Systems and Practices and Climate Change Mitigation

Most focus group discussants and key informants revealed that engaging in sustainable farming systems and practices could contribute to food security and climate change mitigation in Northern Ghana in the medium to the long-term. They added that most farmers were already incorporating some of these agro-ecological agricultural practices into their farming activities. They used different names, phrases, and expressions to reflect and describe these farming practices and systems such as "conservation agriculture," "sustainable farming systems and practices," and "climate-smart agriculture." Some focus group discussants also described their farming practices, some of which fall under the agro-ecological farming systems and practices even though they could not directly link them to sustainable farming practices and climate change impact and mitigation. However, a few discussants in Duori-Guo and Kazigo could relate their farming systems to their socio-economic and environmental benefits (e.g., increased yield, increased soil nutrients, as sources of food and income, attracting rainfall etc.) and adverse environmental impacts (e.g., indiscriminate bushfires and felling of trees, maladaptation, i.e., the sale of firewood and charcoal as alternative livelihood strategies which may promote further climate variability/change and environmental degradation) and their overall implications for climate change impact and mitigation.

My fieldwork revealed a variety of farming practices and systems smallholder farmers in Northern Ghana have been undertaking over the years. They include both sustainable farming systems such as agro-forestry, zero and minimum tillage, conservation agriculture and unsustainable agricultural practices, including mono-cropping and slash and burn practices (Table 12). In response to their motivations for practicing agro-ecological farming systems, discussants and informant gave a litany of benefits, including the provision of food, generation of income and employment (especially for women), as a source of soil nutrients, provision of traditional/herbal medicine, control of soil erosion, and improved crop yields among other motivations (Table 12).

<table>
<tr><th colspan="3">Table 12: Smallholders' farming systems and practices in Northern Ghana</th></tr>
<tr><th>No</th><th>Smallholders' Farming Systems in Northern Ghana: Both Sustainable and Unsustainable Systems/Practices</th><th>Smallholder Farmers’ Motivations for Engaging in Sustainable Farming Systems and Practices</th></tr>
<tr><td>1.</td><td>Mixed farming</td><td rowspan="7">-Source of food-fruits, vegetables, oil, etc.
–Source of local/traditional spices
-Sources of income
-Source of soil nutrients-increased soil fertility
-Sources of employment and small-scale trading, especially for women</td></tr>
<tr><td>2.</td><td>Agro-forestry/planting of trees</td></tr>
<tr><td>3.</td><td>Limited shifting cultivation</td></tr>
<tr><td>4.</td><td>Subsistence farming</td></tr>
<tr><td>5.</td><td>Cover cropping</td></tr>
<tr><td>6.</td><td>Geographic farm diversification</td></tr>
<tr><td>7.</td><td>Crop rotation</td></tr>
</table>

<table>
<tr><td>8.</td><td>Compound farming</td><td rowspan="14">-Provision of nutritional benefits
-Reduction in drudgery and labor budget
-Provision of shade
-Trees attract rains
-Trees as source of firewood/charcoal
-Increased crop productivity
-Less use of chemical fertilizer (i.e., use of organic manure)
-Maintenance of soil micro-organisms
-Compliance with traditional agricultural conventions and practices
-Trees serve as windbreaks
-promoting sustainable agricultural culture
-Source of herbal and traditional medicinal
-Sustenance of smallholder farmers
-Improving human health
-Agro-ecological farming offers a learning opportunity
-Sustainable agricultural growth and development
-Reduction in environmental degradation</td></tr>
<tr><td>9.</td><td>Non-cutting of economic trees</td></tr>
<tr><td>10.</td><td>Non-destruction of sacred groves</td></tr>
<tr><td>11.</td><td>Non-burning of crop residue</td></tr>
<tr><td>12.</td><td>Zero and minimum tillage practices</td></tr>
<tr><td>13.</td><td>Contour plowing</td></tr>
<tr><td>14.</td><td>Integrated weed and soil management, e.g., planting macuna to control weed, soil erosion, and flooding.</td></tr>
<tr><td>15.</td><td></td></tr>
<tr><td>16.</td><td></td></tr>
<tr><td>17.</td><td></td></tr>
<tr><td>18.</td><td></td></tr>
<tr><td>19.</td><td></td></tr>
<tr><td>20.</td><td></td></tr>
<tr><td>21.</td><td></td></tr>
</table>

Note. Source: Constructed from field data, 2017/2018

7.2.2 Bundling Agricultural Insurance Policies with Adoption of Sustainable Farming Systems and New Agricultural Technologies

The question regarding bundling agricultural insurance policies with sustainable farming practices generated a different set of responses from the agricultural insurance staff (informants) and other discussants and informants. The agricultural insurance staff, for instance, indicated their willingness to bundle agricultural insurance contracts with sustainable farming practices. To these informants, this may reduce their (AICs') liabilities in the medium to long-term in the case of DII contracts and those of MPCI policies in the short-term. To them, integrating sustainable farming practices into agricultural endeavors will ensure the medium to long-term profitability and sustainability of the agricultural insurance companies and industry at large. They, however, added that coupling agricultural insurance policies with sustainable farming practices requires re-designing their existing programs and products and incorporating same into newly designed programs and contract. The customization of AIPs and contracts to accommodate this new role or function requires addition work and resources, and as such, involves additional costs. This requires collaborative efforts and funding between AICs, the government, and international development agencies, some study participants averred.

Most discussants and informants expressed their willingness to engage in sustainable agricultural practices if bundled with agricultural insurance policies. They claimed that even before the advent of agricultural insurance, they were already practicing some of these agro-ecological farming practices such as non-destruction or clearance of economic trees, mixed farming, multiple cropping, cover cropping, crop and land rotation, and protection of sacred groves and culturally important and sensitive ecological sites (Table 13).

Smallholder farmers also indicated their readiness to incorporate new agro-technologies such as minimum and zero tillage and integrated pests and soil management practices (e.g., planting of macuna to control soil erosion, weeds, flooding, and soil erosion). Whereas most focus group discussants did not mention the relationship between sustainable farming practices and climate change mitigation directly, some discussants and key informants such as AEAs and staff of ADVANCE, GMA, and AICs did. Some members of the latter group explained that agricultural practices such as agro-forestry, non-burning, and minimum/zero tillage practices have the potential to sequester carbon and reduce the emission of CO_2 and other greenhouse gases into the atmosphere. Some study discussants and informants further reported that smallholder farmers stand to benefit if they integrate these farming systems and practices into their agricultural activities.

7.2.3 Bundling Agricultural Insurance Contracts with Agro-Inputs and Market Access along the Agro-Value Chain Gradient

The field investigations revealed farmers' willingness to incorporate sustainable farming systems and climate change mitigation activities into their farming practices if AICs bundle their policies with the provision of agro-inputs, market access, and other agro-value chain linkages. From the fieldwork, inadequate access to agro-inputs and market were ranked high among other agricultural risks (Tables 4-9). These challenges were linked with reduced yields, post-harvest losses, low income, and poverty. As a way forward, the study participants suggested AICs and their collaborating partners linking smallholders with agro-input dealers (aggregators such as hybrid seeds, fertilizers, and pesticides dealers) and agricultural markets (such as agro-processors, agri-businesses, food suppliers, and buffer stock companies). With these arrangements, smallholder farmers may have access to agro-inputs and markets for their farming activities and produce, respectively, thus, solving some of their key agricultural problems, these study participants indicated.

7.2.4 Instituting Awareness Creation and Sensitization Programs on Sustainable Farming Practices and Climate Change Mitigation

Focus group discussants and key informants also saw sensitization and awareness creation as another way interest of smallholder can be whipped to engage in the agro-ecological farming practices, CSA activities, and climate change mitigation. Even though some discussants were aware that some of their sustainable farming practices could contribute to climate change mitigation, they claimed they were open to learning new practices and technologies that could ensure sustained agricultural productivity. To support this claim, a focus group discussant at Duori-Guo used a metaphor that says:

> *N bie, mɔɔ bang ka ti nii yɛng zɔngni na ti wɔ. Yɛ bang na nang gaa sakuu teng mang kaara, a gangaahaa, a kuoriba karikyiri. Ka ba nang wa yeli ka te tu kye ka be ka te koɔbo yɛlɛ na taa nenbiri, be teng mang tu. Ho ba nyɛɛ, panpana ba ye ka kondɛm so mang bonso koo mang kuɛ a muo haa teng aan bori eng daadaa. Te ba mang la kɔ neng kue bee trɔtare. Teng aangtuaa be kyɛ mang la yong saseɛng kaa kondɛm ba soma. Panpana te pang bugee. Te ba la bang lɛ te nang na e.*

To translate, he said:

> My son, you know that we are blind people. We rely on those of you who have been to school, especially the agricultural extension agents. If they advise us to do anything that will lead to improved yields, we do exactly that. You see, now, we are told to use a type of weedicide called “condemn” that kills all the weeds, and we don’t need to use hoes or tractors to plow the land [Zero tillage] before we sow. We are doing exactly that, but we

also heard on air (FM station) that the weedicide is not good. We are now confused and don't know what to do.

All the key informants agreed that sensitizing smallholder farmers to engage in sustainable farming practices can contribute to climate change mitigation. Some key informants such as AEAs, nucleus farmers, GMA, ADVANCE, and PFAG staff reported that they have been educating smallholders about CSA practices, agro-ecological agriculture, and other sustainable farming practices. Whereas the Upper West Regional Director of ADVANCE said he has been teaching his farmers about Zero and minimum tillage (he actually showed me their rippers), the Regional Representative of PFAG also indicated his association has been sending their members (peasant farmers) to their agro-ecology demonstration farms at Kintampo in B. A (Brong Ahafo Region) and Isaac Baaba's Farm at Paga in the UER to learn about sustainable farming practices.

7.2.5 Accessing Climate Change Mitigation Funds to Provide Subsidized Green Insurance Contracts

Some key informants suggested that AICs and schemes could collaborate with the relevant stakeholders to access climate change adaptation and mitigation funds from both national and international sources. They claimed AICs could partner with Ghana's Ministry of Environment, Science, Technology, and Innovation (MESTI), EPA, Forestry Services Commission (FSC) and other relevant agencies, NGOs, and projects to develop proposals to access funding for agro-based climate mitigation and adaptation activities such as CSA, agro-forestry, community forest reserves, community natural resource management (CNRM) projects, community and household woodlots, and plantation development schemes. To these informants, such funds can be used to provide "green agricultural insurance contracts." Under the green insurance programs, AICs can use the funds secured to support AIS and subsidize premiums of the green insurance contracts, they revealed.

7.2.6 Inserting Specific Sustainable Agricultural Practices and Climate Mitigation Initiatives into Agricultural Insurance Contracts

Some key informants also revealed that another strategy that can be used to promote climate mitigation and sustainable farming practices is by inserting clauses or conditions that require insured farmers to incorporated specific environmentally-friendly activities into their farming practices. This suggestion was made by some key informants, including agricultural insurance staff, AEAs, and nucleus farmers. A GAIP staff reported that one condition in their MPCI policy requires insured farmers to create a fire belt around their farms to prevent bushfires from burning farmers' crops. This aims at reducing the liabilities of the AICs because fire is one of the risks covered by MPCI contracts. This GAIP staff indicated that AICs could incorporate terms and conditions into their agricultural insurance contracts that can promote CSA practices and climate mitigation like how MPCI contracts are coupled with construction of fire belts.

7.2.7 Promoting the Use of Technologies that Require Less Agricultural Land and Inputs

Some key informants also recommended the use of environmentally-friendly agro-technologies with a dual role of promoting climate change mitigation and increasing agricultural productivity. These technologies the study participants identified were mainly modern or scientific- based technologies. These include agricultural intensification practices and the use of high-yielding crop varieties. If these technologies are appropriately utilized, they will use relatively smaller arable lands and agro-inputs, and yet increase crop productivity and production, they claimed. According to these informants, the relatively more modest croplands used implies a limited disturbance of trees and soils, thus, resulting in minimal emission of CO_2 and other greenhouse gases which probably would have been released into the atmosphere if normal or average soils, crop varieties, and agricultural systems were cultivated and practiced.

Some key informants and focus group discussants also enumerated some farming systems and practices with sustainability traits that can contribute to improved yields and climate change mitigation. Some of these conservation farming systems discussants described were cover-cropping, intercropping, non-clearance of economic trees, and non-destruction of sacred groves. Even though some discussants did not directly relate these farming practices to climate change mitigation, they identified them as sustainable farming systems.

7.2.8 Government Subsidization of Agricultural Insurance Programs and Contracts as a a condition for Agricultural Stakeholders to Engage in Sustainable Farming Practices and Climate Mitigation Activities

To promote climate change mitigation using agricultural insurance programs and contracts, some study participants implored bundling subsidized agricultural contracts with sustainable farming practices and climate change mitigation activities. Even without linking sustainable farming practices and climate change mitigation with subsidized crop insurance, focus group discussants and key informants were almost unanimous that AIPs and contracts should be supported and subsidized by the government and other stakeholders to make them available, accessible, and affordable for all farmers. I used the word “almost” because two discussants, an agricultural insurance staff, and a nucleus farmer did not support the government or any stakeholder subsidizing agricultural insurance policies. According to these study participants, government’s involvement in direct support or provision of subsidies may breed bureaucratic inefficiencies in the delivery of agricultural insurance products and services. In support of coupling agricultural insurance policies with sustainable farming practices and climate change mitigation, however, a key informant said:

> In this way, it will look like farmers are working (undertaking climate change mitigation activities) and the government is paying them (subsidizing premiums) for their efforts. This may not even require additional efforts and resources because some of these farmers are already doing them (engaging in climate mitigation activities through their existing farming systems and practices). I have cashew, shea, and dawadawa on my farm. I don't burn [the bush or my crop residue], I use condemn for my maize farm (zero tillage), and many others [other farmers] do same. Anytime you are going to Daffiamah (a farming community in the Nadowli-Kaleo District of the UWR), you can stop by to see my farm for yourself.

7.3 Perspectives of Survey Respondents on How Agricultural Insurance can Promote Sustainable Farming Practices and Climate Change Mitigation in Northern Ghana

Views of respondents were also sought on how agricultural insurance programs and contracts could promote sustainable farming practices and climate change mitigation. Respondents were specifically asked to 1. Indicate ways agricultural insurance schemes and policies could support sustainable farming practices and climate change mitigation, 2. Identify organizations that could lead this crusade and, 3. Indicate how those agencies could promote climate change mitigation. Again, ideas of both insurers and non-insurer respondents were sought on pre-determined opinion statements with the potential for fostering conservation agriculture and climate change mitigation. The questionnaire further required respondents to rank as well as indicate their extent of agreement with suggested agricultural-related climate change mitigation strategies (Appendix VIII). Responses from these questions were then used to estimate the potential of agricultural insurance in promoting sustainable agricultural practices and climate change mitigation among smallholder farmers in Northern Ghana. The organizations identified and the ways they can promote climate change mitigation activities among smallholder farmers in Northern Ghana are listed below (Table13).

<table>
<tr><th colspan="2">Table 13: List of environmental organizations and the ways they can support agricultural insurance stakeholders to contribute to sustainable agriculture and climate mitigation activities in Northern Ghana</th></tr>
<tr><th>Organizations</th><th>Ways these Organizations Can Promote Sustainable Farming Practices and Climate Change Mitigation</th></tr>
<tr><td>Government</td><td rowspan="9">-Amendment of the Insurance Act (Act 724, 2006) or promulgation of a new or separate legislation to accommodate climate change mitigation and sustainable agricultural practices
-Support AICs with their administrative and operational cost (O&A) and reinsurance arrangements
-Premium subsidization
-Sensitization of farmers about agricultural insurance , sustainable agriculture, and climate change mitigation
-NGOs and projects to introduce their client-farmers to agricultural insurance products</td></tr>
<tr><td>Agro-input dealers</td></tr>
<tr><td>Agricultural and climate-related projects, e.g., ACDEP</td></tr>
<tr><td>Agricultural NGOs that support smallholder farmers</td></tr>
<tr><td>Agricultural Insurance Companies</td></tr>
<tr><td>MOFA</td></tr>
<tr><td>EPA</td></tr>
<tr><td>Financial institutions, especially. rural banks, and community cooperative credit unions</td></tr>
<tr><td>Forestry Services Commission (FSC)</td></tr>
</table>

Civil Society Organizations (CSO)	-Provision of incentives or reward systems for farmers engaging in climate change mitigation activities and ecological farming practices -Establishing agro-ecological demonstration farms for farmer education -Provision and promotion of climate-friendly technologies among smallholder farmers
Research institutions-SARI, UDS	
GMA	

Note. Source: Author constructed from field data, 2017/2018

7.4 Determining the Willingness of Agricultural Insurance Companies to Incorporate Climate-Smart gricultural practices and Mitigation Activities into their Insurance Businesses

Respondents were supportive of AICs integrating climate mitigation activities into their operational activities. Even though the questions were centered on the willingness of AICs to incorporate climate mitigation activities into insurance operations, views of non-insurer respondents were also sought. For instance, non-insurers were explicitly asked “do you think it is a good idea for AICs to engage in the following climate change mitigation activities (with follow-up questions on the specific sustainable farming practices and climate change mitigation activities)? On the other hand, insurers were directly asked about their willingness to integrate climate mitigation activities into their operations.

The data analysis shows that all the 15 (100%) respondents supported AICs bundling subsidized agricultural insurance contracts with sustainable farming practices, and by extension, climate change mitigation activities. Also, 14 (93%), 13 (87%), and 13 (87%) of the respondents agreed with AICs rewarding farmers engaging in climate mitigation activities, designing and marketing green insurance policies, and creating awareness about climate change mitigation among smallholder farmers, respectively, (Figure 13).

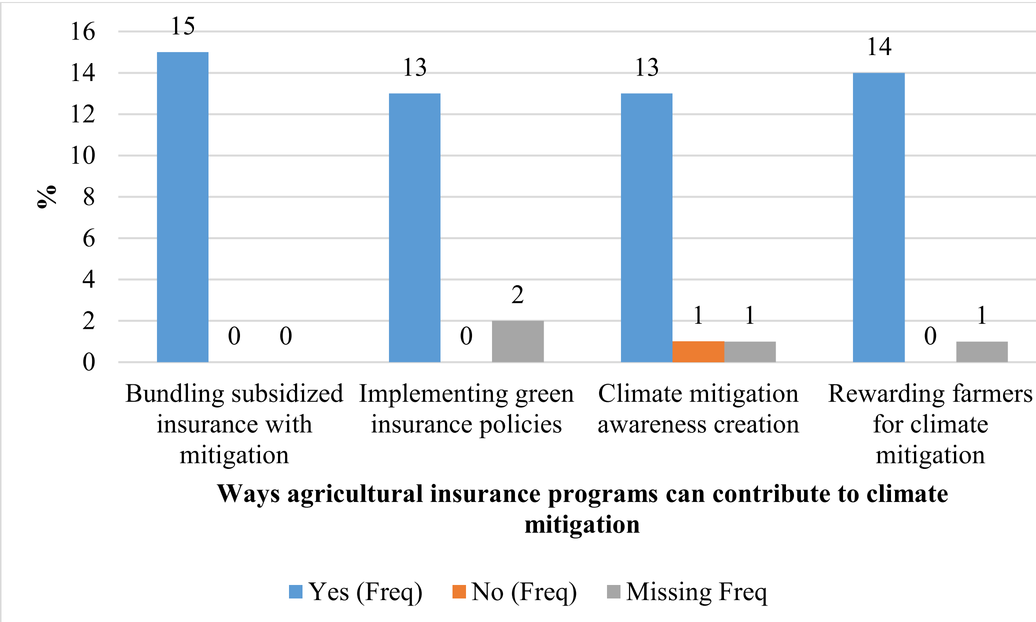


Figure 13: Group bar graph showing respondents' extent of agreement with selected climate change mitigation opinion statements

Zero "0" means no respondent disagreed with bundling agricultural insurance contracts with the above-stated climate change mitigation activities.

Respondents gave various reasons for expressing their willingness (insurers), and support for AICs (non-insurers) to incorporate climate mitigation activities mentioned earlier into agricultural insurance business operations. Some respondents revealed that subsidization of agricultural insurance programs will not only make insurance policies available and accessible to many farmers but will also make agricultural insurance schemes profitable and sustainable. They further added that sensitization programs and reward systems might make many farmers interested in and aware of agricultural insurance and the climate-friendly activities they can employ to contribute to climate change mitigation and general environmental protection. For instance, a respondent wrote, "When other farmers see [some] farmers being rewarded for engaging [in climate change mitigation activities], they will also engage [in climate change mitigation activities], and together, [they will] mitigate climate change." Other respondents also reported that integrating these climate mitigation activities into smallholders' farming systems and practices may not only ensure food security and income stability but also their sustainable provision (i.e., food and income) as well as protection of financial investments of insurers and insured farmers in the long-term. The respondent who disagreed with AICs creating awareness about sustainable agricultural practices and climate change mitigation among smallholder farmers also gave his reasons for taking that line of reasoning. He claimed that climate change adaptation and mitigation issues are technical, and as such, should be handled by experts in that field. This respondent also indicated that climate change mitigation is a non-core business of AICs, and at best, should be regarded as "a [corporate] social responsibility [of Agric I] companies]."

7.5 Respondents' Extent of Agreement with Opinion Statements on Sustainable Farming Practices with the Potential for Climate Change Mitigation

I also asked my survey respondents to indicate their extent of agreement with AICs supporting insured farmers engaging in sustainable farming practices and sound environmental management activities with the potential to promoting climate change mitigation in Northern Ghana. The respondents' extent of agreement was based on a 1-5-bipolar scale (Tables 14 and 15). The analysis reveals that majority of the respondents either agreed or strongly agreed that the farming systems and environmental practices listed in Table 15 could contribute to climate change mitigation, and should, therefore, be supported by the AICs. For instance, 59%, 73%, 27%, 27%, and 33% of the 15 respondents strongly agreed that agro-ecological farming, CSA, non-burning/controlled burning, non-destruction of socio-ecological sites, and afforestation and reforestation practices could contribute to climate change mitigation in Northern Ghana, respectively (Tables 14 and 15).

Table 14: Respondents' extent of agreement with opinion statements on sustainable farming practices with the potential to contributing to climate mitigation expressed as frequency

Opinion statements/Extent of agreement	Strongly disagree	Disagree	No opinion	Agree	Strongly agree	Missing	Total (Freq)
Agro-ecological farming systems and practices	0	1	1	4	9	0	15
Climate-smart agriculture	0	0	1	2	11	1	15
Non-burning/controlled burning practices	0	0	1	9	4	1	15
Non-destruction of socio-ecological sites	0	0	1	8	4	2	15
Afforestation and reforestation	0	0	2	7	5	1	15

Note. Source: Author constructed from field data, 2017/2018

Table 15: Respondents' extent of agreement with opinion statements on sustainable farming practices with the potential to contributing to climate mitigation expressed as a percentage

Opinion statements/Extent of agreement	Strongly disagree	Agree	No opinion	Agree	Strongly agree	Missing	Total (%)
Agro-ecological farming systems and practices	0	7	7	27	59	0	100
Climate-smart agricultural practices	0	0	7	13	73	7	100
Non-burning/controlled burning practices	0	0	7	59	27	7	100
Non-destruction of socio-ecological sites	0	0	7	53	27	13	100

Afforestation and reforestation	0	0	13	47	33	7	100

Note. Source: Author constructed from field data, 2017/2017

The next chapter (i.e., chapter eight) focuses on discussion of my study results. In this chapter, I anchored my results on the broader agricultural insurance and crop risks management scholarly discourse.

Chapter 8: Discussion of Results

8.1 Introduction

This dissertation project was undertaken to explore agricultural stakeholders' perspectives on the potential of agricultural insurance for crop risks management in Northern Ghana. This chapter discusses the major results or findings in relation to the study’s focus questions which sought to:

1) Identify and describe smallholder farmers’ key agricultural risks,

2) Identify smallholder farmers’ key agricultural risks management strategies,

3) Explore how agricultural insurance can support smallholder farmers to manage their major crop risks and,

4) Estimate the interest and willingness of agricultural stakeholders (e.g., insurers and smallholder farmers) in promoting and engaging in sustainable farming practices and climate change mitigation.

8.2 Smallholder Farmers’ Key Agricultural Risks and Agricultural Insurance

My fieldwork in Northern Ghana revealed that smallholder farmers are confronted with a plethora of crop risks. These agricultural challenges can be categorized into weather/climate-induced and non-weather/climate-induced challenges. My study participants were concerned about the adverse effects of both weather and non-weather agricultural risks. Much of the literature on smallholder farmers’ agricultural risks concentrate on weather/climate-induced risks almost to the neglect of the non-weather-related agricultural challenges (Osbahr et al., 2011). The non-weather agricultural hazards equally pose serious food security challenges to marginal farming households in Northern Ghana and other low-income countries. These non-weather risks may exacerbate the climate-induced agricultural risks (Füssel & Klein, 2006; Smit and Skinner 2002). Smit and Skinner (2002), for instance, maintained that agricultural risks management strategies should include both climate change adaptation and non-climate-based agricultural risks management measures. These authors argued that the economic, social, political, technological, and environmental decisions affect agricultural and adaptive activities and decisions and vice versa.

The recognition of weather/climate-induced risks as major agricultural problems is reflected in the interventions often prescribed to address agricultural challenges confronting smallholder farmers developing countries (Osbahr, 2011). These one-sided remedial measures often involve technology-based adaptation strategies such as the cultivation of drought-resistant, early maturing, and water efficient crop varieties; and weather forecasting, early warning, and weather information-related adaptation mechanisms (Makaudze, 2005). Again, most agricultural insurance-related researchers, policymakers, practitioners, and IDAs are promoting weather-based index insurance programs in low-income countries (e.g, Barnett & Mahul, 2007; Carter et al., 2014) almost to the neglect of conventional or all-risks policies (e.g., MPCI contracts). This is what I termed limited protection coupled with the presence of basis risk often associated index-insurance contracts. For instance, the chain of crop risks involves production, transportation, infrastructural, marketing, demand, price, and revenue risks (Hess, Hazell, & Kuhn, 2016; Hossain, 2013; Goel, 2013; Shields, 2010). This means weather-based index insurance only covers part of the production risks, leaving out a gamut of risks along the agro-value chain continuum.

Even with the production risks, weather index insurance only covers the insured index (e.g., rainfall, floods or drought or temperature) (Mahul & Stutley, 2010; Rao, 2010), excluding the other non-weather risks coupled with other categories of basis risks. For instance, soil infertility and crop pests and diseases affect agricultural productivity and yet are not covered by weather-based index insurance contracts. This limited protection has been recognized by Goel (2013) in his complete agro-financial service framework for emerging economies, and he subsequently recommended the development of an integrated index that incorporates both yield and weather indices (i.e., a combination of the vegetative index, rainfall index, and other indices). Though a right call and an improvement upon weather index-based policies, Goel failed to indicate how this integrated index can be developed and synthesized apart from mentioning some of the variables with the rest unknown. Again, the composite index that Goel proposed, i.e., a combination of weather and yield-based indices only addresses some upstream agricultural risks (i.e., some production risks) to the neglect of the downstream risks (i.e., marketing, post-harvesting, and prices risks) in addition to the associated basis risk. This knowledge gap requires further research.

The claim of making agricultural insurance contracts affordable and accessible to marginal farmers in low-income countries through the introduction of index-based insurance programs also comes with its challenges. Indemnity insurance schemes which are often fraught with problems of adverse selection, moral hazards, and increased administrative and operational (A&O) costs are claimed to be unsuitable for smallholder farmers in low-income countries (Barnett & Mahul, 2007; Clarke, Mahul, Rao, & Verma, 2012; Greatrex et al., 2015). It is equally important to acknowledge and be concerned about the huge unprotected risks (i.e., basis) that affect farmers insured under index-based policies. Even though I agree with researchers claiming that weather and climate-induced risks are farmers' key agricultural risks (e.g., Solomon, 2009; Stocker et al., 2013; Walther et al., 2002) and that weather/climate-based index insurance can assist smallholders in low-income countries (Barnett & Mahul, 2007, Rao, 2010), issues of basis risks and other problems commonly associated with weather index insurance contracts should also be a source of concern. For instance, my study participants identified both weather/climate and non-weather-induced risks as their major agricultural challenges even though they placed more premium on the former. This means all the non-weather-induced risks, for instance, disease and pests infestations, psot-harvest losses, fire outbreak etc. are not protected by the drought index contracts in addition to all other weather/climate-related risks (i.e., flooding, heat waves etc.) with the exception of drought. This is a huge gap in the weather index-based agricultural risks management arrangements among smallholder farmers in low-income countries.

Despite the relevance of the arguments of the promoters and supporters to the use weather-index-insurance to assist smallholders in low-income countries to address their agrarian challenges, I add my voice to proposals by Elabed & Carter, (2015), Goel (2013), Greatrex, 2015, and Makaudze (2005) that we go beyond weather-index insurance to devise an integrated index that can protect a greater percentage of smallholders' major agricultural risks (including both weather and non-weather-induced risks) so that the remaining risks can be absorbed by smallholder farmers themselves (Hossain, 2013; Pacheco, Santos, & Levin, 2016. This may be achieved through their indigenous and informal agricultural risks management strategies (Mobarak & Rosenzweig, 2013; Nyong et al., 2007; Tr\a erup, 2012).

To ensure effective management of smallholder farmers' agricultural risks, I argue that governments in low-income countries must support agricultural insurance programs with the technical, infrastructural, and A& O cost in addition to subsidizing the premiums for insured farmers as is done in advanced agricultural insurance programs such as the US, Canadian, and

Spanish agricultural insurance programs. However, this should be done in a modified manner, taking into consideration the peculiar circumstances and weak financial capacities of low-income countries with competing resource uses (Barnett & Mahul, 2007). AICs could in turn bundle crop insurance contracts with sustainable farming practices, climate change mitigation, and responsible environmental behaviors. Fortunately, staff of the two AICs and smallholders in Northern Ghana indicated their willingness to promote and engage in environmentally responsible and sustainable activities, and I believe agricultural insurance stakeholders in other low-income countries may also be willing to do same.

8.2.1 Weather and Climate-induced Agricultural Risk

Weather-based agricultural risks were identified as smallholders key agricultural risks. These included erratic rainfall patterns, poor rainfall distribution, shortening of the farming season (or increasing dry season), flooding, high temperatures, warming of the earth, high evapo-transpiration rates among other adverse weather and climatic phenomena. The study participants further reported that these extreme weather events have been adversely affecting their agricultural activities, thus, exposing smallholder farmers to poverty and food insecurity conditions. The occurrence of climate variability, climate change, and other weather-induced agricultural risks in Northern Ghana was confirmed by my Service-Learning Project (SLP) (Sumani, 2015). Some studies in Northern Ghana (e.g., Acheampong, Ozor, & Owusu, 2014; Armah et al., 2011; Christine Young Adjei, Rhodante Ahlers, & Kodwo Andah, 2012) also corroborated these findings.

Both female and male study participants identified weather and climate-induced agricultural risks as their most important farming challenges. A review of the responses showed a gender-based climate-induced agricultural risks. For example, the female discussants in two of the three focus group communities identified flooding of their rice fields as one of their key agricultural challenges. Females in the Duori-Guo community also ranked occasional excess rains as their 8th most important agricultural risks out of the nine problems they listed, probably because flooding was not a key agricultural challenge in the UWR where Duori-Guo is located. A further probe revealed a feminization of rice cultivation, i.e., women are the primary farmers of this crop. My study was probably the first to find gender-based weather-induced agricultural risks in Northern since I did not find any research with similar findings. The closest study I saw in Northern Ghana was Greatrex and McCarthy's (2016) article on assessing the impact of agricultural insurance on gender dynamics in Northern Ghana, and I agree with their preliminary recommendation that any promotion of agricultural risks management programs should take into consideration the gender-specific needs of farmers, and in my view, the possible feminization of agricultural risks and crop should also be viewed gender-sensitively.

8.2.2 Non-weather/Climate Risks

My study also found a multiplicity of non-weather-related agricultural risks confronting small farming households in Northern Ghana. These risks can be categorized into: 1. Transportation challenges - poor road networks, making it difficult to transport foodstuff from farming communities to markets centers, 2. Marketing challenges- Lack or inadequate market/demand for farm produce, low prices, price fluctuation, and lack of certification of grains to access international markets, 3. Post-harvest losses -lack of standard warehouses or storage facilities, destruction of grains by rodents and weevils, burning of grains storage systems on farms, i.e., crops left to dry on farms or stored in huts on farms, 4. Limited value addition opportunities- inability to process farm-produce into finished or semi-finished products in order to add value to them, and 5. Production risks. Some of the production risks mentioned included soil infertility, lack of agro-inputs, loan inaccessibility, weed infestation (e.g., striga species), crop pests and diseases, and poverty or lack of capital to buy chemical fertilizers, pesticides, weedicides, and other agro-inputs. Other production-related risks reported were the high cost of agro-inputs and their non-availability or available at the wrong time. The miscellaneous non-weather risks included environmental degradation, activities of nomadic Fulani herdsmen, destruction of farmlands by illegal gold mining activities also called "galamsey," and smallholder farmers' negative socio-cultural attitudes, beliefs, and practices.

Findings of some researchers corroborated the results mentioned above. For example, MOFA (2007) captured most of these findings in its Food and Agricultural Sector Development Policy framework (FASDEP) document. MOFA (2007) revealed that small farming households in Northern Ghana have been exposed to pests and disease infestations, low market prices for farm produce, lack of collateral to access loans from financial institutions and inadequate access to agricultural extension and transportation services. Stutley (2010), a World Bank staff who conducted Ghana's first crop insurance feasibility study found that Ghanaian farmers lacked access to agricultural extension and agronomic services and agricultural loans due to their inability to meet the collateral security requirements. Other reviews and news feature articles confirmed the adverse effects of post-harvest losses, inadequate AEAs, Lack of credits, inadequate agro-inputs, lack of market and low prices for smallholder farm produce, pest and disease infestation, activities of alien herdsmen, and environmental degradation (Bugri, 2008; myjoyonline.com, 2018; Stutley, 2010; Van der Geest, 2011).

There was a gender angle to some of the non-weather-based agricultural risks in Northern Ghana too. Most female focus group discussants repoted that males had control over the household finances and farm output, fertile agricultural lands, and income from the sale of farm yields. This gender dimension was portrayed by the high rank female discussants accoded lack of access to productive agricultural fields, tractor and bullock services, and inability to buy agro-inputs such as chemical fertilizers, hybrid seeds, and weedicides as their most important non-weather agricultural challenges (Tables 5, 6, 7, 8, 9, and 10). Their male counterparts ranked some of these agrarian threats low. A further probe revealed that some male household heads mostly sell some of the farm produce and keep the proceeds. Whereas male household heads may use such proceeds for the household or shared farm activities (farm owned by the household), some female discussants and informants claimed women do not usually get anything from the sale of the family farm produce to meet their (women) strategic agro-needs and inputs for their (women's) "second farms" (Farms women own separately from the family farm). Other study participants corroborated these gender-based agricultural risks. Some male and female participants also claimed that the culture in Northern Ghana does not allow women to own land either in their husbands' community or fathers' hometown, thus, doubly denying them access to agricultural lands.

Some studies in Northern Ghana and in other low-income countries also found gender-disaggregated non-weather agricultural risks and land tenure challenges (e.g., Helen & MaCarthy, 2016; Hillier, 2018). Whitehead and Tsikata (2003) found in their investigation into policy discourses on women's land rights in Sub-Saharan Africa that post-colonial African customary land tenure systems and administration are denying women claim to the land. What I am unsure of is whether women in Africa had claim to lands during the pre-colonial era, and therefore, requires further research to fill the gap in our knowledge. Bugre's (2008) research on the effect of land tenure systems on agricultural production and environmental degradation in Africa reported that women and strangers did not have control over the agricultural land use and management decisions under the then customary land tenure systems in north-eastern Ghana (i.e., the current

Upper East region). Bugre (2008) further averred that the lack of security and ownership of agricultural lands also contributed to environmental degradation, unsustainable agricultural practices, and lack of agricultural planning.

8.3 Smallholder Farmers' Key Agricultural Risks Management Strategies

My second research question sought to identify and document smallholder farmers' agricultural risks management strategies. For a study investigating the potential of agricultural insurance for crop risks management, there is the need to understand whether the existing adaptation strategies are effective or not. This section discusses my findings in relation to the larger scholarship within the field of smallholder farmers' agricultural risks management arena.

I found eight broad agricultural risks categories or themes. These themes included: 1. Livelihood-related adaptation strategies, 2. Agro-technology-based adaptation strategies, 3. Farm production management and risks diversification strategies, and 4. Financial inclusiveness adaptation strategies. The remaining adaptation measures were: 5. Socio-cultural and religious adaptation strategies, 6. Information-related adaptation measures, 7. Flood-control adaptation strategies, and 8. Social protection/welfare programs and safety nets.

A discussion of smallholder farmers' agricultural risks management mechanisms was partially informed by Smit and Skinner's (2002) typology of the adaptation options theoretical framework. This framework emphasizes among other things the concurrent discussion of both weather-induced and non-climate-induced agricultural risks. According to Smit and Skinner (2002), economic, social, political, technological, and environmental decisions affect agricultural and adaptive activities and decisions.

My study participants reported a variety of smallholder farmers' agricultural risk management strategies under the livelihood-related adaptation strategies theme. These specific coping measures included food rationing, small-scale trading, and reliance on a variety of foods from the wild. I also found that some smallholders normally depend on wild foods (e.g., shea fruits, dawadawa, baobab, and other fruits and vegetables from the wild), community level commerce (buying and selling, including agro-produce), and engaging in indigenous agro-processing activities (value addition), i.e., preparing and selling cakes, malt, and "pito" to earn enhanced income to cope with adverse effects of bad years. Some authors reported similar findings in the literature. For example, Simms, Andrew, Murphy, and Mary (2005) revealed that some farmers affected by climate change in Africa have been strategically skipping some meals and engaging in off-farm and other alternative livelihood activities in order to cope with food deficit situations confronting them (e.g., off-farm jobs and out-migration). Bawakyillenuo et al. (2016) explored autonomous adaptation strategies among smallholder farmers in Northern Ghana and reported farmers' shifting to off-farming jobs such as trading, the establishment of cottage industries such as groundnut, shea, and rice processing activities among other livelihood activities.

My fieldwork in Northern Ghana also unearthed several agro-technology-based adaptation strategies smallholder farmers have been using to address some of their farming challenges. Some of the scientifically-produced adaptation strategies study participants enumerated were: cultivating drought-tolerant, high-yielding, early maturing, water efficient, and pest and disease-resistant crop varieties which may also do well on marginal soils. A key informant indicated that the Lobbies (a farming tribe in the Wa West District of the Upper West region) usually cultivate a type of maize crop which matures within sixty days. He claimed that it also does well on fragile soils.

The application of western science and technology to agricultural risks management, especially to enable farmers to adapt to adverse effects of climate variability and change is replete with the climate impact and adaptation literature. Many studies confirmed the employment of agro-technology-based adaptation strategies to managing agricultural risks in Northern Ghana and elsewhere. Hansen et al.'s (2018) review of the recent literature on climate risks management and poverty reduction found increased income and improved food security among some farmers through the employment of agricultural risks-reduction technologies in Mexico, Kenya, and in other low-income countries. Hansen et al. (2018) found farmers cultivating drought-tolerant maize and rice in Africa as a way of adapting to climate variability and change. Coming to Ghana, Akudugu, Ditto, and Mahama (2012) in their implications of climate variability and change for food security study in Northern Ghana also reported some farmers cultivating drought resistant and water efficient crops (e.g. improved maize varieties).

8.3.1 Farm-based Production Management Practices and Risks Diversification Strategies

My study participants also revealed a wide range of farm production-based management systems, practices, and farm risks diversification strategies smallholders have been engaging to address some of their agricultural risks. These farm-based practices and diversification strategies can be categorized into four themes, namely : 1. Farm-based agricultural risks management practices, 2. Farm diversification strategies, 3. Weather information-related farm diversification strategies, and 4. Miscellaneous category. Some key informants described these agricultural risks management strategies as traditional or social insurance.

8.3.2 Farm-based Agricultural Risks Management Practices

Some of the farm-based agricultural risks management strategies reported from the field included: agro-forestry practices, irrigation agriculture, preparing and use of organic manure, agrarian tillage systems, crop and land rotation, cover cropping, and selection of lands that can sustain plants during droughts and adapted to marginal soils. Smallholder farmers have been engaging in these risks management strategies to promote their welfare and ensure food and income security. I found from the fieldwork that smallholder farmers usually nurture and protect naturally growing economic trees such as shea, dawadawa, baobab, and many others. They also sometimes develop mango and cashew plantations alongside their farms or inter-plant these tree crops with their normal food crops. Fruits and leaves of such trees serve as food, sources of income, and traditional herbs/medicine. Micro to medium-scale irrigation agriculture was also identified as an adaptation strategy in Northern Ghana. It was, for example, reported that some smallholder farmers have been irrigating their fields around the Vea, Tono, Sankana, Vieri, and Kamba Dams. These irrigation facilities provide employment opportunities, food, and income for smallholder farmers during the long dry off-farming season which is usually characterized by food scarcity, idling, out-migration, poverty, and other social vices, some study participants claimed.

Most of the farm-based risks management strategies reported above have been corroborated by previous studies in some agrarian low-income economies. For instance, Sumani (2008), Molini et al. (2008, 2010), Laube, Schraven, and Awo (2012), and Van Der Geest (2011) also found crop and land rotation, mixed farming, reliance on food from the wild, food rationing, and out-migration from Northern Ghana to Southern Ghana and other climatically favorable destinations as measures smallholder farmers in Northern Ghana have been employing to cope with some of their agricultural risks. Kurukurulasuriya et al. (2008), Hassan (2010), and Simms et al. (2005) in their respective studies in Africa reported farmers using specific farming practices and crops such as improved maize crop varieties and irrigation agricultural systems to adapt to adverse effects of climate variability and change. Findings of these researchers agreed with mine.

My study also found gender discrimination in the allocation of agricultural lands and control over household financial resources. It was revealed that male family heads who often have control over family resources with some of them allocating less productive lands to female farmers and also keeping proceeds from the sale of farm produce to themselves to the detriment of the women. It was reported during the Kazigo females focus group session that women have been preparing manure from crop residues and animal droppings to enrich the impoverished farmlands their husbands usually allocate to them. Even though I have come across some studies that reported gender discrimination in the allocation of resources (e.g., Bugre, 2008; Greatrex & McCarthy, 2016; Whitehead and Tsikata, 2003), I have not encountered any study that reported how marginalized and impoverished females have been addressing their key agricultural risks, especially turning less fertile agricultural lands into productive agrarian fields using innovative indigenous adaptation strategies as my study found in the Kazigu community in the UER of Northern Ghana.

8.3.3 Farm Risks Diversification Strategies

Under the spatial risks diversification strategy, some farmers strategically spread their risks by keeping distant and backyard or compound farms. Some farmers diversify their agricultural risks further by having more than one remote and compound farms. There is also planned migration to climatically favorable areas for farming purposes which could be permanent or temporary.

Other studies have published several ex-ante and ex-post farm risks diversification strategies in the extant literature. These strategies include cultivating different farms at different locations, seeking off-farm jobs, and receiving remittances from migrants (Bingswanger-Mkhize, 2012; Nyong et al. 2007; Simms et al., 2005). Bingswanger-Mkhize (2012) further claimed that the various forms of farm diversifications are responsible for the low uptake of index insurance in some low-income countries; with Mobarak and Roseweig (2012) postulating that formal AICs are selling insurance products to some farmers already informally insured by other traditional or social forms of insurance. Nyong et al. (2007) on the other hand, advised that climate change adaptation and migration efforts in the agricultural sector in Africa and by extension, other developing countries should incorporate indigenous knowledge systems and practices. Abdul-Korah (2007), Laube et al. (2012), and Van der Geest, (2011) in their migration studies in Northern Ghana also labeled out-migration by Northerners (people from northern Ghana) to Southern Ghana and other climatically conducive areas as an effective adaptation strategy. Even though findings of these earlier studies are consistent with mine, they presented their results, especially the spatial farm risks diversification strategies at the general level. For instance, Bingswanger-Mkhize (2012) just mentioned “enterprise diversification within farms.” (Pg. 191) My study discussed into detail and compiled a comprehensive list of farm diversification strategies such as multiple cropping, mixed farming, geographic diversification (farmers having distant farms and backyard farms) and even diversification within diversified farms (i.e., a farming household having more than one remote and compound farms as a way of spreading their risks further). The Climate Change, Agriculture, and Food Security project's (CCAFS)' (2015) baseline survey covering households and organizations in the Lawra and Jirapa communities in the UWR of Ghana recorded adaptation strategies smallholder farmers have been engaging to adapt to adverse effects of the changing weather and climate. Some of these coping measures included multiple cropping, changing crops, mixed farming, agro-forestry practices, and farm diversification. These findings are consistent with mine.

8.3.4 Weather information-related Farm Diversification Strategies

One weather information-related farm diversification strategies I gathered from the field included splitting of the planting days. By this adaptation arrangement, smallholder farmers diversify their crop production risks by planting their crops on strategically determined different dates or periods. This avoids farmers' ‘putting all their eggs in one basket’. Another weather information-related farm risk diversification strategy I gathered from the field was studying the weather or rainfall patterns over the years and adjusting accordingly. Some key informants indicated that they have studied the weather/rainfall patterns over the years and now call themselves “weather experts.” One such a key informant said he has studied the rainfall patterns over the years and has concluded that maize must be planted between June 15 and July 10 each year in north-western Ghana to avoid the annual long spell of drought.

The third weather-related farm risks diversification strategy the study participants mentioned was farmers’ waiting for the rains to stabilize before planting their crops. According to these discussants and informants, the rainfall patterns have become so unpredictable that the first rains may trick farmers to plant without follow-up rains or for droughts to occur later. The study participants claimed that farmers usually adapt to the tricky nature of the erratic rainfall patterns by waiting for the actual rainy season to set-in, i.e., waiting for the rains to start falling regularly. Related to the weather-information adaptation strategy is some farmers studying the properties of their farmlands to identify adaptation information and opportunities. This enables some farmers to grow crops on portions of their farms that can support these crops during droughts and flooding periods, including those that do well on vulnerable farmlands.

The literature search revealed a paucity of data on weather information-related farm diversification strategies (which is different from weather information-related adaptation strategies as will be discussed later). Some studies support my finding on farmers' splitting their planting dates as a strategy to diversify some of their production risks. Weldegebriel and Gustavsson (2017) investigated climate change adaptation and mitigation strategies in the agriculture and water sectors in Ethiopia and reported farmers' splitting their planting days as a way of diversifying their agricultural risks. These authors, however, claimed they could not vouch for the effectiveness of splitting planting dates as an adaptation strategy to climate variability and change. In my study, some focus group discussants and key informants attested to the effectiveness of splitting the planting dates as an effective farm risk diversification mechanism. These study participants claimed that splitting the planting dates made some farmers to escape the adverse effects of the fall armyworm (FAW) disaster that devoured most maize crops during the 2017 farming season in Ghana. My study is probably is among the few to identify splitting planting dates as an effective climate variability and change adaptation strategy and possibly the only one that found splitting crop planting dates as a potent adaptation strategy, especially in Northern Ghana.

Even though some farmers may be employing the remaining three categories of weather information diversification adaptation strategies mentioned above to manage their agricultural risks, they have probably not been reported by earlier studies, especially in Northern Ghana. These agrarian risks management strategies included farmers: 1. Observing the weather or rainfall patterns over the years and adjusting accordingly, 2. Waiting for the rains to stabilize before they start planting, and 3. Studying the properties of the farmlands to identify adaptation information and opportunities. An alternative explanation for the absence of these adaptation strategies in the lietrature could be that earlier scholars used different terms, concepts, or phrases to describe them. For instance, the closest weather information-related adaptation measures I found in the literature were farmers changing their planting dates in Nigeria (Borokini, Osewa, Babalola, Alamu, &

Olubiyi, 2014) and farmers changing the timing of the planting in Northern Ghana (Antwi-Agyei, Stringer, & Dougill, 2014). Technically, the first two weather information-related adaptations mentioned above may not be directly related to splitting the planting dates. Also, studying the properties and history of the farmlands and adjusting appropriately is unrelated to splitting the planting date. Therefore, the above-mentioned weather information-related adaptation strategies form part of the contributions of my dissertation project to knowledge, especially smallholder farmers studying the history and properties of their agricultural lands and using the information to adapt appropriately.

8.3.5 Flood Adaptation Measures.

Flooding was also identified as a key agricultural challenge confronting some smallholder farmers in Northern Ghana, especially for smallholder farmers in flood-prone areas and along the White and Black Volta Rivers and their tributaries. Flooding in Northern Ghana is mainly caused by naturally occurring rains/excess rainfall and the spilled waters from the Bagre Dam in Burkina Faso, my study participants revealed. These floods sometimes inundate farms, carrying away poultry birds, livestock, and drowning farmers in some instances. Some farmers have, therefore, been engaging a variety of adaptation strategies to mitigate and adapt to adverse flooding events. Some of the flood-related adaptation and mitigation strategies my study participants have been engaging include cultivating flood-friendly crops (like rice, sorghum, and some species of cowpea) in flood-prone areas; studying the flooding history of the farm to know which crops do well in flood-prone areas or planting early enough so that by the time the flood water comes in August or September, the crops would have been deeply rooted and stabilized. Such well-established crops may not be adversely affected by flooding, they averred. Other flood-based adaptation measures mentioned were: 1. Raising mounds and beds/ridges (as traditional ways of dealing with flooding) to elevate the crops above the flood-water level, 2. Planting trees, especially macuna species, 3. Placing sandbags across water channels, and, 4. Constructing drainage channels. My study participants revealed that these flood control measures either check the speed of flood waters (thus, reducing soil erosion) or diverting flood waters away from the farm.

Only a few empirical studies in Ghana corroborated my findings on flood adaptation and mitigation strategies in Northern Ghana. Antwi et al. (2015), in testing their community vulnerability assessment framework in selected communities in the Wa West District of the Upper West region attributed the causes of flooding to occasional torrential rainfall and annual water spillage from the Bagre dam which usually affect farmers along the Black Volta River and its tributaries. According to these researchers, farmers in the Wa West usually engage stone bonding, construction of farm canals, and raising mounds and ridges to control flooding. These authors also recommended building financial resilience (including crop insurance), growing flood-tolerant crops, and instituting early warning systems. Tutley (2010) also confirmed that flooding in Northern Ghana is mostly caused by the opening of the Bagre Dam in Burkina Faso and periodic torrential rains. As an agricultural insurance expert with the World Bank, Tutley (2010) unsurprisingly recommended rolling out index-based and multi-peril crop insurance programs and contracts to build resilience among smallholder farmers.

Most other studies (e.g., Challinor et al., 2007) discussed flooding within the built environment and agricultural fields as an adverse effect of climate variability, climate change, and extreme weather events. Most of these studies discussed flooding and its adverse impacts without proffering any solution. The few studies (e.g., Siebert, 2015) that focused on the harmful effects of flooding on agriculture proposed agricultural insurance as an adaptation strategy to flooding that sometimes causes havoc to crops. Siebert (2015) recommended the institution of flood index insurance to assist farmers in Sahelian Africa to adapt to adverse effects of flooding, attributable to climate change. My research has practical application and can also extend the literature regarding studying the agricultural land and flooding history of the farms to know which crops do well in flood-prone areas or planting early enough so that by the time the flood water comes, the crops would have been deeply rooted. Even though I might not have covered all the relevant literature, I have so far not come across any study that documented the use of flooding history and information from farmlands that inform the cultivation of some crops that could avoid or reduce the adverse effects of flooding.

8.3.6 Socio-cultural and Religious Adaptation Strategies

My fieldwork revealed some socio-cultural and religious practices and beliefs some smallholder farmers claimed they have been using to cope with some of their agricultural risks. These adaptation strategies have been categorized into Christian faith and beliefs (CF), African Tradition Religious beliefs and practices (ATR), traditional farming practices also called social or traditional insurance, and cultivation of traditional crops. The male focus group discussants in Duori-guo and Kazigo were sharply divided along Christian faith and Traditional African beliefs lines but united on traditional farming practices and cultivation of some traditional crops as agricultural risks management strategies. The two focus group communities whose members were divided comprised the CB and ATR camps whereas the discussants in the third focus group community (Nyankpala) who did not disagree on religious lines were all Muslims. However, discussants in the Nyanpkala community did not identify Islamic religious believes and practices as providing any form of adaptive responses.

There is insufficient research information on how smallholder farmers have been employing socio-cultural and religious adaptation strategies to manage some of their agricultural risks. This may be understandable because hardcore or western science which dominates the field of research may not believe or accommodate such religious and socio-cultural claims. This dissertation project guided by its approved IRB obligations would not debate these views and beliefs from the study participants except to report them as they are and then ground them in the broader scholarly discourse.

Some studies have corroborated my findings. For example, research by Byg and Salick, (2009), Golo and Yaro (2013), and Jarawura (2014) into religious perceptions, climate change adaptation, and causes of drought in Ghana and Tibet found some rural farmers and local folks claiming the occurrence of droughts, floods, and reduced yields as punishments from their God, gods, and ancestral spirits for either refusing to perform some religious or cultural obligations and sacrifices or engaging in irresponsible and immoral acts. Simms et al.'s (2005) Africa Up in Smoke research found some smallholder African farmers resorting to prayers for God's intervention to prevent the occurrence of droughts, floods, and other weather and climate extremes.

Some of my findings on traditional farming practices and cultivation of certain species of crops reported above are consistent with the findings of some researchers. Some smallholders in low-income countries normally cultivate some indigenous crops such as millet, rice, and sorghum because they possess some special adaptation traits in addition to their traditional and religious significance (Nyong, 2007; Panda, 2013; Stutley, 2010). Panda (2013) reported that the traditional millet crop and paddy rice in India are not only drought-resistant and well-adapted to the local environment but are also mostly intercropped with other crop varieties. He added that most farming households in India used to depend on these well-adapted and early maturing crops (mostly ready for harvesting in 2 or 3 months) during failure of long gestation crops due to drought and other adverse weather events. When index insurance was introduced, Panda (2013) did not support paddy rice farmers switching to cotton cultivation, a mono-crop and which also resulted in the loss of biodiversity and ecological degradation, a situation Müller, Johnson, and Kreuer (2017), Nigus, Nillesen, and Mohnen (2018), and Panda (2013) described as maladaptive. Other scholars also found traditional farming practices and systems such as crop and farm diversification, mixed farming, agro-forestry, crop and land rotation as adaptation strategies (e.g., Bingswanger-Mkhize, 2012; Hess, Hazell, & Kuhn, 2016). Mobarak and Rosenzweig (2012) in exploring the complementary role between informal insurance, i.e., social networks and traditional farming practices and formal insurance titled their article "Selling formal insurance to the informally insured." The title of this article suggests the importance of the socio-cultural and religious beliefs and practices as smallholder farmers' complementary adaptation strategies in Africa, and possibly, other low-income countries.

The socio-cultural and religious-based adaptation strategies may have implications for my study since it (i.e., my dissertation project) has been conducted to explore perceptions of the potential of agricultural insurance for crop risks management in Northern Ghana, and its findings, conclusions, and recommendations may be applicable to other low-income countries. Premiums are mostly actuarially determined based on hardcore or western science principles, and if so, how do matters of faith, beliefs, religion, and socio-cultural factors feature in the decision calculous of actuarial analysis? Will AICs charge lower premiums because Christians and traditionalists will pray and make sacrifices for their God or gods and ancestors to prevent droughts and floods from occurring? How will insurers know whether the occurrence or non-occurrence of agricultural risks are attributable to these religious and socio-cultural factors? Will insurers also charge higher premiums because God or gods and ancestors may punish insured clients with crop pests and diseases or low yields for immoral behaviors and refusal to pacify or make sacrifices to their ancestors and gods? Will AICs also engage in soothsaying, religious and spiritual consultations to know the causes of agricultural risks? These and many other questions are begging for answers. The interaction between socio-cultural and religious factors and agricultural insurance is scholarly new, and therefore, needs special consideration in the agricultural risk management scholarship. Though an important area with possible far-reaching implications for crop insurance take-up rates, I have not come across any research work in this area, especially in Northern Ghana, hence, the need for a more focused and in-depth research on the impact of socio-cultural and religious factors on AIPs and contracts in low-income countries, including Northern Ghana.

8.3.7 Information-related Adaptation Measures.

Relevant agro-meteorological and extension information is one of the resources that can inform adaptation to weather/climate-induced risks and other general agricultural challenges confronting the agricultural sector (Goel, 2013, Makaudze, 2005). My fieldwork gathered the different sources of agricultural-related pieces of information smallholders in Northern Ghana have been employing to manage some of their agricultural risks. These agro-related information sources included smallholder farmers: 1. Picking signals from agro-meteorological-related researchers, AEAs, and informed farmers (e.g., nucleus farmers), 2. Receiving agro-meteorological and extension information from some technical agricultural stakeholders, especially the use of rainfall information to plan their farming activities from GMA, ESOKO, GAIP and WorldCover, and 3. Using information from their (farmers') participation in awareness and sensitization programs to manage some of their key agricultural risks.

The use of hydro-meteorological information for adaptation to adverse effects of climate variability, climate change, and extreme weather events in the agricultural sector has been recognized in the literature (e.g., Goel, 2013, Loblois & Quirion, 2013; Makaudze, 2005; Siebert, 2015; Tutley, 2010). Makaudze (2005) made a strong argument in his dissertation research for meteorological agencies and other relevant stakeholders to make relevant weather information readily accessible and available to smallholders for adaptation purposes. He specifically posed the question "do seasonal climate forecasts and crop insurance matter for smallholder farmers in Zimbabwe?" (pg. ii). His answers to this question are consistent with some of my findings under the information-related adaptation strategies in Northern Ghana.

My findings agree with those of other studies that preceded my dissertation research. Makaudze (2005), for example, found that seasonal weather forecast has the potential to assist smallholder farmers to mitigate drought risks in Zimbabwe, and by extension, in other low-income countries with similar conditions. To maximize the benefits, he recommended that the state agencies responsible for rendering these weather-based information services should provide region/area-specific weather information to smallholder farmers. He further suggested the use of crop insurance to transfer smallholder farmers' residual risks to the AICs. The weakness with Makaudze' first recommendation is the reliance on only state agencies to provide weather information to smallholder farmers because these bodies may not have the requisite human, technical, material, and financial resources to discharge their responsibilities effectively and efficiently. This weakness has been addressed by Goel' (2013) complete agro-financial service framework for emerging economies. Goel (2013) recommended the institution of innovative product delivery channels where AICs would appoint agro-financial agents knowledgeable in financial, agro-meteorological, and agricultural extension and agronomic issues to sensitize and guide small-scale farmers at the grassroots level.

8.3.8 Financial Adaptation Strategies

Smallholder farmers require financial inclusiveness to enhance their farming operations. In this regard, I gathered from my fieldwork in Northern Ghana that some smallholders have been obtaining loans from formal financial institutions and using their membership with micro-finance institutions (MFIs) such as Community Cooperative Credit Unions (CCUs), Community Banks (CBs), Rural Banks (RBs), and Village Savings and Loans Associations (VSLAs)) to access and use loans to address some of their agricultural challenges. Some of these financial institutions have also been providing additional services to farmers, including consumer credit facilities to their farmer-members. Whereas most farmers were reported to have had challenges accessing agro-loans from formal financial institutions due to rigid collateral security requirements, other farmers' membership with MFIs, group solidarity, and savings with some FBOs, associations, and groups acted as a guarantee for agro-loans from these grassroots financial organizations.

The findings mentioned above have been corroborated in the agricultural insurance literature. For example, one function of index insurance in low-income countries widely reported in the literature is provision of access to agro-loans and other financial services (Grierson, 2012, Ramirez & Colson, 2013; Johnson, 2013, Tutley, 2010; Giné & Yang, 2009; Goel, 2013). To these authors, financial institutions are willing to grant loans to farmers with agricultural insurance contracts because if they (farmers) encounter a bad year as a result of an insured peril, the compensation may be used to defray the loan. This argument was corroborated by the staff of some aggregator financial institutions which have been collaborating with GAIP. In addition to the adverse effects of basis risk, which may leave some agricultural production risks unprotected, some of my study participants also reported that the role of agricultural insurance in providing guarantees for agro-loans is in theory and not a reality. A nucleus farmer (i.e., a key informant) revealed he used his drought index policy as a collateral security for an agro-loan and was denied the loan facility by a financial institution. This concern has also been captured by other studies. For instance, Marr et al. (2016) in their research "adoption and impact of index-insurance on credit and smallholder farmers in developing countries: A systematic review" reported this concern when they said, " it is unknown to what extent credit suppliers would react to the insured status of farmers." (pg. 94). This suggests that the role of agricultural insurance in providing access to agro-loans needs further research and clarity.

The ability of MFIs such as CBs, CCUs, RBs, and VSLAs to provide their farmer-clients with loans and other agro-based services have been reported in the literature (Mobarak & Rosenzweig, 2012; Reinhard, 2012). These authors, especially Mobarak and Rosenzweig (2012) and Nyong et al. (2007) encouraged farmers at the local level in the global south to insure their aggregate or covariate risks with AICs while using their membership with MFIs, FBOs, and other indigenous risks management organizations and strategies (social networks, traditional farming practices, crop and farm diversification, etc.) to address their idiosyncratic risks. Most agricultural insurance researchers, policymakers, practitioners, and IDAs are also emphasizing the complementary role of index-based agricultural insurance contracts with MFIs and other indigenous adaptation strategies. Most smallholder farmers seem to be unaware of the complementary role between index insurance policies, MFIs, and other indigenous agricultural risks management mechanisms. This is evidenced by most community members belonging to VSLAs and other FBOs with a low or even no patronage of complementary agricultural insurance services. This makes smallholder farmers potentially vulnerable to adverse effects of covariate risk since all members of the groups and communities are likely to be affected. This may also weaken the ability of the informal adaptation strategies to assist other farmers since all the farmers may be affected at the same time.This is an area AICs, and other agricultural stakeholders need to consider going forward.

8.4 Social Protection Programs and Safety Nets as Smallholder Farmers' Adaptation Strategies

My fieldwork in Northern Ghana revealed that most farmers' often employ a variety of informal adaptation strategies as their first protection layer against weather/climate risks and other agricultural challenges. Any residual adverse effects are then addressed by additional or formal agricultural risks management strategies (second protection layer). Where there are remaining adverse effects with the propensity to push farmers below the poverty line, governments and other development partners often provide safety nets, social protection, and welfare programs to cushion their citizens, including farmers to stay afloat above the poverty line, at least (Mahul & Stutley, 2010; Panda, 2013; Zahniser et al., 2010). These social protection services and safety nets in Northern Ghana are provided by both the Government of Ghana through statutorily mandated Ministries, Departments, and Agencies (MDAs) such as the Ministry of Children, Women, and Social Protection, Department of Social Welfare, NADMO, LEAP and some projects, non-profits, and IDAs such as USAID/ADVANCE, WFP, UNICEF, CRS, GIZ, IPA, and ESOKO. Some of these welfare services included the provision of relief items and food aid, provision of training and agro-inputs (e.g., cash grants, free or subsidized fertilizers, hybrid seeds, livestock, tractor and other technical services), weather information, and supporting value addition to agro-produce, including agro-processing and marketing opportunities along the agricultural value chain.

The application of social protection, welfare programs, and safety nets to support poor and marginal citizens in low-income countries as described above has been extensively documented in the literature. Adger et al. (2003), Smit et al. (1999), and IPCC's scientists' conceptualization of the adaptation circuit as reported by Zahniser, Arriola, & Somwaru (2010) described farmers' sequential adaptation strategies in their conceptual frameworks linearly and as if they (i.e., the adaptation strategies) were mutually exclusive. According to these researchers, farmers mostly employ autonomous adaptation strategies to cope with their initial agricultural risks followed by the engagement of planned agricultural risks management mechanisms to address any residual risks (i.e., risks remaining after applying both autonomous adaptation strategies). Social protection systems and safety nets are then used to address any remaining risks or impacts after the deployment of both autonomous and planned adaptation strategies.

The adaptation circuit described above may not have universal applicability in all situations. For instance, the data I gathered from the field suggest that individual farmers, governments, and other IDAs may sometimes employ planned or ex-ante adaptation strategies to address both initial and residual impacts simultaneously and may not wait to deal with initial adverse effects before tackling negative net or residual effects (ex-post risks). Even most governments in the global south are now restructuring their ex-post disaster management organizations to incorporate ex-ante risks mitigation strategies such as sensitization and awareness creation, monitoring, environmental impact assessment, and issue of early warning systems. Zahniser et al. (2010) and Smit and Skinner (2002) also disagreed with the sequential arrangement of farmers' adaptation strategies in the agricultural sector. Smit and Skinner (2002) went further to incorporate the non-sequential agricultural risks management measures into their typology of adaptation strategies in the Canadian agricultural sector as: a) technology-based adaptation strategies, b) government stabilization programs, including agricultural insurance, c) farm-based management strategies, and d) financial adaptation mechanisms. These authors did not mention anywhere in their typology of adaption options theoretical framework that some risks have to be dealt with before others. This, therefore, supports my findings and those of other scholars that the sequential arrangement of agricultural risks management strategies into the order of autonomous, planned, and social protection programs and safety nets may not have universal applicability in the agricultural sector.

8.5 The Extent of Effectiveness of Smallholder Farmers' Adaptation Strategies

My dissertation project also investigated the degree of effectiveness of smallholder farmers' adaptation strategies in order to determine the potential of agricultural insurance for crop risks management among smallholders in Northern Ghana. This integrated assessment of the extent of effectiveness of smallholder farmers' adaptation strategies found most farmers indicating their coping measures were effective to a large extent, with a few saying they were effective or not effective at all. The study participants revealed that smallholder farmers' adaptation strategies were 64.8% effective to a large extent with 10.5% and 20.7% indicating these risks management strategies were effective and ineffective, respectively. Four percent (4.0%) of the participants (mainly survey respondents) did not answer the question regarding the extent of effectiveness of smallholders' coping measures. (Figures 15 and 16)

From my interactions with discussants and informants, each farming household employed a variety of adaptation strategies to cope with their key agricultural risks. This same trend was also observed from the completed questionnaires. A possible hypothesis could be that if one adaptation measure does not work for one farming household, it might work for other(s). For instance, I got to know through triangulations that a female discussant who said their sons (referring to males in the community) usually migrate down-south and to do galamsey and return sick or even dead also cultivated drought-resistant and short-duration maize crop the previous year and indicated that her household harvested enough corn and that they could depend on it till the next (2017) farming season and even beyond. This implies engaging multiple adaptation strategies at the same time could be an effective way to address smallholder farmers' agricultural risks.This narration justifies the claim that adaptation strategies, in general, are effective to some extent. This has also been abundantly demonstrated in the climate change impact literature. Whereas Kurukulasuriya et al., (2006) and Kurukulasuriya & Mendelsohn (2008) maintained that irrigation and livestock rearing could reduce the vulnerability of farmers in different agro-ecological zones (AEZs) in Africa, Armah et al., (2011) revealed that expanding irrigation agriculture which currently involved only 0.2% (11,000ha) of arable land would diminish food insecurity conditions in Ghana.

This dissertation research is probably one of few studies that comprehensively and empirically assessed the extent of effectiveness of smallholder farmers' agricultural risks management agricultural risk management strategies in low-income countries, both weather and non-climate agricultural risks, and there may be none in Northern Ghana. Secondly, it may also be among a few, or there may even be no study linking the degree of effectiveness of smallholders' agricultural risks mitigation strategies to agricultural insurance as well as estimating the degree of effectiveness of smallholders agricultural risk management strategies quantitatively. However, I have come across some climate change vulnerability assessment and other related studies that just mentioned in passing the extent of effectiveness of agricultural risks management tools without conducting any comprehensive evaluation on them or relating them to agricultural insurance.

8.6 The Role of Agricultural Insurance in Crop Risks Management among Smallholder Farmers

Different agricultural insurance stakeholders ascribe different motivations for smallholder farmers' participation in AIPs. However, there has not been any study that specifically explored why smallholders have been purchasing crop insurance contracts over the years in Northern

Ghana, especially from a multi-layered stakeholder perspective, i.e., primary smallholder farmers, and secondary and tertiary agricultural stakeholders. This dissertation project was crafted to respond to this gap, especially from the perspectives of agricultural insurance stakeholders in Northern Ghana. While attempting to contribute to this discourse, I also posed the question: what does the extant literature also say about the role of agricultural insurance in smallholder farmers' crop risks management in Northern Ghana other low-income countries vis-a -my findings? This question constitutes the motivation and focus for a discussion of the results in this section.

My fieldwork generated a wide range of responses which suggest that AIPs and contracts have been providing resilience and protection against insured farmers' crop production risks. The study participants revealed that agricultural insurance schemes (AIS) and policies have been beneficial to insured farmers directly or indirectly in the following ways: 1. Motivation to increase crop production, 2. Protection of farm investments, 3. Provision of agricultural insurance and agricultural-related information and education, 4. Promoting food security, 5. Improving access to financial services, 6. Ensuring stability and sustainability in farming undertakings, 7. Enhancing agricultural planning, and 8. Mobilizing revenue for national development (indirect benefit). Refer to chapter 8 for detailed information on the role of agricultural insurance in crop risks management in Northern Ghana.

Some researchers, policymakers, practitioners, and other agricultural insurance stakeholder have reported similar findings presented above. For example, some studies have found that compensations paid to insured farmers when the trigger events occur have been motivating and increasing the confidence of some farmers in low-income countries to improve their agricultural production (Barnette & Mahul, 2007; Lotze-Campen & Hopp, 2012; Nnadi, 2013; Panda, 2013; Rao, 2010; Tutley, 2010), protecting financial investments of farmers (Acheampong & Nunoo, 2014; Haruna, 2015; Panda, 2013a), providing stability and sustainability in agricultural undertakings (Panda, 2013a, Barnett & Mahul, 2007, Smit & Watts, 2009), and ensuring household food security during bad years (Panda, 2013; Jose & Valluru, 1997). Some earlier studies conducted in Ghana and other low-low income countries also found that some AIPs facilitate access to agricultural loans, agro-inputs (such as improved seeds, fertilizers), agro-based value chain linkages (Haruna et al, 2017; Goel, 2013; Yang & Yine; 2009; Hochrainer et al., 2009; Karlan et al., 2009), and agro-meteorological, agricultural extension, and agronomic information (Goel, 2013; Makaudze, 2005). Makaudze (2005) also reported that coupling weather forecasting with purchase of agricultural insurance products can ensure predictability in the occurrences of extreme weather event, the associated impacts on crop yields, and payment of compensation. Extending Makaudze's views further, I found agricultural insurance providing predictability as described above as having the potential to enhancing agricultural planning, stability, and sustainability in agricultural undertakings in Northern Ghana. Although Makaudze made a useful contribution to the agricultural insurance scholarship, there may not be a high degree of certainty in the predictability of the weather information and its impacts on crop yields and claim payments as he claimed. This uncertainty may also affect the planning, stability, and sustainability of agricultural undertakings. In the case of a drought index policy, for instance, the effect of basis risk may interfere with the expected compensation as an input into the agricultural planning process. Also, a trigger event in the case of DII contract could generate claim payments anywhere between 0%-100% of the total expected or projected sum assured. Aside from the uncertainty of the weather predictions, the percentage of claims a farmer can expect may be uncertain at the begging of the planting season to aid effective planning, especially from developing countries like Zimbabwe and Ghana. The effect of adverse selection, moral hazards, and fraud may also deny the insured farmer compensation in the case of MPCI contracts if it is later detected. This may affect the anticipated compensation to be used for agricultural planning purposes. In a nutshell, agricultural insurance may enhance stability, sustainability, and planning in the agricultural sector, but one cannot be 100% certain of this benefit. What is certain is that compensation is supposed to be paid if the trigger event occurs in the case of an index insurance contract; what is uncertain is, whether it will be paid, when it will be paid, and how much the claims will be. There is, therefore, the need to continue to research as some researchers at the Financial Instrument Team of the International Research Institute for Climate Science and Society (IRI), some agro-meteorological agencies of low-income countries, and other development partners are currently working hard to improve weather forecasting and its predictability.

The role of conventional insurance in mobilizing resources for national development is not new. Mills (2012) in his article "the greening of insurance" reported that the insurance sector is the most extensive industry in the world worth about US$4.6 trillion and also accounting for 7% of the global economy as at 2012. These macro-economic indicators were determined at the global level. It was, however, intriguing for some study participants in a developing country like Ghana where agricultural insurance is still emerging to recognize that agricultural insurance has been or can mobilize resources for national development. It was ingenious on the part of some study participants to recognize that resources can be mobilized for national development from the agricultural insurance sector's possible excess premiums over claims, direct investment by the AICs, payment of taxes to the government, and use of proceeds from its (agricultural insurance sector's) motivation to increase agricultural production, protecting agricultural investments, and using benefits accruing from the sector to invest in the national economy, ultimately translating into national development. In exploring the role of agricultural insurance in crop risks management, my anticipation was for the study participant to indicate how agricultural insurance contracts have been or can be beneficial to them, i.e., direct benefits and not indirect ones. This was a surprise finding.

Most index-based agricultural insurance programs in low-income countries usually provide some free services to their clients such as access to agricultural, Agricultural insurance, and agro-meteorological and extension information (e.g., Goel, 2013; Hochrainer et al., 2009; Hossain, 2013; Yine & Yang, 2009). Even though my study found GAIP and WorldCover collaborating with other agricultural sector stakeholders to provide some of these services such as weather information, early warning systems, agricultural extension and agronomic education and services; bundling agricultural insurance contracts with agro-inputs, including chemical fertilizers, hybrid seeds, and facilitating market access and value addition to farm produce was not part of the deal. In answering questions on insured farmers' expectations from AICs, most focus group discussants, key informants, and survey respondents expect insurers to bundle agricultural insurance contracts with the provision of agro-inputs and the relevant value chain linkages such as marketing and agro-processing opportunities as described above from the farm gate to the final consumer. Instead of AICs, I rather found nucleus farmers or leaders of FBOs purchasing agricultural insurance policies for their out-growers or members and bundling these contracts with provision of agro-inputs such as fertilizers, seeds, marketing avenues, and tractor services under special terms for repayments either in cash or kind. By this arrangement, out-growers pay for these services after selling their farm produce or using part the harvest to settle the nucleus farmers, with the insurance contracts acting as a second protection layer. I think these are innovations, lessons, and best practices that can be learned and embraced by other AICs and agricultural stakeholders in other low-income countries.

8.7 The Role of Agricultural Insurance in Promoting Sustainable Farming Practices and Climate Change Mitigation

Considering the importance of agricultural insurance for crop risks management, there has been a continuous search for sustainable AIP, especially in low-income countries. This is mostly done through the conduct of feasibility studies, piloting of AIPs and contracts, post-feasibility and piloting phase evaluations and mainstream research (Banerjee, 2012; Smit & Watts, 2009; Tutley; 2010). The sustainability of any program or system can be premised on four pillars, namely-social, economic, ecological/environmental, and institutional/organizational domains (Azapagic & Perdan, 2000, Brundtland Commission Report, 1987; Serageldin, Steer, & Cernea, 1994), and agricultural insurance is not not an exception. In this dissertation, an exploration of how agricultural insurance can promote sustainable farming practices and climate change mitigation is restricted to the ecological pillar of sustainable development. Sustainable farming practices as used here include agro-ecological farming systems, agro-forestry, CSA practices, and conservation agriculture, and these concepts will subsequently be used interchangeably.

Some researchers have called on the insurance industry in general and agricultural insurance stakeholders, in particular, to promote and engage in sustainable farming practices and climate change mitigation to ensure the overall sustainability of the industry (Adegoke et al., 2017; Claassen, 2015; Mills, 2007). This is because climate change has been blamed for escalating the industry's liabilities (Berz, 1999; Mills, 2007; 2009) and causing maladaptation and ecological degradation (Klein & Maciver, 1999; Müller, Johnson, & Kreuer, 2017; Panda, 2013), probably unintentionally. This prompted some ecologically conscious and sustainable development minded researchers, including Phelan et al. (2011), Galaz et al. (2015), and Müller and Kreuer (2016) to research into topics such as “Ecological viability or liability? Insurance system responses to climate risk”, "Why ecologies should care about financial markets," and "Ecologists should care about insurance, too", respectively. In amplifying the discussion, Phelan et al. (2011) revealed that “most insurance system responses to date are generally adaptive and weakly mitigative” pg. 1.

However, the role of agricultural insurance in promoting agro-ecological farming systems and climate change mitigation is an emerging field (Dahlström et al., 2003a; Skees & Collier, 2012). Mills (2007) argued that the insurance industry contributes to the climate change challenge and must also be part of the solution. My fourth research question in response to Mills' (2007) and other researchers' call for further research explored: 1. The willingness of AICs and other agricultural insurance stakeholders to engage in and promote sustainable farming practices and climate change mitigation, 2. How this can be achieved, and 3. Benefits of promoting sustainable agricultural practices and climate change mitigation to both the insurers and insured. In response to the questions mentioned above, my study participants enumerated the various ways this can be done. These findings include: 1. Both insurers and other agricultural stakeholders indicated their willingness to engage in and support agro-ecological farming practices and climate change mitigation, 2. Some of the ways smallholder farmers can contribute to sustainable agriculture and climate change mitigation include- engaging in agro-ecological and CSA practices such as agro-forestry, non-burning of the bush and crop residue, establishment of agro-ecological demonstration farms, and undertaking afforestation and reforestation activities, protection of sacred groves and culturally important ecological sites, and engaging in zero and minimum tillage and conservation agricultural practices (Table 13). It was also observed that most farmers were already engaging in some of these sustainable farming systems and practice at the time of the fieldwork. 3. Smallholder farmers’ motivations for engaging in sustainable farming practices include: achieving food security, improved crop yields, farming practices serving as a source of employment and income, (especially for women), compliance with traditional agricultural conventions and norms, farming practices as a source of soil nutrients, and reduction in environmental degradation among other motivations (Table 13).

Agricultural insurance providers and regulators also indicated ways they can promote sustainable agricultural practices and climate change mitigation. These measures include:

1. Bundling agricultural insurance policies with the adoption of agro-ecological farming practices and environmentally-friendly agricultural technologies-e.g., agro-forestry, non-burning, and engaging in zero and minimum tillage.

2. Coupling agricultural insurance contracts with the provision of agro-inputs, agro-value additions, and market access as a condition for smallholder farmers to engage in conservation agricultural practices-e.g. providing smallholder farmers with chemical fertilizers and improved seeds as a condition for them to incorporate agro-diversity and agro-forestry practices into their farming undertakings.

3. AICs and their collaborating partners creating awareness among smallholder farmers about sustainable agricultural systems and climate change mitigation, i.e., sensitizing farmers about CSA, agro-ecological farming practices, and zero and minimum stillage.

4. AICs collaborating with technical departments and agencies in both the public and private sectors (e.g., EPA, FSD, MOFA, GMA, SARI, UDS, MESTI, UNDP, FAO, WFP) to access resources from multinational, bilateral, and UN's climate change adaptation and mitigation funds to provide farmers with subsidized "green" insurance contracts.

5. Inserting specific climate change mitigation and CSA clauses and conditions into agricultural insurance contracts.

6. Promoting the use of agro-technologies that require the use of less agro-inputs and land for improved yields-e.g., the use of organic manure, chemical fertilizers, and high-yielding crop varieties

7. Government support and subsidization of AIPs and contracts as a condition for insurers and insured farmers to promote and engage in sustainable farming practices and climate change mitigation-e.g., government supporting AICs with the requisite infrastructure, re-insurance guarantees, and A&O cost support for AICs to be able to sell affordable policies to farmers and still make minimum profit, at least. With this support, farmers, in turn, are expected to reciprocate this gesture by engaging in sustainable agricultural practices and climate change mitigation activities as a requirement for government's subsidization of their premiums. Both farmers and insurers indicated their readiness to support and engage in thes arrangements.

The role of agricultural insurance in promoting sustainable agriculture and climate change is generally an unexplored territory globally, more especially in low-income countries. As a result of the grey nature of this field, most of my findings may be original, and can, therefore, make an immense contribution to the agricultural insurance scholarship, policy, practice, and the regulatory environment. This notwithstanding, some of my findings are consistent with results and recommendations of the few studies in this field. For instance, some studies also found that some insurance stakeholders' motivation for engaging in agro-ecological farming practices and climate change mitigation activities included increasing the profitability of AICs (Mills, 2007, 2009, 2012), ensuring environmental sustainability and profitability (Claassen, 2015a; McKinley, n.d.; Panda, 2013;), and compliance with contractual agreements (Claassen, 2015a).

The willingness of agricultural insurance stakeholders to take advantage of the numerous opportunities provided by the climate change adaptation and mitigation funds to promote and engage in climate adaptation and mitigation activities has been corroborated in the literature. For example, Dahlström, Skea, and Stahel (2003) reported that the insurance industry could contribute towards climate change mitigation through the creation of carbon sinks and carbon sequestration if the right administrative and regulatory systems were instituted. Skees and Collier (2012) also revealed that governments could collaborate with other stakeholders and development partners to access resources from climate change adaptation and mitigation funds as provided by the UNFCCC to support the provision of "green" subsidized insurance contracts to marginal farmers in low-income countries.

Findings from Mills' (2009) review of the global insurance industry's response to climate change) and his greening of insurance (2012) articles are consistent with views of my study participants regarding how AICs can promote climate change mitigation. Mills (2009, 2012) revealed that insurance companies' commitment to climate change mitigation includes supporting climate change research, designing and marketing climate and environmentally-friendly insurance products and services, creating awareness about climate change, and incorporating climate change issues into insurance companies' investment decisions and policies. Even though some of these commitments are not directly targeting farmers, their implementation could help them (i.e., farmers). For instance, awareness about climate change, climate-friendly agricultural insurance policies, support to climate change research and climate-friendly agricultural insurance investment decisions may affect and influence farmers' agricultural decisions and actions.

Throughout my literature review, I only came across few empirical researchers who investigated issues relating to the role of agricultural insurance in promoting sustainable farming practices and climate change mitigation as discussed above. Many other investigators found some of the problems my study participants raised but not in direct relation to agro-ecological farming practices and climate change mitigation. I have so far not encountered any study in Ghana or Northern Ghana that specifically explored the willingness of a multi-layered agricultural insurance stakeholders to promoting or engaging in CSA practices and climate change mitigation even though most other studies focused on willingness to pay (WTP) or purchase agricultural insurance contracts (e.g., Balma et al., 2016; Bugre et al.; 2017; Danso-Abbeam et al., 2014; Kwadzo, Kuwornu, & Adamu; 2013). Other studies in some low-income were based on bundling agricultural insurance contracts with agro-inputs, loans, marketing opportunities, value additions, and linking farmers with agro-processors along the agricultural value chain (e.g., Cell, 2009; Hochrainer et al., 2009; Lotze-Campen & Popp, 2012b; Yang & Yine, 2009), and not agro-ecological farming and climate change mitigation activities. Other virgin areas (especially in Northern Ghana) my research explored were: a) dentification of ways agricultural insurance can contribute to sustainable agriculture and climate change mitigation, especially from the ecological lens, b) motivations for insurers and insured farmers to promote and engage in CSA and climate change mitigation, c) bundling agricultural insurance policies with sustainable farming practices and new agro-technologies, d) coupling government's support and subsidization of AIPs with promotion and engagement in sustainable farming practices and climate change mitigation by AICs and insured farmers -e.g., government supporting AICs with the requisite infrastructure, and they, in turn, providing farmers with subsidized ‘green’ contracts.

Findings from these grey areas as reported above may be original, and can, therefore, extend the discourse on agricultural insurance further, especially concerning how agriculturalinsurance can contribute to sustainable farming practices and climate mitigation in low-income countries from multi-layered stakeholder perspectives. This dissertation project, therefore, provides the opportunity for best practices and lessons to be learned by AIPs in other low-income countries.

The next chapter presents the summary, conclusions, and recommendations of the study.

Chapter 9: Summary of Study, Conclusions, and Recommendations

9.1 Introduction

Chapter nine summarizes the previous chapters and draws central conclusions from the results chapters four through eight. It also discusses the scholarly, practical, policy, and regulatory implications of the study on agricultural insurance in Ghana and ends with a discussion of the study's, recommendations for further research.

9.2 Summary of the Dissertation

This dissertation project was undertaken to explore agricultural stakeholders' perceptions of the potential of agricultural insurance for crop risks management among smallholder farmers in Northern Ghana. Successive governments in collaboration with some IDAs have rolled out different interventions in their attempt to assist smallholder farmers to mitigate their agricultural risks in some low-income countries, including African countries. Even though some of these interventions aided the farmers, the problems still persist, especially climate variability, climate change, and weather extremities. This is particularly worrying because smallholder farmers in Northern Ghana and in most other tropical developing countries depend on rain-fed agriculture (Acheampong et al., 2014; Sumani, 2008). To support smallholders to address their key agricultural challenges, some researchers, development partners, and policymakers (e.g., Barnett & Mahul, 2007; Carter et al. 2016; Carter et al., 2014) maintained that agricultural insurance, especially index-based insurance has the potential to assist smallholder farmers to address their key agricultural risks . Some low-income countries are already conducting feasibility studies, piloting, up-scaling, and operationalizing AIPs, and Ghana has also recently joined the train.

There are currently two operational AICs in Ghana, namely, GAIP and WorldCover (WC). Innovative Insurance Product for the Adaptation to Climate Change (IIPACC) and subsequently GAIP started piloting various agricultural insurance products in Northern Ghana since 2009 and is currently being up-scaled by GAIP almost throughout Ghana. WorldCover is also presently test-running its DII policies in Northern Ghana and going through the licensing acquisition process at the same time. The Government of Ghana has also indicated its intention to start a new AIP in the 2018 farming season called Ghana Incentive-based Risks Sharing for Agricultural Lending Program (GIRSAL).

Despite all these initiatives, little research has explored the potential of agricultural insurance for crop risks management in Northern Ghana. However, some researchers reported that some index-based AIP in some low-income countries have recorded mixed reactions, low-take-up rates, and issues of maladaptation and ecological degradation (Binswanger-Mkhize, 2012; Cell, 2009; Galaz et al., 2015; Klein & Maciver, 1999; Phelan et al., 2011), yet no such a study has specifically been conducted to either explore the potential of agricultural insurance for crop risks management or examine whether concerns expressed about the extent of effectiveness and environmental ramifications of AIPs elsewhere are also occurring in Northern Ghana. The few studies conducted in Northern Ghana only looked at the role of agricultural insurance in investment protection, promoting the use of agro-inputs, provision of safety nets, and WTP for agricultural insurance services. The closest study was Stutley's (2010) agricultural insurance feasibility study in Ghana. This dissertation project has, therefore, been designed to investigate the gaps identified above. I specifically sought to find answers to the following research questions:

1. What are smallholder farmers' key agricultural risks?

2. What strategies have smallholder farmers been employing to manage their key agricultural risks? And to what extent are these strategies effective?3. How have AIPs and contracts (i.e., the benefits of agricultural insurance) been or can support smallholder farmers to manage their key crop risks?4. Are AICs and insured farmers willing to promote and engage in sustainable farming practices and climate change mitigation? If yes, how can this be achieved? And what are their motivations for promoting and engaging in sustainable farming practices and climate change mitigation activities?

I employed a convergent mixed methods research design to answer the research questions posed above. I also used a combination of stratified, multi-stage, random, purposeful, and snowballing techniques to select my sampling units. I again employed six FGD sessions in three farming communities,namely, Duori-Guo, Kazigo, and Nyankpala to gather responses from fifty-one farmer-discussants (28 females and 23 males). I equally interviewed twenty-nine key informants (7 women and 22 men) comprising AEAs, agricultural insurance staff, nucleus farmers, GMA staff, NIC, and agricultural-based NGOs and projects. Again, I administered questionnaires to three females and twelve male respondents. The discussions and interviews were audio recorded, transcribed verbatim, coded with emerging patterns and themes identified. Some of the variables were exported into Excel for further processing and analysis. Responses from survey respondents were also organized, coded, cleaned and the various variables exported into Excel and SPSS for analysis. As a convergent mixed method study, both the qualitative and quantitative date were then merged for further analysis.

Weather and non-weather-induced agricultural risks were listed as smallholder farmers' key agricultural risks in Northern Ghana. The study participants ranked climate-induced agricultural risks as the most devastating agrarian challenge affecting smallholder farmers in

Northern Ghana. Some weather/climate-related risks the study participants enumerated were erratic rainfall patterns, droughts, excessive evapo-transpiration rates, floods, poor rainfall distribution, and high temperature values or heat waves. The non-weather-based risks the study participants mentioned were difficulties associated with the acquisition of agro-inputs (e.g., their non-availability or availability at the wrong time, agro-inputs being expensive, poor quality seeds etc.), crop pests and disease infestations, poor transportation networks, market-related problems (low demand, low prices, price fluctuation), post-harvest losses, inadequate tractors/bullocks/farmhands (farmers often queue for these services, leading to late plowing). Included in the list were inadequate agro-processing and value addition opportunities, harmful activities of alien Fulani herdsmen, negative socio-cultural and religious beliefs and practices, and environmental degradation, among other challenges.

The study participants also identified a plethora of smallholder farmers' agricultural risks management strategies, including science and technology-based adaptation strategies which involves the cultivation of improved crop varieties such as drought-resistant, high-yielding, water efficient, flood tolerant, and short-maturing crops; engaging in livelihood-related adaptation activities -e.g., out-migration, off-farm jobs, food rationing, small-scale trading, illegal small-scale gold mining, obtaining fruits and vegetables from the wild; and farm-based risks diversification adaptation strategies, i.e., multiple cropping, mixed farming, farm diversification, agro-forestry practices, land and crop rotation, and CSA. Other adaptation strategies reported were: financial inclusiveness, e.g., purchase of agricultural insurance policies, acquisition of formal and informal loans, and farmers' membership with MFIs such as CCUs, CBs, VSLAs, and FBOs where they save and can obtain loans, weather/climate information-based adaptation measures (e.g. provision and utilization of agro-meteorological, extension, and agronomic information to guide farmers' agricultural activities), and farmer-generated weather information and farm history based adaptation strategies that is, farmers themselves studying the rainfall and weather patterns over the years and adjusting accordingly as well as sharing such adaptive information with other farmers, studying the drought, flood, and crop growth history of their farms and using such information to adapt appropriately. Discussants, informants, and survey respondents further reported other adaptation measures such as, flood-related adaptation strategies such as the cultivation of flood-friendly crops, molding of mounds to raise roots of crops above water level, construction of drainage channels to divert flood water away from the farms, placement of sandbags across water channels to reduce water speed and soil erosion, smallholder farmers using their socio-cultural, traditional, and religious adaptation strategies i.e., cultivation of traditional crops known to be drought and flood tolerant, using their faith and beliefs as adaptation strategies, and the use of social protection and safety nets as agricultural risks coping mechanisms (e.g., government, NADMO, LEAP, IDAs, and NGOs providing ex-post food aid, free or subsidized fertilizers and other agro-inputs and relief items to vulnerable farmers).

The adaptation strategies mentioned above were assessed to be effective to a large extent. For instance, the study participants said their agricultural risks management strategies mentioned above were 64.8% effective to some extent, 20.7% completely ineffective, and 10.5% effective with 4.0% as a missing value, (i.e., 4.0 % of the study participants did not answer the question), mainly from the survey respondents**.** The statistics presented above have implications for the potential of agricultural insurance in Northern Ghana.

This dissertation research revealed eight ways smallholder farmers' participation in AIPs and contracts have been or can (i.e., hypothetical functions) enable them to mitigate adverse effects of some of their agricultural risks. The benefits of agricultural insurance range from: 1.

increasing farmers' confidence and motivating them to increase agricultural production, 2. protecting farmers' agricultural investments, 3. financial risks protection and provision of other agro-related services, 4. ensuring food security, 5. provision of agricultural, agricultural insurance, and agro-meteorological information and education to farmers, 6. providing stability and sustainability of farming undertakings, 7. enhancing agricultural planning, and 8. mobilizing revenue for national development. These eight functions of agricultural insurance provides direct and indirect benefits to insured farmers. The functions of AIPs and contracts itemized above expand the benefits of agricultural insurance in low-income countries vis-à-vis those mentioned in the extant literature.

I also explored the willingness of agricultural insurance stakeholders to promote and engage in sustainable agricultural practices and climate change mitigation activities. I specifically investigated how this can be done and the stakeholders' motivation to supporting and engaging in agro-ecological and CSA practices. I found that insurers and smallholder farmers unanimously indicated their readiness to promote and engage in conservation agriculture and climate change mitigation. Other secondary and tertiary study participants who were neither smallholder farmers nor insurance staff also declared their support for such an innovative and novel idea. Staff of the AICs revealed that their companies could promote sustainable agricultural systems and climate mitigation through: 1. bundling subsidized and affordable contracts with sustainable farming practices and climate change mitigation activities if AIP are also supported and subsidized by the government with infrastructural, technical, reinsurance, and A&O cost, 2. incentivizing or reward smallholder farmers to continue to engage in agro-ecological farming practices, especially with resources from government and climate mitigation and adaptation funds, 3. AICs and their collaborating partners creating awareness and sensitizing smallholder farmers about CSA, agro-ecological farming practices, and conservation agriculture, 4. AICs partnering with the relevant statutory MDAs (e.g., MESTI, EPA, FSD etc.), IDAs, NGOs, and other appropriate private sector organizations to write proposals to access climate adaptation and mitigations funds to provide subsidized green insurance contracts with explicit clauses and conditions compelling beneficiary farmers to engage in the prescribed green agricultural and climate change mitigation activities (Tables 13), and 5. inserting specific terms and conditions that promote sustainable farming practices and climate change mitigation activities into agricultural insurance contracts.

Smallholder farmers also indicated their willingness to continue to engage in sustainable agricultural systems and to increase and improve their agro-ecological farming practices and climate change mitigation activities if motivated. They also mentioned the factors that would motivate them to engage in sustainable agricultural and climate-friendly agrarian-based activities. These include: 1. Coupling provision of agro-inputs, market access, and agro-based value chain activities with conservation agricultural practices and non-farm-based climate change mitigation strategies (e.g., afforestation, reforestation, plantations, CNRM activities and community forest reserves), 2. Bundling agricultural insurance policies with CSA practices (i.e., leading to soil carbon sequestration) and technology-based adaptation strategies (e.g., agricultural intensification and cultivation of high-yielding crop varieties) that require the use of less agricultural land, leading to release of less CO_2 and other GHGs, and 3. Rewarding farmers for incorporating sustainable farming practices and climate change mitigation into their farming activities.

As a study exploring perceptions of the potential of agricultural insurance for climate change mitigation and in promoting sustainable farming practices, the study participants were also asked to indicate smallholder farmers' existing agricultural systems and their motivation for engaging in those farming practices (Table 13). The study participants reported both sustainable and unsustainable agricultural practices. Some of the environmentally-friendly farming practices and systems identified were: Agro-forestry, minimum and zero tillage systems, mixed farming, farm and crop diversification, land and crop rotation, cover cropping, and non-burning, especially of crop residue. The few unsustainable farming practices listed were farming close to water bodies (leading to siltation) and using bushfires to clear agricultural lands (causing air pollution, global warming, denying soil of organic manure, and loss of biodiversity). Farmers motivation for employing these sustainable farming practices included increased agricultural productivity and food security, some of these practices acting as sources of employment and income (especially for females), provision of soil nutrients and maintenance of soil micro-organisms, provision of shade, trees attracting rains, compliance with traditional authority and rules, source of traditional and herbal medicine, and reduction in farmers' labor budget- reduction in drudgery through the use of controled bushfires and zero and minimum tillage practices to clear weeds and agricultural lands.

9.3 Conclusions

I conclude based on stakeholder perspectives that agricultural insurance has an enormous potential for both crop risks management and in promoting sustainable farming practices and climate change mitigation in Northern Ghana. I arrived at this conclusion because the data analysis and stakeholder perspectives suggest that smallholder farmers in Northern are exposed to a multiplicity of agricultural risks, both weather, and non-weather-induced. These risks are reportedly visiting untold hardships on smallholder farmers with severe food security implications.

Generally, smallholder farmers' adaptation strategies were found to be effective to some extent. For instance, 67.5%, 10.9%, and 21.5 of the study participants indicated their adaptation strategies were effective to some extent, 100% effective, and ineffective, respectively. This implies that 89% (i.e., 67.5% +21.5%) of the study participants described smallholder farmers' agricultural risks management strategies as being ineffective to varying degrees. The potential of agricultural insurance for crop risks management in Northern was, therefore, determined from the implied agricultural risks mitigation gap estimated from the lack of 100% effectiveness of smallholder farmers’ existing adaptation strategies. The gap identified in perceived effectiveness of existing adaptation strategies demonstrates that agricultural insurance as complementary planned or ex-ante crop risks mitigation strategy has a huge potential that can be harnessed to support smallholder farmers in Northern to manage their key agricultural risks. The challenge, however, is how to tap into this potential. Stutley (2010) of the agricultural insurance unit of the World Bank was right in recommending the introduction of agricultural insurance products in his feasibility study in Ghana eight years ago, and his findings are still relevant to some extent today, thus, corroborating mine as recently as 2018. However, there are new demands, dynamics, and expectations from agricultural insurance stakeholders which Stutley's study probably did not identify or anticipate but have emerged because of the emergence of new agricultural risks and developments. For example, apart from wanting to be involved or consulted in the design of AIPs and contracts, insured farmers also expect AICs not only to visit them regularly but also to sympathize with them if they suffer losses that are not protected by the insurance contracts.

Findings from the role of agricultural insurance in assisting farmers to address their agricultural risks suggest that AIPs and contracts are indeed beneficial to farmers to some extent. However, some study participants enumerated some challenges associated with the operationalization of agricultural insurance schemes in Northern Ghana, including low penetration rate, low awareness, issues of basis risks, incomplete protection of farmers ‘upstream risks (i.e., DII providing partial crop production risks protection) and non-protection of farmers’ downstream risks such as price, market, demand, revenue, and post-harvest loss risks. Addressing these risks will enhance the potential of agricultural insurance in Northern Ghana and other low-income countries.

I also conclude that agricultural insurance has the potential in promoting sustainable farming practices and climate change mitigation proactively in Northern Ghana. This potential was gauged from the willingness of both AICs represented by agricultural insurance staff and the study participants to promote and engage in sustainable agricultural practices and climate change mitigation activities. However, the readiness to support and undertake agro-ecological, CSA, and conservation agricultural practices was estimated hypothetically (a weakness), i.e., discussants, key informants, and survey respondents probably indicated their willingness to promote and engage in sustainable farming practices and climate change mitigation activities in order to appear environmentally responsible before the fieldwork team or they responded in the affirmative because they felt that was what the study team wanted to hear without any real intention to back their answers with action. I am not in the position to concretely confirm or deny that the study participants will or will not fulfill their promise to support and engage in initiatives that can contribute to sustainable agricultural practices and climate change mitigation. What is clear is the revelation from the study results that some smallholder farmers were already incorporating agro-ecological and agro-diversity practices into their farming activities at the time of the fieldwork with tremendous benefits such as provision of food, income, employment, soil nutrients, and herbal medicine).

The farmers further indicated their willingness to engage in more agro-ecological farming practices with the potential for climate change mitigation if motivated and provided with insurance contracts bundled with agro-inputs, agro-meteorological, and other agricultural value chain-related services and opportunities. The AICs also expressed their willingness to provide these services if the government and other development partners support them (AICs) with technical, infrastructural, material, financial, reinsurance, and A&O cost to be able to provide affordable and accessible agricultural insurance products and services on a profitable and sustainable basis. Some researchers in the agricultural insurance scholarship also maintained that unsustainable farming practices, changing climate, and weather extremities are increasing the liabilities of insurance companies and further argued that the reversal of these environmental threats would inure to the profitability and sustainability of the insurance industry in general, and AICs in particular (Berz, 1999; Mills, 2007, 2009).

9.4 Contributions

The contribution of this dissertation project is four-fold: scholarly, practical, policy, and regulatory contributions. The first scholarly contribution is the comprehensive identification and discussion of agricultural risks confronting smallholder farmers in Northern Ghana. This involves the simultaneous identification and discussion of both weather and non-weather-induced agricultural risks facing smallholder farmers in Northern Ghana from multi-stakeholder perspectives, i.e., primary smallholder farmers (i.e., focus group discussants) and secondary and tertiary key informants and survey respondents. Previous studies identified agricultural risks confronting smallholder farmers,mainly weather/climate-induced risks almost to the neglect of the non-weather-based agricultural risks (e.g., Osbahr et al., 2011 study in Uganda) or discussed them separately even though both categories of risks adversely affect farmers and can reinforce each other. This dissertation research approached this issue differently by undertaking the concurrent identification and discussion of both weather and non-weather-based agricultural risks affecting smallholder farmers in Northern Ghana. This position was informed by my fieldwork where smallholder farmers indicated that both weather/climate and non-weather/climate-induced agricultural risks posed serious challenges to their agricultural activities. This finding is consistent with the way other studies approach the identification and discussion of agricultural risks and the associated adaptation strategies comprehensively in Canada, the USA, and other countries (e.g., McLeman & Smit, 2006 and Smit & Skinner, 2002).

Most climate impact studies in the agricultural sector usually identify agricultural risks and recommend the accompanying adaptation strategies, thus, only linking agricultural risks and the associated adaptation strategies. My dissertation project went beyond the linkage between smallholder farmers' agricultural risks and the related adaptation strategies to assess the effectiveness of the adaptation strategies in addition to the role agricultural insurance plays in assisting smallholders to manage their crop risks as well as promote sustainable farming practices and climate change mitigation in a single study in Northern Ghana. I refer to this contribution as a six-in-one research or one-stop-shop study.

This six-in-one study, i.e., one research linking agricultural risks, adaptation strategies, extent of effectiveness of the adaptation strategies, the role of agricultural insurance in crops risks management, and in promoting sustainable agriculture and climate change mitigation is necessary for establishing perceptions of the potential of agricultural insurance for sustainable crops risks management among smallholder farmers in Northern Ghana qualitatively and by extension, other low-income countries. First, agricultural insurance has the potential if there are agricultural risks and existing coping strategies are unable to address them adequately. Secondly, agricultural insurance becomes a sustainable agricultural risks management tool if it can promote sustainable farming systems and climate change mitigation. This would have the benefit of making agricultural insurance businesses sustainable and profitable in the medium to long-term since sustainable farming practices and climate change mitigation initiatives may reduce the liabilities of AICs

(Mills, 2007), thus increasing their profitability and sustainability, ceteris paribus, i.e., all things being equal. The reduced insured risks and profitability of AICs will, in turn, make agricultural insurance contracts available, affordable, and accessible to smallholders. This would also motivate an increase in uptake rates, further leading to the profitability and sustainability of AIPs because risks can be pooled spatially and temporally, and the cycle goes on. The novelty of this dissertation project is its one-stop-shop configuration and the cyclical nature of the reduced risks, increased accessibility and affordability, increased up-take rates, AICs becoming profitable and sustainable business entities, and the cycle goes on engineered by the six-in-one linkages described above.

This explorative research is among the few if not the first to link agricultural insurance to the promotion of sustainable farming practices and climate change mitigation in Northern Ghana. The closest study I found in Ghana was McKinley's (2014) thesis on "The Economic Viability of Cocoa Crop Insurance in Ghana" and an article he co-authored with other scholars on "The Potential of Climate-Smart Cocoa Insurance: A Pathway to Increase Yields and Reduce Farmers' Risks from Climate Change in Ghana (n.d.). However, this study was conducted in Southern Ghana on a tree crop, that is, the cocoa tree crop. My study took place in Northern Ghana, involving arable crops.

Globally, the role of agricultural insurance in promoting sustainable agriculture and climate change mitigation is an emerging field with only few developed and developing countries embracing it even though there are reports that activities of some AICs and programs are causing ecological degradation and maladaptation (Klein & Maciver, 1999; Mills, 2007, 2009, 2012; Panda, 2013), probably as unintended consequences. Some researchers have started raising awareness about the negative environmental consequences of some agricultural insurance programs (Galaz et al., 2015; Müller & Kreuer, 2016; Phelan et al., 2011) with other scholars and practitioners showing how agricultural insurance can support climate change mitigation (Dahlström, Skea, & Stahel, 2003; Skees & Collier, 2012). My study also explored how agricultural insurance can promote sustainable farming practices and climate change among smallholder farmers in Northern Ghana and found it to have a strong support from both insurers and smallholder farmers as evidenced by their willingness to participate in activities with the potential for promoting sustainable agricultural practices and climate change mitigation

This dissertation project is also among the few empirical studies that found the feminization of some agricultural risks, crops, and the associated adaptation strategies (i.e., gender-disaggregated agricultural risks, crops, and adaptation measures) and gender-based family resource control and allocation of agricultural lands. During the FGDs in the Kazigo and Nyankpala communities of the UER and NR, respectively, I found flooding of rice fields, inability to purchase agro-inputs, and lack of access to tractor and bullock services as females' major agricultural challenge compared to males. Rice was also identified as a feminized crop (i.e., mostly cultivated by females and which I labeled as the feminization of rice cultivation) and it was widely reported that rice fields have been exposed to severe flooding in the Kazigo and Nyankpala communities over the year, leading to losses in rice yields. It also emerged that males who traidionall own and control land in Northern Ghana usually allocate less fertile agricultural lands to female farmers. To cope with the situation, I found that women in the Kazigo community have been devising innovative and less financial demanding adaptation strategies by preparing organic manure from crop residue, livestock dung, poultry bird droppings, and water to convert infertile lands to productive farmlands. This feminized adaptation strategy is a type of CSA practice. It was further reported that men usually snatch such feminized fertile fields from the women the next farming season and are allocated unproductive lands again, and the cycle goes on. This is the plight of some women-farmers in Northern Ghana. Bugre (2008) and Greatrex and MaCarthy (2016) also found discrimination against women in the allocation of agricultural lands and control over household financial resources in Northern Ghana. My study extended these findings by reporting how women have devised innovative and non-financially demanding ways of addressing some of the feminized agricultural risks.

Another significant contribution of this study to the theoretical enhancement and consolidation in the agricultural adaptation literature from multi-layered stakeholder perspectives in Northern Ghana is a finding contrary to the established convention by some researchers that there is a sequential and predictable pattern of adaptation circuit to climate-induced agricultural risks. According to Adger et al. (2003) and Smit et al. (1999), farmers often employ their autonomous adaptation strategies to cope with their initial agricultural risks, followed by the engagement of planned agricultural risks management measures to address any residual challenge. Social protection programs and safety nets are then used to address any remaining adverse impact after the deployment of both autonomous and planned adaptation strategies. The linear adaptation circuit described above may not hold true for all situations. For instance, my study results and field observations, to the contrary, found that farming households, governments, and other non-public sector organizations sometimes deploy autonomous and planned adaptation arrangements and social protection assistance and safety nets to smallholder farmers concurrently and do not wait to address initial adverse effects before tackling residual effects. Even most governments in the global south are now restructuring their ex-post disaster management organizations to incorporate ex-ante risks mitigation strategies such as sensitization and awareness creation, monitoring, environmental impact assessment, and issue of early warning systems. Some researchers who conducted their studies in Europe (e.g., Zahniser et al., 2010) and Canada (e.g., Smit and Skinner,

2002) have also disagreed with the universal applicability of the sequential arrangement of farmers' adaptation strategies in the agricultural sector.

Other scholarly contributions of this dissertation project include: 1. The recognition that some smallholder farmers in Northern Ghana have been splitting their planting dates as a climate variability and change adaptation strategy, 2. Farmers observing the weather or rainfall patterns over the years and adjusting accordingly, 3. Farmers waiting for the rains to stabilize before they start planting, and 4. Smallholder farmers studying the droughts history and other properties of their farmlands for possible adaptation information and opportunities. I am citing these adaptation strategies as mentioned above as scholarly contributions because I did not find them clearly laid out in the extant literature, especially in Northern Ghana. An alternative explanation for the absence of these adaptation strategies could be that earlier scholars used different terms, concepts, or phrases to describe them. For instance, the closest weather-information related adaptation measures I found in the literature were some farmers changing their planting dates in Nigeria (Borokini et al., 2014) and Northern Ghana (Antwi-Agyei et al., 2014). Technically, the first three adaptation strategies as mentioned above are not the same as farmers changing their planting dates. Again, studying the properties and history of the farmlands and adjusting appropriately is apparently unrelated to changing the planting dates. The weather information-related adaptation strategies mentioned above form part of the contributions of my dissertation project.

My study also identified a variety of adaptation strategies smallholder farmers in Northern Ghana have been using to adapt to adverse flooding conditions. These flood-related adaptation and mitigation strategies include: cultivating flood-friendly crops in flood-prone areas, studying the flooding history of the farms to know which crops do well in flood-prone areas, or planting early enough so that by the time the flood waters come, the crops would have established. Other flood adaptation measures found included: molding mounds and beds/ridges to raise the roots of the crops above the flowing water level, planting trees, especially macuna species, placing sandbags across water channels, and constructing drainage channels. These adaptation measures either check the speed of flooding waters (thus, reducing soil erosion) or conduct flooding waters away from the farm. Some earlier studies discussed the adverse effects of flooding on agriculture and reported or recommended flood mitigation and adaptation strategies in Sahelian Africa (Sierbert, 2015) and Northern Ghana (Antwi-Adjei, 2014) such as flood insurance, stone bonding, constructing drainage canals, raising mounds/ridges, and growing flood-friendly crops such as rice and sorghum. My research has practical application and can also add to the literature regarding studying the flooding history of agricultural lands to know which crops do well in flood-prone areas or planting early enough so that by the time the flood water comes, the crops would have been deeply rooted. Even though I might not have covered all the relevant literature, I have not come across any study that documented the use of flooding history and information of agricultural lands to guide the cultivation of crops that could avoid or reduced the adverse effects of flooding, hence, the contribution of my dissertation project in this regard.

Another major scholarly contribution to the agricultural sector adaptation literature with implications for the effective implementation of agricultural insurance programs is the identification of the potential interactions between smallholder farmers' socio-cultural and religious adaptation factors and agricultural insurance programs and contracts. There is scanty research information on how smallholder farmers can employ socio-economic and religious adaptation strategies to manage their agricultural risks. This may be because western science which dominates the field of research may not believe or accommodate such religious and socio-cultural claims. My findings have been corroborated by a few earlier studies. For instance, research by Byg and Salick, (2009), Golo and Yaro (2013), and Jarawura (2014) into religious perceptions in relation to climate change adaptation and causes of drought in Ghana and Tibet found some rural farmers blaming the occurrence of droughts, floods, and reduced yields as punishments from their God, gods, and ancestral spirits for either refusing to perform some religious or cultural obligations and sacrifices or engaging in irresponsible and immoral acts. However, these socio-cultural and religious perceptions are in relation to climate variability/change adaptation strategies and not agricultural insurance. Some scholars who researched into issues of micro-insurance in some low-income countries found inverse relationship between farmers' belief in socio-cultural and religious adaptation strategies and up-take rates in agricultural insurance policies (Gheyssens & Günther 2012; Dror et al., 2012; Dalal & Murduch, 2012). My study may be the first to recognize and acknowledge the relationship between the socio-cultural and religious adaptation factors and agricultural insurance, especially, the implications of the former on the provision of (supply) and patronage (demand) for agricultural insurance services in Northern Ghana.

My research on the potential of agricultural insurance for crop risks management in Northern Ghana has a wide range of practical applications and benefits for farmers, the government of Ghana, and the agricultural insurance industry. These agricultural insurance programs and contracts are either currently being introduced (e.g., GIRSAL) by the government of Ghana, going through the license acquisition process by WC, being up-scaled throughout Ghana by GAIP, and those AICs and programs yet to spring up. My findings and recommendations have a wide range of lessons, good practices, and takeaways that can benefit this emerging industry in Ghana and other low-income country. The recommendations based on agricultural insurance stakeholders' expectations may inform the re-design and design of existing and new AIPs and contracts, respectively, to march expectations of the stakeholders. Farmers are hoping to be actively involved in the design and re-design of AIPs so that they may have a say in the type of risks, crops, and contracts to be rolled out and also wish to be consulted in all the stages involved in the implementation of AIPs. This has the potential to inform the design of comprehensive risks coverage policies and also build understanding and trust in the AIPs and contracts, AICs, and increase the interest, competence, and confidence levels of smallholder farmers participating in AIPs (Patt et al, 2009). These farmer-sensitive programs and policies may increase take-up rates and result in a win-win arrangement for the AICs and insured farmers. The government of Ghana may also use this research information to support and build a robust agricultural insurance sector as an effective risks transfer strategy that can reduce its (government's) budgetary pressures since an efficient agricultural insurance industry may address farmers' ex-ante agricultural challenges with the government only coming in to support in the event of the occurrence of ex-post agricultural risks and impacts. The findings, conclusions, and recommendations of this study could also be beneficial to agricultural stakeholders in other low-income countries.

This research also has a policy and regulatory implications for the agricultural sector in general and the agricultural insurance industry in particular. Unlike the Ghana National Health Insurance Authority (NHIA), i.e., the health sector which has its own Act (Act 852 of 2012), agricultural insurance operations are sub-summed under the general Insurance Act (Act 724, 2006) which says "the object of the Commission [i.e., Ghana National Insurance Commission of Ghana-NIC] is to ensure effective administration, supervision, regulation, monitoring, and control of the business of insurance to protect insurance policyholders and the insurance industry other than health insurance under the National Health Insurance Act, 2003" (Pg. 8) (Act 650, 2003 is amemded by Act 852, 2012). I argue that the agricultural sector which is Ghana's largest economic sector requires its own Act like the case of the NHIA to be able to regulate the industry effectively and efficiently. There are currently two proposals on the table regarding agricultural insurance legislations: 1. Whether to enact a new law that will accommodate issues of agricultural insurance or 2. To amend the existing Insurance Act (Act 724, 2006) to reflet the new development and dynamics. I will go futher to recommend that a separate and new agricultural insurance Act be promulgated just like the case of the NHIA Act (Act 650 of 2003 as amemded by Act 852, 2012) in the health sector. Whichever path the, government, NIC, and its collaborators choose, the findings and recommendations of my dissertation project and other related studies will be relevant to the enactment of the new or separate Act or an amendment to the existing Insurance Act (Act 724, 2006).

There is also no clearly spelt-out agricultural insurance policy to guide risks mitigation and management in Ghana's agricultural sector as is the case in the US Agricultural Stabilization Programs and Farm Bills, which clearly spell out the amount of government support to the agricultural sector often exposed to a multiplicity of risks. The main reason for the US federal government introducing these heavily subsidized safety nets and income stabilization programs is to motivate investments in the agricultural and insurance sectors by both the private insurers and insured farmers (Jose & Valluru, 1997; Shield, 2010). Since agricultural insurance is a new and an emerging field in Ghana, there is not much research output and related information for the stakeholders to rely on. The findings and recommendations from this study and earlier ones can provide leverage for the government, represented by MOFA, NIC, and other stakeholders to give policy direction to agricultural risks mitigation and management in Ghana

9.5 Recommendations

Based on the results, discussions, and conclusions drawn above, I put forward two categories of recommendations regarding, including: 1. How agricultural insurance stakeholders can tap into the potential of agricultural insurance as acknowledged above, and 2. Further research.

9.5.1 Recommendations on How Agricultural Stakeholders can Harness the Potential of Agricultural Insurance

For agricultural insurance stakeholders to get maximum benefits from their operation and participation in AIPs, I recommendations AICs or smallholder farmers:

1. Rolling out extensive and intensive awareness creation and sensitization programs on agricultural insurance activities. This will not only address the challenge of low awaress and penetration rates and the complex subject of agricultural insurance (especially index-based AIPs and contracts) but also expose smallholder farmers and other agricultural insurance stakeholders to the existence and benefits of agricultural insurance,
2. Exploring how to design and implement comprehensive, (i.e., most risks coverage contracts) and yet affordable risk protection plans,
3. Exploring how to design farmer-and gender-sensitive programs and contracts not only to meet the expectations of farmers but also to accommodate female farmers' strategic and specialized needs and concerns
4. Finding ways to address the problem of basis risks, adverse selection, and moral hazards, including both upstream and downstream risks.

5. Bundling the purchase of agricultural insurance policies with the provision of agro-inputs and agro-meteorological, extension, agronomic information as well as marketing and agro-value chain opportunities.

6. Coupling the provision and purchase of agricultural insurance contracts with government supported and subsidized AIPs and policies to ensure the accessibility, affordability, and availability of agricultural insurance services to smallholder farmers. This may in turn promote the viability, profitability and sustainability of AICs and programs. AIPs and contracts can further be bundled with the promotion and engagement in sustainable farming practices and climate change mitigation.

7. Providing agricultural insurance services based on public/private partnership model. Piloting of an index-based agricultural insurance called IIPACC in Northern Ghana in 2009 was initiated by GIZ in partnership with the government of Ghana represented by the NIC and has since been expanding to cover the entire country. As an emerging industry with colossal capital, technical, human, financial, material, and infrastructural outlays requirements, there is the need for government support to the industry to ensure its viability, profitability, and sustainability. The government can support with technical (sensitization and research support), infrastructural (provision and equipping weather stations and satellite platforms), reinsurance, regulation, and A& O cost assistance and subsidization of agricultural insurance programs and premiums. This initial support is necessary for the industry to establish and stabilized before the support can then be withdrawn for the industry to be self-sustaining (Banerjee & Berg, 2012). As a mixed or semi-capitalist economy, pure private AICs like WorldCover should be allowed to operate and use the government-sponsored infrastructure if they wish. Whether the model is public/private, solely public or private, these insurance companies should be required by the yet to be promulgated or

amended Insurance Act to make it mandatory for AICs to promote, engage in, and bundle their contracts with agro-ecological farming practices and climate change mitigation activities, which Mills (2012) called "the greening of insurance" (pg.1424) as a condition for government support and subsidization of agricultural insurance programs and premiums.

8. Diversify their agricultural risks management strategies by employing multiple adaptation mechanisms. This is the most effective way smallholder farmers can deal with their agricultural risks because if some strategies fail, the others may not, i.e., all adaptation strategies cannot fail at the same time. This arrangement may ensure risks layering and complementary agricultural risk management between the diversified risks management strategies and agricultural insurance contracts.

9.5.2 Recommendations for Further Research:

Research is a necessary condition for the success of every organization and program, including AIPs. In recognition of this fact, I recommend future research to be focused on:

1. Replicating this study with increased sample size:This dissertation project could not cover many potential participants due to time and resource constraints, hence, my recommendation for replicating it with an increased participants sample size either in Northern Ghana, Southern Ghana or other low-income countries. Such studies must make special efforts to include more females, especially as key informants and survey respondents. Such replicated studies may not only enhance and extend my research but also validate or disconfirm my findings, conclusions, and the efficacy of the recommendations. This may create opportunities for further research.

2. Exploring how agricultural insurance programs and contracts can promote sustainable agricultural practices and climate change mitigation while addreesing unintended consequences at the same time. To date, there has been no empirical research attempt to find out whether

agricultural insurance schemes and contracts are resulting in unintended adverse consequences such as environmental degradation and maladaptation in Northern Ghana as reported by other studies elsewhere. This study encourages other researchers to focus on the ecological and climate implications of AIS and policies in Ghana and other low-income countries. Such studies may further focus on dentifying specific ways AICs and insured farmers can promote and engage in agro-ecological farming systems, CSA practices, and conservation agriculture. Some researchers may also explore possible funding mechanisms that can be used to support the additional costs AICs are likely to incur as a result of undertaking this additional role. If these inadvertent impacts are identified and addressed, agricultural insurance programs and contracts can indeed be sustainable agricultural risks adaptation and mitigation strategies.

3. Explore how to design and implement agricultural insurance contracts that comprehensively cover both upstream and downstream agricultural risks at affordable premiums: It is evident from the study results on stakeholder perspectives that current agricultural insurance contracts, especially index-based contracts do not provide comprehensive agricultural risks protection for participating farmers. Such policies do not comprehensively cover farmers' production risks nor their transportation, post-harvest, marketing/demand, price, and revenue risks (downstream risks); yet smallholder farmers are vulnerable to all these categories of risks in addition to the usual basis risk. To ensure that agricultural insurance schemes and contracts provide effective protection to participating farmers, future research efforts should focus on designing agricultural insurance programs and contracts that are not only sensitive to the needs of smallholder farmers but also provide comprehensive agricultural risks protection at affordable premiums to vulnerable and marginal smallholder farmers in low income countries. Such research efforts could specifically focus on:

i. Re-calibrating MPCI policies to still maintain their all-risks attributes at reduced premiums. This may have the potential of increasing the penetration rates among smallholder farmers

ii. Instituting innovative strategies and technologies to continue to reduce the adverse effects of basis risks on smallholder farmers

iii. Addressing both covariate and idiosyncratic risks. In the medium to long-term, research efforts should aim at identifying and recommending factors that can motivate smallholder farmers to use index-based agricultural insurance contracts to address their covariate risks while using their grassroots level coping measures such as their membership with MFIs and social network support systems (social insurance) to manage their idiosyncratic risks as a way of complementing the index insurance contracts to address farmers' agricultural risks

iv. Designing indices that better correlate actual yield losses in the long-term

4. Investigating the impact of socio-cultural and religious-based adaptation strategies on agricultural insurance programs and contracts: These informal adaptation measures may have implications for take-up rates of agricultural insurance contracts. Potential research areas may include the influence of socio-cultural and religious factors on i) premium rates, ii) the occurrence or non-occurrence of trigger events or thresholds, and iii) take-up rates. These and many other questions are begging for answers and further research could focus on providing answers to these questions

5. Exploring how AIPs and contracts can promote effective access to smallholder farmers' agro-loans. It is widely reported in the agricultural insurance literature that agricultural insurance provides access to credit facilities for insured farmers (BalmaIssaka et al., 2016; Makaudze, 2005) and other studies also made counter-claims (e.g., McIntosh, Sarris, & Papadopoulos, 2013), i.e.,

the contradictory theoretical and practical roles of AIS and contract providing guarantees for smallholder farmers' agricultural loans. There is lack of clarity on the extent to which insurance contracts can provide guarantees for smallholder farmers' agro-loans. The same trend emerged in my fieldwork. Whereas some key informants, especially MFIs and agricultural insurance staff claimed that agricultural insurance policies provide guarantees for access to farm loans from financial institutions, some informants also reported that even with valid contracts, they were denied agro- loans to buy agro-inputs to support their farming activities, and were asked to provide alternative forms of collateral. Marr et al. (2016) aptly captured this lack of clarity when they reported that, " it is unknown to what extent credit suppliers would react to the insured status of farmers" (pg. 94). Further research is needed to provide clarity regarding the extent to which agricultural insurance contracts can provide effective guarantees for agricultural loans, especially for smallholder farmers in low-income countries.

References

Abdul-Korah, G. B. (2007). “Where Is Not Home?”: Dagaaba migrants in the Brong Ahafo Region, 1980 to the Present. *African Affairs*, *106*(422), 71–94. https://doi.org/10.1093/afraf/adl023

Abugri, S. A., Amikuzuno, J., & Daadi, E. B. (2017). Looking out for a better mitigation strategy: smallholder farmers’ willingness to pay for drought-index crop insurance premium in the Northern Region of Ghana. *Agriculture & Food Security*, *6*(1), 71.

Acheampong, E. N., Ozor, N., & Owusu, E. S. (2014). Vulnerability assessment of Northern Ghana to climate variability. *Climatic Change*, *126*(1–2), 31–44.

Adger, W. N., Huq, S., Brown, K., Conway, D., & Hulme, M. (2003). Adaptation to climate change in the developing world. *Progress in Development Studies*, *3*(3), 179–195.

Adiku SGK, Debrah-Afanyede E, Greatrex H, Zougmore R, MacCarthy DS. 2017. Weather-index based crop insurance as a social adaptation to climate change and variability in the Upper West Region of Ghana: Developing a participatory approach. CCAFS Working Paper no. 189. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

Afriyie, L., Zabel, A., & Damnyag, L. (n.d.). Index-based insurance for cocoa production in Ghana: Just a mirage?

Aggarwal, P. K., & Sivakumar, M. V. (2010). Global climate change and food security in South Asia: An adaptation and mitigation framework. In *Climate change and food security in South Asia* (pp. 253–275). Springer. Retrieved from http://link.springer.com/chapter/10.1007/978-90-481-9516-9_16

Akudugu, M. A., Dittoh, S., & Mahama, E. S. (2012). The implications of climate change on food security and rural livelihoods: Experiences from Northern Ghana. *Journal of Environment and Earth Science*, *2*(3), 21–29.

Anik, S. I., & Khan, M. A. S. A. (2012). Climate change adaptation through local knowledge in the north eastern region of Bangladesh. *Mitigation and Adaptation Strategies for Global Change*, *17*(8), 879–896.

Antwi, E. K., Boakye-Danquah, J., Barima Owusu, A., Loh, S. K., Mensah, R., Boafo, Y. A., & Apronti, P. T. (2015). Community vulnerability assessment index for flood prone savannah agro-ecological zone: A case study of Wa West District, Ghana. *Weather and Climate Extremes*, *10*, *Part B*, 56–69. https://doi.org/10.1016/j.wace.2015.10.008

Antwi-Agyei, P., Stringer, L. C., Fraser, E. D. G., & Dougill, A. J. (2013). Characterising the nature of household vulnerability to climate variability: empirical evidence from two regions of Ghana [electronic resource]. *Environment, Development and Sustainability*, *15*(4), 903–926. https://doi.org/10.1007/s10668-012-9418-9

Asitik, A. J. (2016). *Entrepreneurship: a means to poverty reduction in rural northern Ghana?* University of Central Lancashire. Retrieved from http://clok.uclan.ac.uk/15482/

Azapagic, A., & Perdan, S. (2000). Indicators of sustainable development for industry: a general framework. *Process Safety and Environmental Protection*, *78*(4), 243–261.

BalmaIssaka, Y., Wumbei, B. L., Buckner, J., & Nartey, R. Y. (2016). Willingness to participate in the market for crop drought index insurance among farmers in Ghana. *African Journal of Agricultural Research*, *11*(14), 1257–1265.

Banerjee, C., & Berg, E. (2012). *Policy for implementation of index based weather insurance revisited: the case of Nicaragua*. St. Louis, United States: Federal Reserve Bank of St Louis. Retrieved from http://search.proquest.com.antioch.idm.oclc.org/abiglobal/docview/1697476709/FA3960874F64FDEPQ/4

Barnett, B. J., & Mahul, O. (2007). Weather index insurance for agriculture and rural Areas in Lower-Income Countries. *American Journal of Agricultural Economics*, *89*(5), 1241–1247. https://doi.org/10.1111/j.1467-8276.2007.01091.x

Bawakyillenuo, S., Yaro, J. A., & Teye, J. (2016). Exploring the autonomous adaptation strategies to climate change and climate variability in selected villages in the rural northern savannah zone of Ghana. *Local Environment*, *21*(3), 361–382. https://doi.org/10.1080/13549839.2014.965671

Bazeley, P. (2009). *Integrating data analyses in mixed methods research*. SAGE Publications Sage CA: Los Angeles, CA.

Below, T., Artner, A., Siebert, R., Sieber, S., & others. (2010). Micro-level practices to adapt to climate change for African small-scale farmers. *A Review of Selected Literature. Environ. Prod. Technol. Division*, *953*. Retrieved from https://preventionweb.net/files/12863_IFPRIfeb2010.pdf

Berz, G. A. (1999). Catastrophes and climate change: Concerns and possible countermeasures of the insurance industry. *Mitigation and Adaptation Strategies for Global Change*, *4*(3/4), 283–293.

Binswanger-Mkhize, H. P. (2012). Is there too much hype about index-based agricultural insurance? *Journal of Development Studies*, *48*(2), 187–200.

Borokini, T. I., Osewa, S. O., Babalola, F. D., Alamu, O., & Olubiyi, M. R. (2014). Adaptation strategies to combating climate variability and extremity among farmers in selected farm settlements in Oyo State, Nigeria. *Albanian Journal of Agricultural Sciences*, *13*(3), 32.

Brahic, C. (2009). Can insurance giants save the poor from climate change? *New Scientist*, *203*(2715), 8–9.

Bryman, A. (2006). Integrating quantitative and qualitative research: how is it done? *Qualitative Research*, *6*(1), 97–113.

Bugri, J. T. (2008). The dynamics of tenure security, agricultural production and environmental degradation in Africa: Evidence from stakeholders in north-east Ghana. *Land Use Policy*, *25*(2), 271–285.

Byg, A., & Salick, J. (2009). Local perspectives on a global phenomenon-climate change in Eastern Tibetan villages. *Global Environmental Change,* 19, 156–166.

in themarket for crop drought index insurance among farmers in Ghana. *African Journal of Agricultural Research*, *11*(14), 1257–1265.

Carter, M. R., Cheng, L., & Sarris, A. (2016). Where and how index insurance can boost the adoption of improved agricultural technologies. *Journal of Development Economics*, *118*, 59–71.

Carter, m. r., de janvry, a., sadoulet, e., & sarris, a. (2014). *Index-based weather insurance for developing countries: A review of evidence and a set of propositions for up-scaling: [1]*. St. Louis, United States: Federal Reserve Bank of St Louis. Retrieved from http://search.proquest.com.antioch.idm.oclc.org/abiglobal/docview/1698043360/FA3960874F64FDEPQ/2

Clark, V. P., & Creswell, J. W. (2011). Designing and conducting mixed methods research. *Vol*, *3*, 93–94.

Cell, C. C. (2009). Crop insurance as a risk management strategy in Bangladesh. *Department of Environment. Ministry of Environment and Forests. Government of the People's Republic of Bangladesh, Dhaka*. Retrieved from http://www.climatechangecell.org.bd/publications/ResearchDocs/Crop_Insurance.pdf

Chakravarti, J. S. (1920). *Agricultural insurance: a practical scheme suited to Indian Conditions*. Government Press, Bangalore.

Challinor, A., Wheeler, T., Garforth, C., Craufurd, P., & Kassam, A. (2007). Assessing the vulnerability of food crop systems in Africa to climate change. *Climatic Change*, *83*(3), 381–399. https://doi.org/10.1007/s10584-007-9249-0

Chantarat, S., Mude, A. G., Barrett, C. B., & Carter, M. R. (2013). Designing index-based livestock insurance for managing asset risk in northern Kenya. *Journal of Risk and Insurance*, *80*(1), 205–237.

Christine Young Adjei, Rhodante Ahlers, & Kodwo Andah. (2012). Climate variability and vulnerability of rural people in Northern Ghana. *Desalination & Water Treatment*, *44*(1–3), 360–360.

Claassen, R. (2015). 2014 Farm Act continues most previous trends in conservation. *Amber Waves: The Economics of Food, Farming, Natural Resources, & Rural America*, 1–15.

Clarke, D., Mahul, O., Rao, K. N., & Verma, N. (2012). Weather based crop insurance in India. *World Bank Policy Research Working Paper*, (5985). Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2016750

Coe, R., & Stern, R. D. (2011). Assessing and addressing climate-induced risk in sub-saharan rainfed agriculture: lessons learned. *Experimental Agriculture*, *47*(2), 395–410. https://doi.org/10.1017/S001447971100010X

Cole, J. B., & Gibson, R. (2010). Analysis and feasibility of crop revenue insurance in China. *Agriculture and Agricultural Science Procedia*, *1*, 136–145.

Colson, G., Ramirez, O. A., & Fu, S. (2014). Crop insurance savings accounts: A viable alternative to crop insurance? *Applied Economic Perspectives and Policy*, ppu002.

Dahlström, K., Skea, J., & Stahel, W. R. (2003). Innovation, insurability and sustainable development: sharing risk management between insurers and the state. *Geneva Papers on Risk and Insurance. Issues and Practice*, 394–412.

Dalal, A., & Morduch, J. (2010). *The psychology of microinsurance: Small changes can make a surprising difference*. ILO.

Danso-Abbeam, G., Addai, K. N., & Ehiakpor, D. (2014). Willingness to pay for farm insurance by smallholder cocoa farmers in Ghana. *Journal of Social Science for Policy Implications*, *2*(1), 163–183.

Dror, I., Dalal, A., & Matul, M. (2012). Emerging practices in consumer education on risk management and insurance.

Edenhofer, O., Wallacher, J., Lotze-Campen, H., Reder, M., Knopf, B., & Müller, J. (2012). *Climate change, justice and sustainability: linking climate and development policy*. Springer Science & Business Media. Retrieved from https://books.google.com/books?hl=en&lr=&id=epsmm-bhnqcC&oi=fnd&pg=PR5&dq=climate+change,+justice+and+sustainability:+Linking+Climate+and+Development+Policy&ots=YUO4u6joK8&sig=uaEhJsDpAnYt_Nw5RUlJ16EK2EU

Elabed, G., & Carter, M. R. (2015). Compound-risk aversion, ambiguity and the willingness to pay for microinsurance. *Journal of Economic Behavior & Organization*, *118*, 150–166.

Enjolras, G., & Sentis, P. (2011). Crop insurance policies and purchases in France. *Agricultural Economics*, *42*(4), 475–486.

Environmental Protection Agency (EPA) (2003). National action program to combat drought and desertification. Accra, Ghana, EPA.

Foley, J. A., Ramankutty, N., Brauman, K. A., Cassidy, E. S., Gerber, J. S., Johnston, M., … West, P. C. (2011). Solutions for a cultivated planet. *Nature*, *478*(7369), 337.

Füssel, H.-M. (2007). Adaptation planning for climate change: concepts, assessment approaches, and key lessons. *Sustainability Science*, *2*(2), 265–275.

Füssel, H.-M. (2012). Vulnerability to climate change and poverty. In *climate change, justice and sustainability* (pp. 9–17). Springer. Retrieved from http://link.springer.com/chapter/10.1007/978-94-007-4540-7_2

Füssel, H.-M., & Klein, R. J. (2006). Climate change vulnerability assessments: an evolution of conceptual thinking. *Climatic Change*, *75*(3), 301–329.

Galaz, V., Gars, J., Moberg, F., Nykvist, B., & Repinski, C. (2015). Why ecologists should care about financial markets. *Trends in Ecology & Evolution*, *30*(10), 571–580.

Ghana National Insurance Commission (NIC). (2006). Insurance Act, Act 724 of 2006. NIC: Accra, Ghana

Ghana Statistical Service (GSS)/Ministry of Food and Agriculture (MOFA). (2017). Government of Ghana agricultural policy document

Giné, X., & Yang, D. (2009). Insurance, credit, and technology adoption: Field experimental evidence from Malawi. *Journal of Development Economics*, *89*(1), 1–11.

Gheyssens, J., & Günther, I. (2012). *Risk experiments in gains and losses: A case study for Benin*. Wider Working Paper.

Giné, X., & Yang, D. (2009). Insurance, credit, and technology adoption: Field experimental evidencefrom Malawi. *Journal of Development Economics*, *89*(1), 1–11.

Goel, K. (2013). A complete agro-financial service framework for emerging economies. *The Journal of Risk Finance*, *14*(5), 490–497.

Golo, B.K., & Yaro, J.A. (2013). Reclaiming stewardship in Ghana: Religion and climate

Goodwin, B. K. (2001). US farm safety nets and the 2000 Agricultural Risk Protection Act. *Canadian Journal of Agricultural Economics/Revue Canadienne d'agroeconomie*, *49*(4), 543–555.

Greatrex, H. and MaCarthy, D. (2016). Assessing the impact of agricultural insurance on gender dynamics in Northern Ghana. (Article in process).

Greatrex, H., Hansen, J., Garvin, S., Diro, R., Le Guen, M., Blakeley, S., … Osgood, D. (2015). Scaling up index insurance for smallholder farmers: Recent evidence and insights. *CCAFS Report, CGIAR, Copenhagen*.

Greene, J. C., Caracelli, V. J., & Graham, W. F. (1989). Toward a conceptual framework for mixed-method evaluation designs. *Educational Evaluation and Policy Analysis*, *11*(3), 255–274.

Group 3, I. P. on C. C. W. (2007). *Climate change 2007: mitigation: contribution of working group III to the fourth assessment report of the intergovernmental panel on climate change: summary for policymakers and technical summary*. Cambridge University Press. of Ghana 2018 Economic Policy and Budget Statement

Halcrow, H. G. (1948). *The theory of crop insurance*. publisher not identified.

Hansen, J., Hellin, J., Rosenstock, T., Fisher, E., Cairns, J., Stirling, C., … Campbell, B. (2018). Climate risk

Haruna, B. (2015). *Measuring the effects of weather-index insurance purchase on farm investment and yield among smallholder farmers in Northern Ghana*. The Ohio State University. Retrieved from https://etd.ohiolink.edu/!etd.send_file?accession=osu1437745690&disposition=attachment

Haruna, B., Sohngen, B., Yahaya, I., & Wiredu, A. N. (2017). Effects of weather-index

insurance: the case of smallholder maize farmers in Northern Ghana. International Journal of Food and Agricu

ltural Economics, 5(3), 75–85.

Hassan, R. M. (2010). Implications of climate change for agricultural sector performance in Africa: policy challenges and research agenda. *Journal of African Economies*, *19*(suppl 2), ii77–ii105.

Hess, U., Hazell, P., & Kuhn, S. (2016). *Innovations and emerging trends in agricultural insurance*. GIZ.

Hillier, D. (2018). Facing Risk: Options and challenges in ensuring that climate/disaster risk finance and insurance deliver for poor people.

Hochrainer, S., Mechler, R., & Pflug, G. (2009). Climate change and financial adaptation in Africa. Investigating the impact of climate change on the robustness of index-based microinsurance in Malawi. *Mitigation and Adaptation Strategies for Global Change*, *14*(3), 231–250. https://doi.org/10.1007/s11027-008-9162-5

Hossain, S. (2013). Problems and prospects of weather index-based crop insurance for rural farmers in Bangladesh. *Dev Ctry Stud*, *3*(12), 208–220.
management and rural poverty reduction. *Agricultural Systems*.

IFAD (n.d.). Feeding the world through sustainable agriculture. Retrieved from https://www.ifad.org/web/guest/crops

Jensen, N. D., & Barrett, C. B. (2015). Agricultural index insurance for Sub-Saharan African development. Retrieved from http://barrett.dyson.cornell.edu/files/papers/Agricultural%20index%20insurance%20for%20development%20in%20Sub-Saharan%20Africa%20Nov%202015.pdf

Johnson, L. (2013). Index insurance and the articulation of risk-bearing subjects. *Environment and Planning A*, *45*(11), 2663–2681.

Jose, H. D., & Valluru, R. S. (1997). Insights from the crop insurance reform act of 1994. *Agribusiness*, *13*(6), 587–598.

Kalra, N., Chander, S., Pathak, H., Aggarwal, P. K., Gupta, N. C., Sehgal, M., & Chakraborty, D. (2007). Impacts of climate change on agriculture. *Outlook on AGRICULTURE*, *36*(2), 109–118.

Karlan, D., Kutsoati, E., McMillan, M., & Udry, C. (2011). Crop price indemnified loans for farmers: A pilot experiment in rural Ghana. *Journal of Risk and Insurance*, *78*(1), 37–55.

Karlan, D., Osei-Akoto, I., Osei, R., & Udry, C. (2011). Examining underinvestment in agriculture: Measuring returns to capital and insurance.

Keeble, B. R. (1988). The Brundtland report: 'Our common future.' *Medicine and War*, *4*(1), 17–25

Klein, R. J., & Maciver, D. C. (1999). Adaptation to climate variability and change: methodological issues. *Mitigation and Adaptation Strategies for Global Change*, *4*(3–4), 189–198.

Kwadzo, G. T., Kuwornu, J. K., & Amadu, I. S. (2013). Food crop farmers' willingness to

Participate in market-based crop insurance scheme: Evidence from Ghana. *Research in Applied Economics*, *5*(1), 1.

Kurukulasuriya, P., Mendelsohn, R., Hassan, R., Benhin, J., Deressa, T., Diop, M., … others.

(2006). Will African agriculture survive climate change? *The World Bank Economic Review*, *20*(3), 367–388.

Kurukulasuriya, P., & Mendelsohn, R. O. (2008). How will climate change shift agro-ecological zones and impact African agriculture? *World Bank Policy Research Working Paper Series, Vol*. Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1267078

dynamics and

Laube, W., Schraven, B., & Awo, M. (2012). Smallholder adaptation to climate change:

Liesivaara, P., & Myyrä, S. (2014). Willingness to pay for agricultural crop insurance in the

northern EU. *Agricultural Finance Review*, *74*(4), 539–554.

limits in Northern Ghana. *Climatic Change*, *111*(3–4), 753–774.

Leblois, A., Quirion, P., Alhassane, A., & Traoré, S. (2014). Weather index drought insurance:

An ex-ante evaluation for millet growers in Niger. *Environmental and Resource Economics*, *57*(4), 527–551. https://doi.org/10.1007/s10640-013-9641-3

Lipper, L., Thornton, P., Campbell, B. M., Baedeker, T., Braimoh, A., Bwalya, M., … others. (2014). Climate-smart agriculture for food security. *Nature Climate Change*, *4*(12), 1068–1072.

Lotze-Campen, H., & Popp, A. (2012). Agricultural adaptation options: Production technology, insurance, trade. In *Climate Change, Justice and Sustainability* (pp. 171–178). Springer. Retrieved from http://link.springer.com/chapter/10.1007/978-94-007-4540-7_16

Lotze-Campen, H., Müller, C., Popp, A., & Füssel, H.-M. (2012). Food security in a changing climate. In *Climate Change, Justice and Sustainability* (pp. 33–43). Springer. Retrieved from http://link.springer.com/chapter/10.1007/978-94-007-4540-7_4

Madajewicz, M., Tsegay, A. H., & Norton, M. (2014). Managing risks to agricultural livelihoods:impact evaluation of the HARITA Program in Tigray, Ethiopia, 2009–2012. In *7th AfrEA International Conference, Cameroon*.

Mahul, O. (2003). Hedging price risk in the presence of crop yield and revenue insurance. *European Review of Agricultural Economics*, *30*(2), 217–239.

Mahul, O., & Stutley, C. J. (2010). *Government support to agricultural insurance: challenges and options for developing countries*. World Bank Publications. Retrieved from https://books.google.com/books?hl=en&lr=&id=FUlAxyMxgL8C&oi=fnd&pg=PR5&dq=agricultural+insurance+%2B+mahul&ots=mPCmukFnmn&sig=A5WVxIAR8iQJ14rYTP1oxxS9kjw

Mahul, O., & Wright, B. D. (2003). Designing optimal crop revenue insurance. *American Journal of Agricultural Economics*, *85*(3), 580–589.

Makaudze, E. M. (2005). *Do seasonal climate forecasts and crop insurance matter for smallholder farmers in Zimbabwe? Using contingent valuation method and remote sensing applications*. The Ohio State University. Retrieved from https://etd.ohiolink.edu/!etd.send_file?accession=osu1110389049&disposition=attachment

Marr, A., Winkel, A., van Asseldonk, M., Lensink, R., & Bulte, E. (2016). Adoption and impact of index-insurance and credit for smallholder farmers in developing countries: A systematic review. *Agricultural Finance Review; Bingley*, *76*(1), 94–118.

McKinley, J. D. (2014). *The economic viability of cocoa crop insurance in Ghana* (M.S.). University of Arkansas, Ann Arbor. Retrieved from ProQuest Dissertations & Theses Full Text. (1640930291)

McKinley, J. D., Asare, R. A., & Nalley, L. L. (n.d.). Assessing the potential of climate-smart cocoa insurance: A pathway to increase yields and reduce farmers' risks from climate-change in Ghana. Retrieved from https://www.researchgate.net/profile/Justin_Mckinley/publication/270574835_Assessing_the_Potential_of_Climate-Smart_Cocoa_Insurance_A_Pathway_to_Increase_Yields_and_Reduce_Farmers_Risks_from_Climate-Change_in_Ghana/links/54d8094b0cf2464758190570.pdf

McLeman, R., & Smit, B. (2006). Vulnerability to climate change hazards and risks: crop and flood insurance. *Canadian Geographer*, *50*(2), 217–226. https://doi.org/10.1111/j.0008-3658.2006.00136.x

Meze-Hausken, E., Patt, A., & Fritz, S. (2009). Reducing climate risk for micro-insurance providers in Africa: a case study of Ethiopia. *Global Environmental Change*, *19*(1), 66–73.

Mills, E. (2009). A global review of insurance industry responses to climate change. *The Geneva Papers on Risk and Insurance-Issues and Practice*, *34*(3), 323–359.

Mills, E. (2007). Synergisms between climate change mitigation and adaptation: an insurance perspective. *Mitigation and Adaptation Strategies for Global Change*, *12*(5), 809–842.

Mills, E. (2012). The greening of insurance. *Science*, *338*(6113), 1424–1425.

Ministry of Finance and Economic Planning, Ghana (2017). Government of Ghana economic policy and budget statement for 2018

Ministry of Food and Agriculture, Ghana. (2007). Food and agricultural sector development project (FASDEP)

MOFA. (2010). Medium term agriculture investment plan https://www.grain.org/attachments/2684/download (Retrieved 24th November, 2016)

Moellendorf, D. (2015). Climate change justice. *Philosophy Compass*, *10*(3), 173–186. https://doi.org/10.1111/phc3.12201

Molini, V., Keyzer, M., van den Boom, B., Zant, W., & others. (2008). Creating safety nets through semi-parametric index-based insurance: A simulation for Northern Ghana. *Agricultural Finance Review*, *68*(1), 223–246.

Molini, V., Keyzer, M., van den Boom, B., Zant, W., Nsowah-Nuamah, N., & others. (2010). Safety nets and index-based insurance: Historical assessment and semiparametric simulation for Northern Ghana. *Economic Development and Cultural Change*, *58*(4), 671–712.

Morton, J. F. (2007). The impact of climate change on smallholder and subsistence agriculture. *Proceedings of the National Academy of Sciences*, *104*(50), 19680–19685.

Mosier, A. R., Halvorson, A. D., Reule, C. A., & Liu, X. J. (2006). Net global warming potential and greenhouse gas intensity in irrigated cropping systems in northeastern Colorado. *Journal of Environmental Quality*, *35*(4), 1584–1598.

Müller, B., Johnson, L., & Kreuer, D. (2017). Maladaptive outcomes of climate insurance in agriculture. *Global Environmental Change*, *46*, 23–33.

Müller, B., & Kreuer, D. (2016). Ecologists should care about insurance, too. *Trends in Ecology & Evolution*, *31*(1), 1.

Myjoyonline.com. (n.d.). Ghana News - Drought destroys 200-hectare orange, palm oil farms. Retrieved March 3, 2016, from http://www.myjoyonline.com/news/2016/March-2nd/drought-destroys-200-hectare-orange-palm-oil-farms.php

Nigus, H., Nillesen, E., & Mohnen, P. (2018). *The effect of weather index insurance on social capital: Experimental evidence from Ethiopia*. United Nations University-Maastricht Economic and Social Research Institute on Innovation and Technology (MERIT).

Nnadi, F. N., Chikaire, J., Echetama, J. A., Ihenacho, R. A., Umunnakwe, P. C., & Utazi, C. O. (2013). agricultural insurance : A strategic tool for climate change adaptation in the agricultural sector. *Net Journal of Agricultural Science*, *1*(1), 1–9.

Nyong, A., Adesina, F., & Elasha, B. O. (2007). The value of indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel. *Mitigation and Adaptation Strategies for Global Change*, *12*(5), 787–797.

Olmstead, J., & Kleinschmit, J. (2011). A Risky Proposition. *Institute for Agriculture and Trade Policy*. Retrieved from http://g20civil.com/articles/2011_11_11_ARiskyProposition_JO_JK.pdf

Olubiyo, S. O., Hill, G. P., & Webster, J. P. G. (2009). Econometric analysis of the impact of agricultural insurance on farming systems in the middle belt, Nigeria. *African Journal of Food, Agriculture, Nutrition & Development*, *9*(6), 1406–1418.

Osbahr, H., Dorward, P., Stern, R., & Cooper, S. (2011). Supporting agricultural innovation in Uganda to respond to climate risk: linking climate change and variability with farmer perceptions. *Experimental Agriculture*, *47*(2), 293–316.

Pacheco, J. M., Santos, F. C., & Levin, S. A. (2016). Evolutionary dynamics of collective index insurance. *Journal of Mathematical Biology*, *72*(4), 997–1010.

Panda, A. (2013). Climate variability and the role of access to crop insurance as a social-protection measure: Insights from India. *Development Policy Review*, *31*(s2), o57–o73.

Parry, M. ., Rosenzweig, C., Iglesias, A., Livermore, M., & Fischer, G. (2004). Effects of climate change on global food production under SRES emissions and socio-economic scenarios. *Global Environmental Change*, *14*(1), 53–67. https://doi.org/10.1016/j.gloenvcha.2003.10.008

Patankar, M. (2011). Comprehensive risk cover through remote sensing techniques in agriculture insurance for developing countries: a pilot project. Retrieved from http://www.ilo.int/public/english/employment/mifacility/download/repaper6.pdf

Patt, A., Peterson, N., Carter, M., Velez, M., Hess, U., & Suarez, P. (2009). Making index insurance attractive to farmers. *Mitigation and Adaptation Strategies for Global Change*, *14*(8), 737–753. https://doi.org/10.1007/s11027-009-9196-3

Patton, M. Q. (2002). Qualitative research & evaluation methods (3rd edition). Thousand Oaks, Calif: SAGE Publications, Inc.

Phelan, L., Taplin, R., Henderson-Sellers, A., & Albrecht, G. (2011). Ecological viability or liability? Insurance system responses to climate risk. *Environmental Policy and Governance*, *21*(2), 112–130.

Piao, S., Ciais, P., Huang, Y., Shen, Z., Peng, S., Li, J., … others. (2010). The impacts of climate change on water resources and agriculture in China. *Nature*, *467*(7311), 43–51.

Porrini, D., & Schwarze, R. (2014). Insurance models and European climate change policies: an assessment. *European Journal of Law and Economics*, *38*(1), 7–28.

Pratibha, G., Srinivas, I., Rao, K. V., Shanker, A. K., Raju, B. M. K., Choudhary, D. K., … Maheswari, M. (2016). Net global warming potential and greenhouse gas intensity of conventional and conservation agriculture system in rainfed semi-arid tropics of India. *Atmospheric Environment*, *145*, 239–250.

Ramirez, O. A., Colson, G., & others. (2013). Can we do better than crop insurance? The case for farmer owned crop insurance savings accounts. *Choices*, *28*(3), 1–4.

Rao, K. N. (2010). Index based crop insurance. *Agriculture and Agricultural Science Procedia*, *1*, 193–203.

Reinhard, D. (2012). Potentials and limitations of micro-insurance for protecting the poor. In *Climate Change, Justice and Sustainability* (pp. 227–237). Springer. Retrieved from http://link.springer.com/chapter/10.1007/978-94-007-4540-7_22

Roberts, C. M. (2010). *The dissertation journey: A practical and comprehensive guide to planning, writing, and defending your dissertation*. Corwin Press. Retrieved from https://books.google.com/books?hl=en&lr=&id=uot1AwAAQBAJ&oi=fnd&pg=PP1&dq=The+dissertation+journey&ots=7chujCo1dT&sig=mp9hfhGK0Ken1eilOTfbJ9nm6bM

Rogers Everett, M. (1995). Diffusion of innovations. *New York*, 12.

Tachie-Obeng, E., Akponikpè, P. B. I., & Adiku, S. (2013). Considering effective adaptation options to impacts of climate change for maize production in Ghana. *Environmental Development*, *5*, 131–145. https://doi.org/10.1016/j.envdev.2012.11.008

Rosenzweig, C., Parry, M. L., & others. (1994). Potential impact of climate change on world food supply. *Nature*, *367*(6459), 133–138.

Rosenzweig, C., & Tubiello, F. N. (2007). Adaptation and mitigation strategies in agriculture: an analysis of potential synergies. *Mitigation and Adaptation Strategies for Global Change*, *12*(5), 855–873.

Serageldin, I., Steer, A. D., & Cernea, M. M. (1994). *Making development sustainable: from concepts to action* (Vol. 2). World Bank Publications.

Shields, D. A. (2009). Federal Crop Insurance: Background and Issues. Congressional Research Service, Library of Congress. Retrieved from http://adriansmith.house.gov/sites/adriansmith.house.gov/files/CRS%20-%20Crop%20Insurance.pdf

Siebert, A. (2015). *Assessing the viability of index insurance as an adaptation tool in a changing climate context: Case study in the West African Sahel* (Ph.D.). Rutgers The State University of New Jersey - New Brunswick, Ann Arbor. Retrieved from http://search.proquest.com.antioch.idm.oclc.org/docview/1676475909?accountid=26438

Simms, A., Reid, H., & others. (2005). *Africa: Up in Smoke?* Oxfam. Retrieved from https://books.google.com/books?hl=en&lr=&id=qU1y8kfkEkAC&oi=fnd&pg=PA1&dq=Africa+up+in+smoke&ots=r2ndRKJ3rx&sig=YzFDkoHR50Ck2BijTGm2B8Q1xck

Skees, J. R., & Collier, B. (2012). The roles of weather insurance and the carbon market. In *Greening the Financial Sector* (pp. 111–164). Springer. Retrieved from http://link.springer.com/chapter/10.1007/978-3-642-05087-9_4

Skees, J. R. (2008). Challenges for use of index-based weather insurance in lower income countries. *Agricultural Finance Review*, *68*(1), 197–217

Smit, B., Burton, I., Klein, R. J., & Street, R. (1999). The science of adaptation: a framework for assessment. *Mitigation and Adaptation Strategies for Global Change*, *4*(3–4), 199–213.

Smit, B., & Pilifosova, O. (2003). Adaptation to climate change in the context of sustainable development and equity. *Sustainable Development*, *8*(9), 9.

Smit, B., & Skinner, M. W. (2002). Adaptation options in agriculture to climate change: a typology. *Mitigation and Adaptation Strategies for Global Change*, *7*(1), 85–114.

Smith, V. H., Goodwin, B. K., & Brown, J. (2010). Private and public roles in providing agricultural insurance in the United States. *Public Insurance and Private Markets*, 173–210.

Smith, V., & Watts, M. (2009). *Index based agricultural insurance in developing countries: Feasibility, scalability and sustainability*. Bill & Melinda Gates Foundation. Retrieved from ttps://www.agriskmanagementforum.org/sites/agriskmanagementforum.org/files/Documents/vsmith-index-insurance.pdf

Snyder, C. S., Bruulsema, T. W., Jensen, T. L., & Fixen, P. E. (2009). Review of greenhouse gas emissions from crop production systems and fertilizer management effects. *Agriculture, Ecosystems & Environment*, *133*(3–4), 247–266.

Solomon, S. (2009). *Climate change 2007: The physical science basis*. Taylor & Francis. Retrieved from http://www.tandfonline.com/doi/pdf/10.1080/03736245.2009.9725337

Songsore, J., and Denkabe A. (1991). Challenging rural poverty in northern Ghana: The case of Upper West Region. Universitetet I Trondheim, Trondheim.

Stern, N. (2007). *The economics of climate change: The Stern review*. Cambridge University press. Retrieved from https://books.google.com/books?hl=en&lr=&id=U-VmIrGGZgAC&oi=fnd&pg=PA1&dq=+biological+and+economic+impacts+of+climate+change&ots=9dr-6qeuo9&sig=84gvFlSw5A6IOM0G0rmVz6Xvod4

Stocker, T. F., Qin, D., Plattner, G. K., Tignor, M., Allen, S. K., Boschung, J., … Midgley, B. M. (2013). IPCC, 2013: climate change 2013: the physical science basis. Contribution of working group I to the fifth assessment report of the intergovernmental panel on climate change.

Sumani, J.B.B. (2008). Impact of climate change on human migration in the Upper West Region of Ghana. MSc. Thesis, Antioch University New England, Unpublished)

Sumani, J.B.B. (2015). Facilitating the implementation of Ghana Agricultural Insurance Pool

Tadesse, M. A., Shiferaw, B. A., & Erenstein, O. (2015). Weather index insurance for managing drought risk in smallholder agriculture: lessons and policy implications for sub-Saharan Africa. *Agricultural and Food Economics*, *3*(1), 1–21.

Teddlie, C., & Tashakkori, A. (2009). Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioral sciences. Sage.

The World Bank. (2015). Agricultural Finance http://www.worldbank.org/en/topic/financialsector/brief/agriculture-finance (Retrieved 24th November, 2016)

Thomas, D. R. (2006). A general inductive approach for analyzing qualitative evaluation data. *American Journal of Evaluation*, *27*(2), 237–246.

Thomas, R. M. (2003). *Blending qualitative and quantitative research methods in theses and dissertations*. Corwin Press. Retrieved from https://books.google.com/books?hl=en&lr=&id=qx-yzSILfbMC&oi=fnd&pg=PR9&dq=Blending+qualitattive+and+quantitative+research+methods+in+theses+and+dissertations&ots=whhSAVcCjB&sig=z6l27Jzgmfiiwoiuel88wEYUn9g

Trochim, W. M. (2005). *Research methods: The concise knowledge base*. Atomic Dog Publishing.

Tr\a erup, S. L. (2012). Informal networks and resilience to climate change impact: a collective approach to index insurance. *Global Environmental Change*, *22*(1), 255–267

Van der Geest, K. (2011). North-South migration in Ghana: what role for the environment? *International Migration*, *49*(s1).

Walther, G.-R., Post, E., Convey, P., Menzel, A., Parmesan, C., Beebee, T. J., … Bairlein, F. (2002). Ecological responses to recent climate change. *Nature*, *416*(6879), 389–395.

Ward, P. S., Florax, R. J. G. M., & Flores-Lagunes, A. (2014). Climate change and agricultural productivity in Sub-Saharan Africa: a spatial sample selection model. *European Review of Agricultural Economics*, *41*(2), 199–226. https://doi.org/10.1093/erae/jbt025

Weldegebriel, N. W., & Gustavsson, H. (2017). Climate change adaptation and mitigation strategies vis-a-vis the agriculture and water sectors in Ethiopia-Case Review/Study of the EPCC Project. *Environ Pollut Climate Change*, *1*(125), 2.

Wentz, E. A. (2013). *How to design, write, and present a successful dissertation proposal*. Thousand Oaks, California:SAGE Publications

Whitehead, A., & Tsikata, D. (2003). Policy discourses on women’s land rights in Sub–Saharan

Africa: The implications of the re–turn to the Customary. *Journal of Agrarian Change*, *3*(1–2), 67–112.

World Bank (2010a). *World Development Report 2010: Development and climate change*. Washington, D.C.: The World Bank.

WorldCover. (n.d). WorldCover crop insurance for smallholder farmers. Retrieved from https://press.worldcovr.com/

Yuzva, K., Botzen, W. W., Aerts, J., & Brouwer, R. (2018). A global review of the impact of basis risk on the functioning of and demand for index insurance. *International Journal of Disaster Risk Reduction*.

Zahniser, S., Arriola, C., & Somwaru, A. (2010). *The European Union's framework for climate change adaptation: Implications of agriculture's adaptation through sustained yield growth*. International Agricultural Trade Research Consortium. Retrieved from http://econpapers.repec.org/RePEc:ags:iatr10:91406

Zant, W. (2008). Hot Stuff: index insurance for Indian smallholder pepper growers. *World Development*, *36*(9), 1585–1606.

Ziska, L. H., & Runion, G. B. (2007). Future weed, pest, and disease problems for plants. *Agroecosystems in a Changing Climate*, 261–287.

Appendix I: Socio-Economic and Demographic Characteristics of the Study Participants

The data analysis began with a presentation of the socio-economic and demographic characteristics of the study participants. The study participants were stratified into focus group discussants, key informants, and survey respondents. This sub-section on the socio-economic and demographic characteristics of the participants focuses on the age distribution, gender and level of education, the occupation of the participants, geographic scale of operation, and the relationship of the study participants to agricultural insurance (Agric. I).

This analysis is meant to provide background information on the study participants and how these characteristics (i.e., study variables) have influenced their responses to questions posed. These general variables include 1) main agricultural risks, 2) agricultural risk management strategies, 3) roles of Agric. I, and , 4) how Agric. I programs and contracts can promote sustainable agricultural practices, including climate change mitigation. This section also offered me the opportunity to triangulate the socio-economic and demographic information provided with subsequent responses to improve the accuracy and trustworthiness of the results and the associated conclusions and recommendations.

Based on the stratification of the study participants into different categories operating at various geographic scales, similar and dissimilar perspectives were drawn from the differing response groups at the community, regional, zonal, and national levels. This categorization was particularly important because it revealed which agricultural problems were associated with which response group, community, and in which region. This allowed me to make community and region-specific recommendations instead of suggesting blanket and over-generalized solutions.

Gender and Age Distribution of Focus Group Discussants

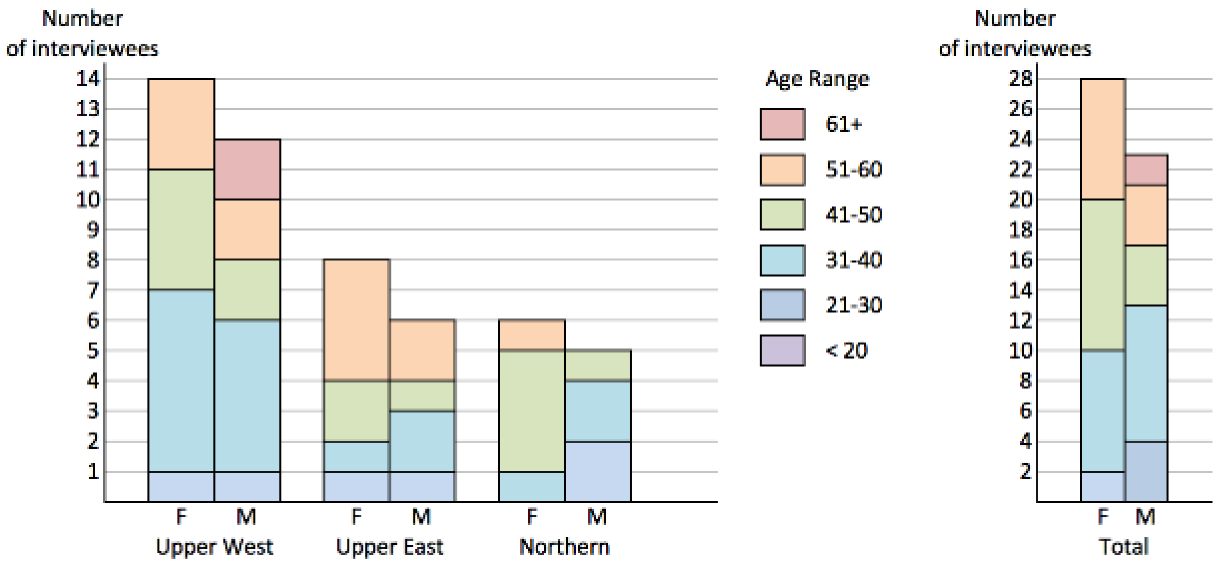


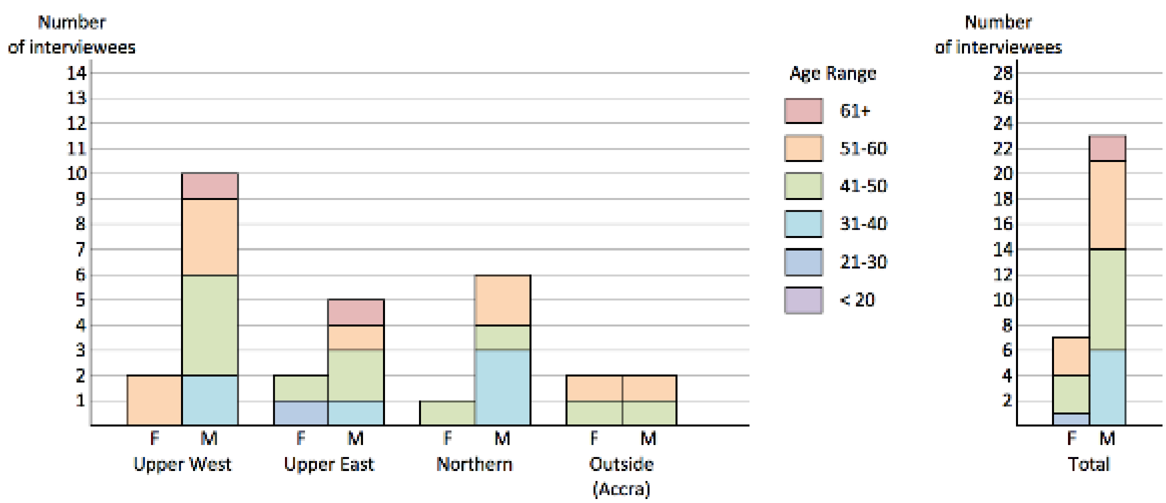
Figure 1a and 1b: Group bar graphs showing number of discussants by region, gender, and age

Source: The code to create this plot was created by H. Greatrex and used with her permission.

Figure 1a shows the age distribution of the 51 discussants across the six focus group discussions in the three communities based on gender, namely, Duori-Guo in the Upper West region (UWR), Kazigo in the Upper East region (UER), and Nyankpala in the Northern region (NR). Figure 1b also shows gender difference in the number and age of discussants. For instance, the focus groups recorded more female discussants than males in all focus group communities. Female discussants were also more elderly than their male counterparts.

Age Distribution and Gender of Key Informants

Key informants were interviewed from the UWR, UER, NR, and Accra, i.e., outside Northern Ghana. Figures 2a and 2b portray the gender and age distribution of these informants. In contrast to the number of female discussants, there were more male informants in all the three regions of the North. For instance, UWR recorded 10 males versus 2 females; UER reported 5 males compared to 2 females, and NR had 5 males with 1 female except Accra where there was gender parity (i.e., 2 males and 2 females). Also, there was not much difference in the age distribution between male and female discussants except that ages of majority of the informants ranged from 41-60 (69%) unlike the case of the discussants where majority fell within the 31-50 age groups (60%).



Figures 2a and 2b: Bar graph displaying number of key informants by region, gender, and age

Source: The code to create this plot was created by H. Greatrex and used with her permission.

Age Distribution and Gender of Survey Respondents

Age of Respondents.

The majority (40%) of the respondents fell within the 51-60 age group at the time of the survey. This was followed by 31-40 (27%), 41-50 (27%) and 21-30 (6%) with no respondent below 20 or above 61 years old (Figure 3a).

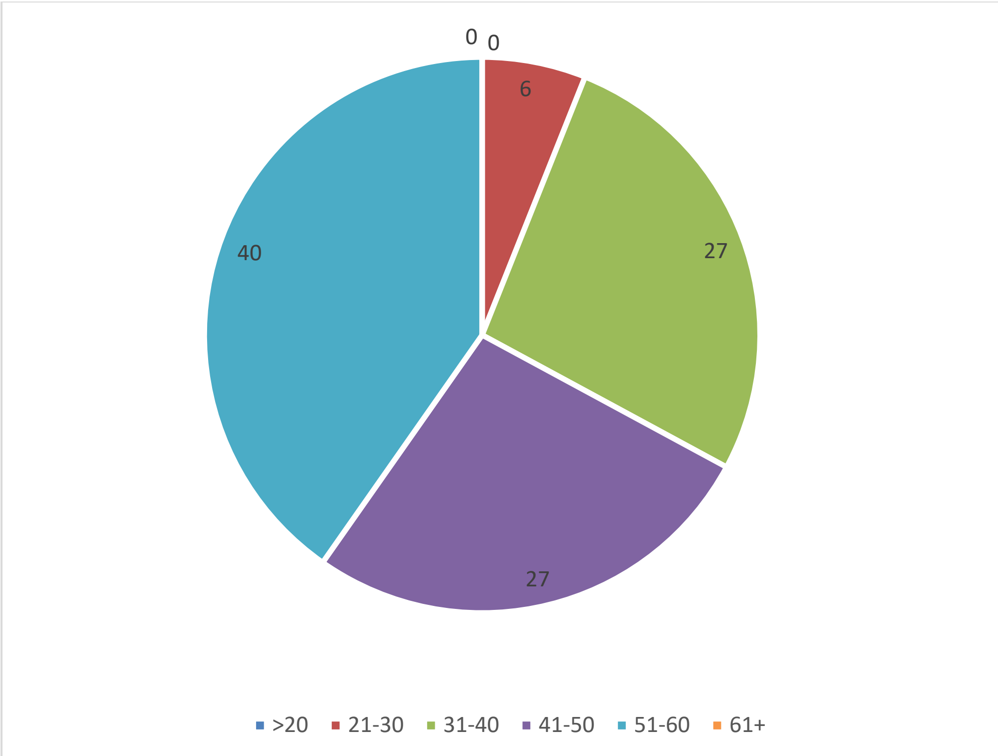


Figure 3: Pie chat revealing survey respondents' age distribution

Note. '0' implies no respondent fell within the age bracket that recorded '0' age. This means no respondent was less than 20 years or 61 and above.

Gender of Respondents.

Majority of the respondents, i.e., twelve out of the 15 respondents were males with only three being females. This trend is not different from the pattern key informants revealed, i.e., more male informants than females. This was, however, contrary to the focus group discussants where females were in the majority in the three focus group sessions. Males dominated what I refer to as secondary (key informants) and tertiary (survey respondents) study participants' categories. On the contrary, females were in the majority at the primary level (focus group communities) at the time of the fieldwork (Figures 1b, 2b, and Table 1a).

Table 1: Gender of respondents		
Gender of respondents	Frequency	%
Females	3	20
Males	12	80
Total	15	100

Educational Background of the Study participants

This sub-heading covers the educational levels of only key informants and survey respondents and not those of focus group discussants. This decision was informed by findings from my service learning project (SLP) and pre-testing of my data collection instruments. For instance, whereas key informants and survey respondents readily mentioned their highest educational qualifications during the SLP phase, focus group discussants were not willing to disclose their educational statuses. It was observed during the said SLP and pre-testing interview sessions that most interviewees and discussants were unwilling to indicate whether they had been to school or not but were also leaving the interview grounds when such personal questions were asked. To satisfy my approved IRB requirements and also to ensure maximum participation, a decision was made not to ask focus group discussants about their level of education.

Educational Background of Key Informants

Figure 4 reveals the educational background of key informants interviewed. All the 29 key informants had one form of educational qualification or the other at the time of the fieldwork. Figure 4 reveals that 76% of the key informants had tertiary education with 14% and 10% representing secondary and elementary educational qualifications respectively.

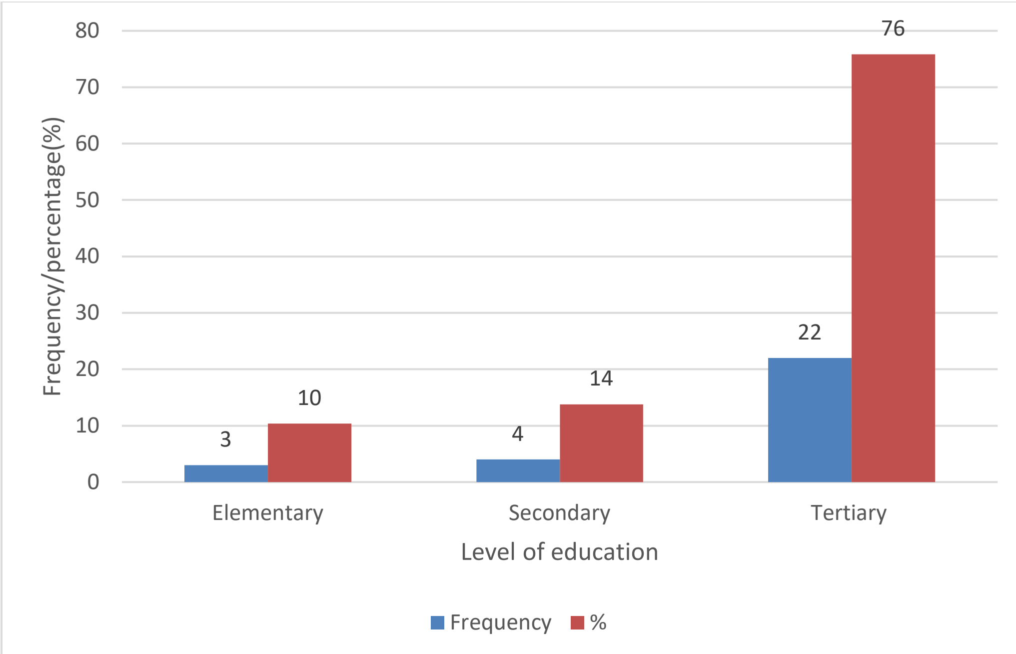


Figure 4: Bar graph portraying key informants' level of education

Level of Education of Survey respondents

Most tertiary level participants, i.e., survey respondents had tertiary qualifications (e.g., first degree, second degree, and Ph.D.) at the time of the survey. For instance, 14 (93%) of the 15 respondents either had Diploma, HND (Higher National Diploma), B.A., B.Sc., M.A., M.Sc., MPhil or Master's Degree or Ph.D. Only one respondent had secondary education (Table 2a).

Table 4

Educational levels of survey respondents

Level of education	Frequency	%
Secondary	1	7
Tertiary	14	93
Total	15	100

Occupation of Study Participants, their Geographic Operational Scales, and Relationship with Agricultural Insurance

I solicited responses from discussants, informants, and respondents regarding what they do for a living (occupation), their spatial scale of operation, and how their work relates to agricultural insurance. This sub-section is further broken down into smaller sections due to the peculiarity of the different categories of participants and for convenient presentation and analysis of the socio-economic and demographic data.

Occupation of Focus Group Discussants

All the three focus group communities are located within the Savannah Agro-ecological zone. These communities have common weather, climate, and ecological characteristics. The main difference is that the inhabitants of Duori-Guo and Kazigo are mainly Christians (mostly Catholic) and believers of the African Traditional Religion (ATR) whereas those of Nyankpala are predominantly Muslims. These religious differences also define the socio-economic and adaptation strategies. For example, I found from the fieldwork that some members of the Duori-Guo and Kazigo communities were engaged in the preparation and sale of malt, brewing and selling “pito” (a local alcoholic beverage), and rearing pigs and dogs whereas it is a religious taboo to engage in these activities in the traditional Nyankpala community setting, which is predominantly a Muslim community. The other half of the Nyankpala community which is cosmopolitan hosts the Savannah Research Institute (SARI) and the Nyankpala Campus of the University for Development Studies (UDS) whereas the Duori-Guo and Kazigo communities do not have such growth pole centers. Smallholder farmers may, therefore, be benefitting from their economic activities (e.g., selling provisions and cooked food to scientists, faculty, staff, and students) and innovative ideas research, and technologies whereas their counterparts in Duori-Guo and Kazigo may not.

Even though these communities cultivate common crops such as maize and sorghum, there are also community-specific crops. Farmers in Duori-Guo usually cultivate millet and cowpea whereas those in Kazigo grow soybeans. Farmers in Kazigo and Nyankpala normally farm rice. There are also more NGOs and projects supporting farmers in Nyankpala (e.g., SARI, UDS, and nearby Tamale-the regional capital of Northern Region) and Kazigo such as Dezenani Integrated Development Organization (DIDO), owned and operated by the Kazigo "pio" (chief of kazigo) and supported by UNICEF, CRS, and the Catholic Church. Flooding, especially of rice fields also poses a challenge to farmers, especially women in Nyankpala and Kazigo communities whereas that is not the case in the Duori-Guo community.

The occupation of discussants has been analyzed based on each focus group community. I have also disaggregated the analysis based on participants' gender, primary, and secondary occupation. By this arrangement, I discussed the occupation of Duori-Guo focus group discussants in the Upper West region separately from those of the Kazigo and Nyanpkala communities in the Upper East and Northern Regions respectively.

Duori-Guo Community Focus Group Discussants' Primary and Secondary Occupation

Female discussants were asked to list their livelihood activities and then arrange them into primary and secondary occupations. In response, 93% (13 out of the 14) of the discussants identified agriculture as their primary occupation with only one discussant indicating food processing and vending (preparation of cakes for sale, locally known as "koosee") was her primary occupation. Brewing and sale of "pito" (a type of local beer) was mentioned as the most important secondary occupation (39%) with food vending (preparation and sale of cakes) (17%) and harvesting and sale of firewood and charcoal (17%) following. Rearing of livestock (13%), the sale of herbs (9%), and farming (5) were also added to the list of female secondary livelihood activities (Figure 5).

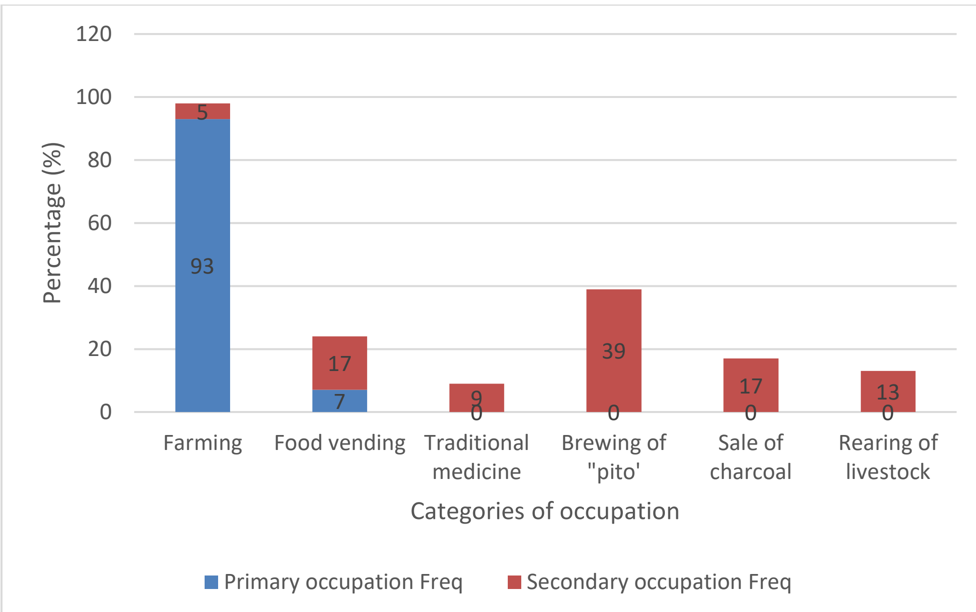


Figure 5: Group bar graph displaying Duori-Guo females' primary and secondary occupation

Note. '0' score means no focus group discussant mentioned traditional medicine, 'pito' brewing, sale of charcoal, and livestock rearing as their primary occupation.

On the other hand, all (100%) the male discussants revealed that farming was their primary occupation at the time of the fieldwork. Rearing of livestock, seasonal migration, and engaging in traditional medicinal activities and soothsaying also accounted for 59%, 23%, and 18% of their secondary occupations respectively (Figure 6).

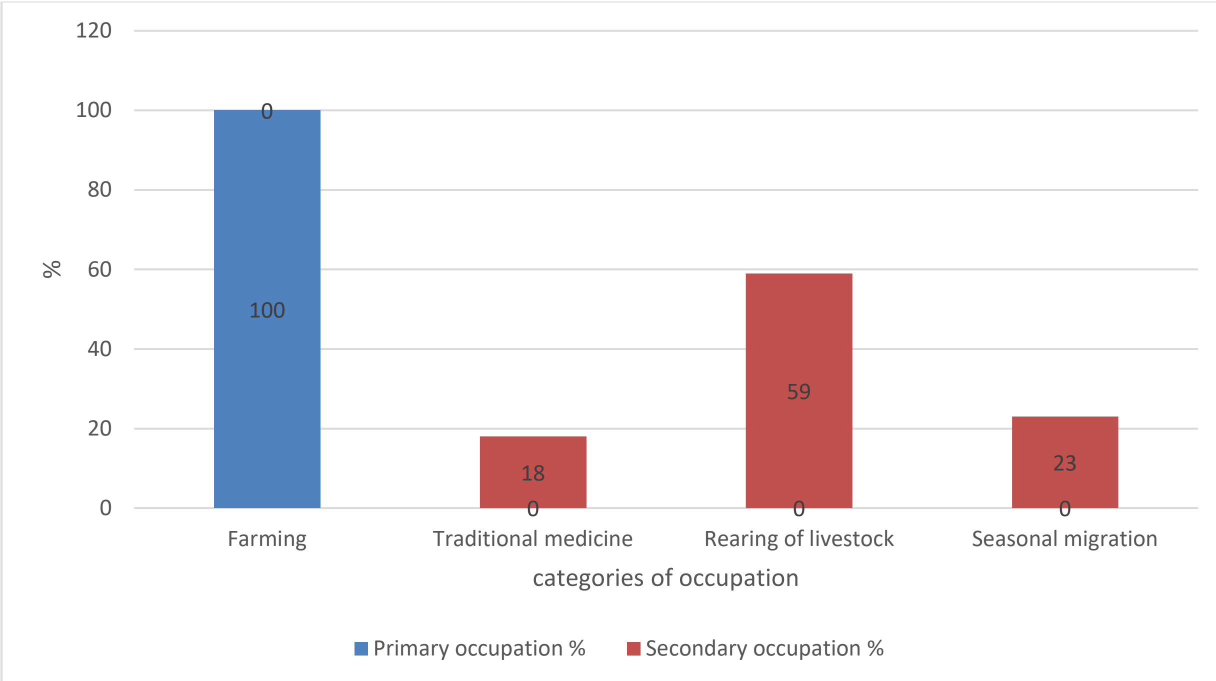


Figure 6: Bar graph portraying Duori-Guo males' primary and secondary occupation

Note. "0%' means no male focus group discussant mentioned traditional medicine, livestock rearing, and seasonal migration as their primary occupation. Farming was also never mentioned as a secondary occupation.

Kazigo Community Focus Group Discussants' Primary and Secondary Occupation

Almost all (90%) the female discussants in the Kazigo community identified farming as their most important occupation with 10% engaging in agro-produce trading (buying and selling groundnuts). Food vending (20%) (Preparing and selling cakes, porridge, and kenkey), trading in agro-produce (20%) (Preparing malt to sell to pito brewers) and brewing and selling pito (20%) were reported as some of their (females) secondary economic activities. These female discussants also included farming (10%), hair dressing (10%), seam stressing (10%), and sale of fruits and vegetables from the wild (e.g., baobab) (10%) as other secondary livelihood activities (Figure 7). I personally saw the baobab fruits stockpiled for sale (Figure 14 in page 56).

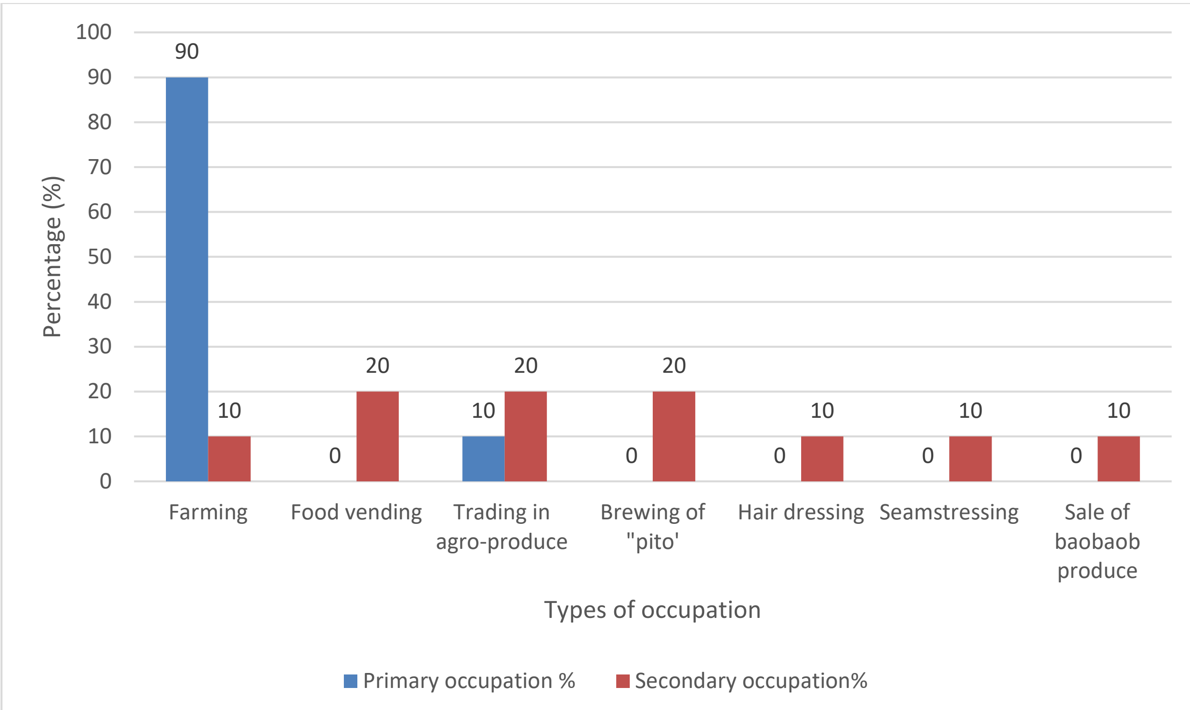


Figure 7: Group bar graph showing Kazigo females' primary and secondary occupation

'0' means discussants never mentioned the corresponding livelihood activity category as their primary occupation. For instance, food vending was never stated as a primary occupation in the Kazigo community

Farming was reported as the most important (100%) occupation for male focus group discussants in the Kazigo community and its environs. These discussants also mentioned livestock rearing (43%), seasonal migration (29%), small-scale trading (14%), and agricultural insurance agent/contact person for GAIP (14) as some of their secondary occupational activities (Figure 8).

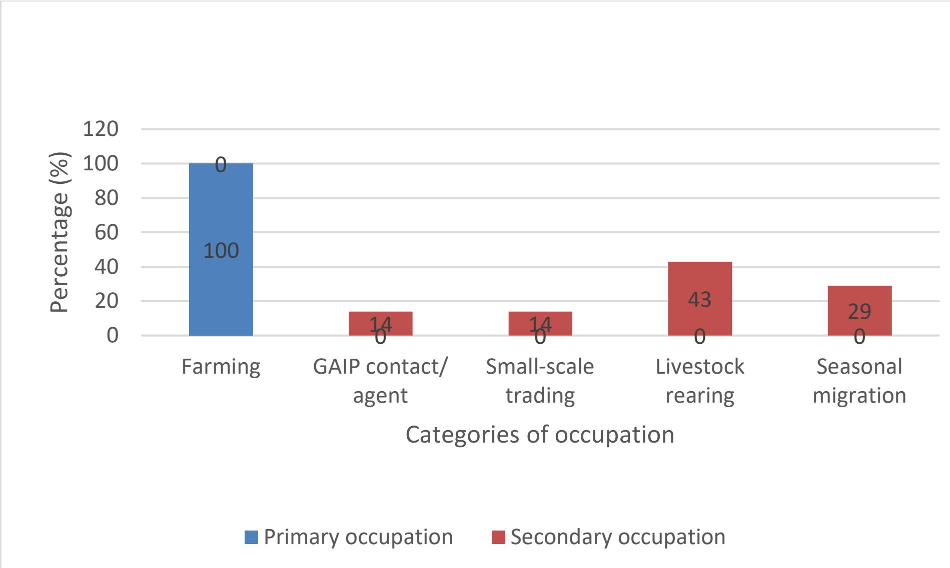


Figure 8: Group bar graph portraying Kazigo male focus group discussants' primary and secondary occupation

Note. The frequency score '0' implies that the discussants never employed the corresponding livelihood activity as their primary occupation, i.e., seasonal migration was never mentioned as a primary occupation.

Nyankpala Community Focus Group Discussants' Primary and Secondary Occupation

All (100%) of the Nyankpala female focus group discussants said farming was their primary occupation during the fieldwork with rice processing (milling, packaging, and selling) and small-scale trading accounting for 60% and 40% of their secondary occupations respectively (Figure 9).

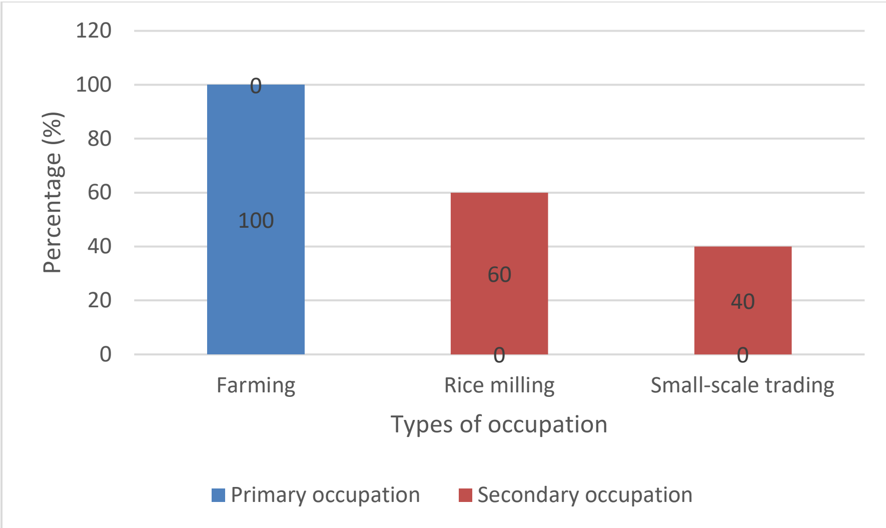


Figure 9: Group bar graph presenting Nyankpala females' focus group discussants' primary and secondary occupation

Note. '0' indicates that discussants did not mention rice milling and small-scale trading as their primary occupation or farming as their secondary occupation.

Their male counterparts also scored farming as their most important livelihood activity (80%) followed by security work, what is termed watchman in Ghanaian parlance (20%). They also rated rearing of livestock (43%), small-scale trading (29%), hunting (14%), and farming (by the security men only) (14%) as other economic activities smallholder farmers mostly undertake to supplement produce from their farms and security work) (Figure 10).

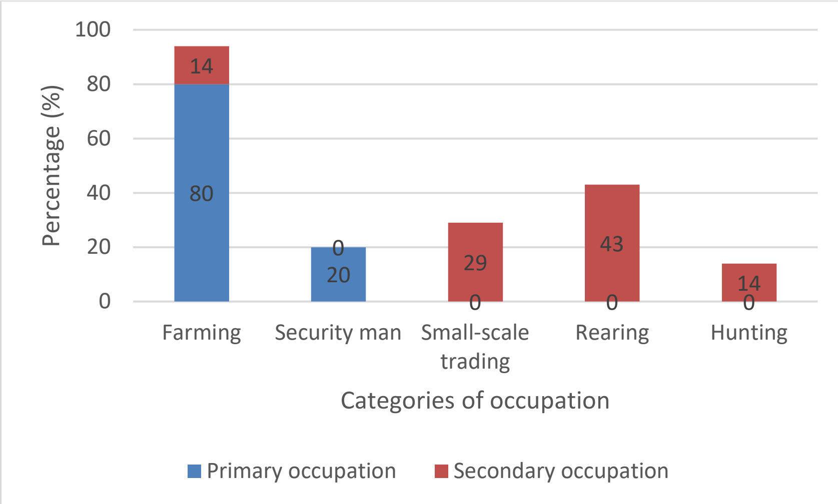


Figure 10: Group bar graph revealing Nyankpala males' focus group discussants' primary and secondary occupation

'0' means no focus group discussant mentioned small-scale trading, livestock rearing, and hunting as his primary occupation and security work (being a watchman) as secondary occupation.

Geographic Scale of Operation of Study Participants and their Relationship with Agricultural Insurance

To enhance the validity and reliability of the study's results, conclusions, and the associated recommendations, the relevant geographic scale of operations of the study participants and their relationship with agricultural insurance were sought. Based on the different geographic scales, perspectives of some smallholder farmers were gathered at the micro-spatial scale (focus group discussants at community level). Views of key informants and survey respondents at the meso and macro-spatial scales respectively (district, regional, zonal, and national levels) were also collated. This categorization was to ensure that study participants' views at the various geographic scales were relevant to small-scale agriculture in general and agricultural insurance in Northern Ghana, in particular.

Appendix II: Evidenced of Approved IRB Application

Online IRB Application Approved: Exploring the potential of crop index insurance for sustainable climate change adaptation and mitigation among smallholder farmers in Northern Ghana July 22, 2016, 9:20 am

to me, bsammons

Dear John Bosco Baguri Sumani ,

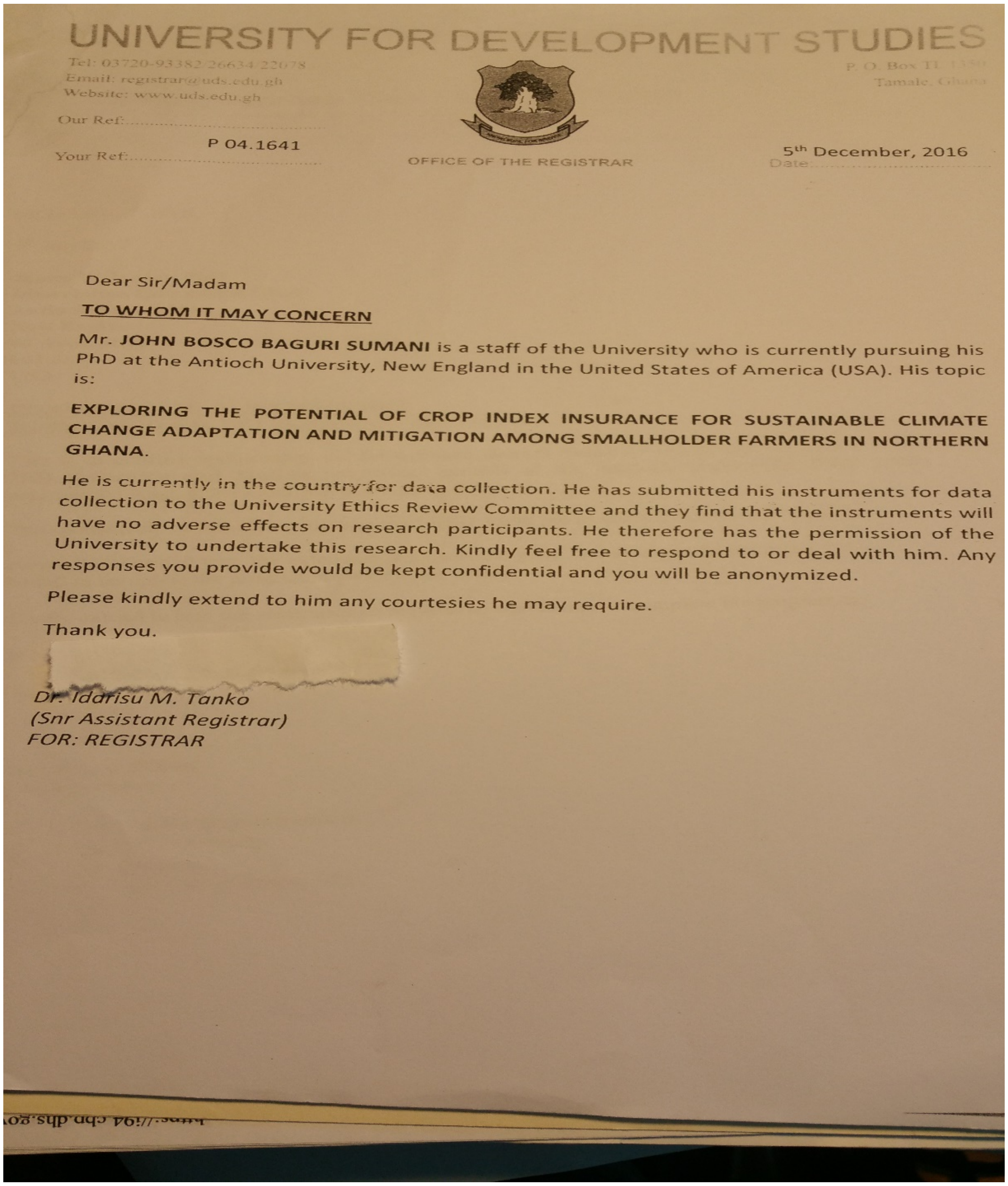
As Chair of the Institutional Review Board (IRB) for 'Antioch University New England, I am letting you know that the committee has reviewed your Ethics Application. Based on the information presented in your Ethics Application, your study has been approved.

Your data collection is approved from 07/22/2016 to 07/21/2017. If your data collection should extend beyond this time period, you are required to submit a Request for Extension Application to the IRB. Any changes in the protocol(s) for this study must be formally requested by submitting a request for amendment from the IRB committee. Any adverse event, should one occur during this study, must be reported immediately to the IRB committee. Please review the IRB forms available for these exceptional circumstances.

Sincerely,

Kevin Lyness

Appendix III: Approved IRB Letter from University for Development Studies, Ghana



UNIVERSITY FOR DEVELOPMENT STUDIES

Tel: 03720-93382/26634/22078
Email: registrar@uds.edu.gh
Website: www.uds.edu.gh

P. O. Box TL 1350
Tamale, Ghana

Our Ref: ....

Your Ref: P 04.1641

OFFICE OF THE REGISTRAR

Date: 5th December, 2016

Dear Sir/Madam

<u>TO WHOM IT MAY CONCERN</u>

Mr. **JOHN BOSCO BAGURI SUMANI** is a staff of the University who is currently pursuing his PhD at the Antioch University, New England in the United States of America (USA). His topic is:

EXPLORING THE POTENTIAL OF CROP INDEX INSURANCE FOR SUSTAINABLE CLIMATE CHANGE ADAPTATION AND MITIGATION AMONG SMALLHOLDER FARMERS IN NORTHERN GHANA.

He is currently in the country for data collection. He has submitted his instruments for data collection to the University Ethics Review Committee and they find that the instruments will have no adverse effects on research participants. He therefore has the permission of the University to undertake this research. Kindly feel free to respond to or deal with him. Any responses you provide would be kept confidential and you will be anonymized.

Please kindly extend to him any courtesies he may require.

Thank you.

Dr. Idarisu M. Tanko
(Snr Assistant Registrar)
FOR: REGISTRAR

Appendix IV: Sample Approved Consent of Letter for Focus Group Discussants

Title: Crop insurance for smallholder farmers in Northern Ghana

Researcher: John Bosco Baguri Sumani, Environment Studies Department, Antioch University New England, Keene, NH, USA.

PURPOSE

Our goal is to find out how crop insurance can help smallholder farmers deal with weather and climate-related problems.

PROCEDURES

If you decide to be part of this survey, you will take part in an interview for about 40-60 minutes. During the interview, we will ask you questions and note down your answers. We will also audio record your responses while you take part in the discussion and may take pictures of you as well. The audio recordings will be used to enrich the qualitative analysis of the data. The photographs will also be used to show the data collection process visually during subsequent presentation sessions of the research work. You have the right to decline to be audio recorded or photographed and your decision will be respected.

RISKS

There are no major risks involved in this study. We will ask you questions about your household, weather and climate, and crop insurance. You have the right not to answer any of the questions we ask you or stop the survey at any time with no penalty.

BENEFITS

There will be no direct financial or material compensation. I am, however, willing to share the results of my study with you if you are interested. Your answers could also help create affordable crop insurance programs and contracts which may benefit you in the medium to the long-term.

CONFIDENTIALITY AND PRIVACY

Your name will not appear in the research report or anywhere. We will not also share information obtained from you with anyone and will destroy it after three years. We will also respect your privacy as well as your cultural beliefs and values.

VOLUNTARY PARTICIPATION

While we will want all selected farmers to take part in this study, you have the right not to. If you decide to take part in this interview, you can stop any time.

QUESTIONS

If you also have questions or concerns about your rights as a participant, you may contact Dr. Kevin Lyness, Chair of the Antioch University New England Institutional Review Board (IRB) through +1 603-283-2444 or klyness@antioch.edu or Dr. Melinda Treadwell, the Provost of Antioch University New England through +1 603 283-2444 or mtreadwell@antioch.edu

EVIDENCE OF CONSENT

I have read this consent form, or this consent form has been translated to me in the local dialect, and I have given approval for my community members to participate in this interview as our tradition demands. Even though consent to take part in the interview could be granted by the opinion leader(s) on behalf community members, individual respondents have the right to decide to participate or withdraw at any time or not to participate without any punishment.

Name of Community:

……………………………………………… …………………………………..

…………………………….. ………………..

1. Name of Community Head Position/Title Sign/Thump Print Date

DOCUMENTATION OF POSSIBLE CONCERNS

I am leaving some informed consent forms with your community opinion leader, i.e., Chief or Assembly Member. If you have any ethical, confidential or privacy issue with this interview, kindly contact your Chief or Assembly Member to assist you to document your concern(s) in the space provided below:

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

Appendix V: Sample Approved Consent Letter for Non-farmer participants (i.e., Key Informants and Survey Respondents)

Title: Crop insurance for smallholder farmers in Northern Ghana

Researcher: John Bosco Baguri Sumani, Environment Studies Department, Antioch University New England, Keene, NH.

PURPOSE

Our goal is to find out how crop insurance can help smallholder farmers and insurers cope with weather and climate-related farming risks.

PROCEDURES

If you decide to be part of this survey, we will ask you to complete a questionnaire for about 30-50 minutes. The questions will require that you provide specific and general answers.

RISKS

There are no major risks involved in this study. We will ask you questions about your household, weather and climate, and crop insurance. You have the right not to answer any of the questions we ask you or stop the survey at any time with no penalty

BENEFITS

There will be no direct financial or material compensation. I am, however, willing to share the results of my study with you if you are interested. Your answers could help create affordable and sustainable crop insurance programs and contracts. These programs and contracts may benefit farmers, insurers, and other stakeholders in the medium to the long-term.

CONFIDENTIALITY AND PRIVACY

Your name and workplace will not appear in the research report or anywhere. We will not also share information obtained from you with anyone and will destroy it after three years.

VOLUNTARY PARTICIPATION

While we will want all selected insurers and insurance stakeholders to take part in this study, you have the right not to. If you decide to take part in this questionnaire survey, you can stop any time.

QUESTIONS

If you also have questions or concerns about your rights as a participant, you may contact Dr. Kevin Lyness, Chair of the Antioch University New England Institutional Review Board (IRB) through +1 603-283-2444 or klyness@antioch.edu or Dr. Melinda Treadwell, the Provost of Antioch University New England through +1 603 283-2444 or mtreadwell@antioch.edu

DOCUMENTATION OF POSSIBLE CONCERNS

If you have any ethical, confidential or privacy issue with this questionnaire, kindly document your concern(s) in the space provided below:

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

EVIDENCE OF CONSENT

I have read this consent form and decided that I will take part in this study. I understand that I can withdraw at any time.

……………………………	……………….	……………………..
Name of Participant	Signature	Date

Appendix VI: Sample Focus Group Discussion (FGD) Interview Guide

1. Facilitating Moderator: Facilitating Recorder/Notes Takers:

Principal Supervising Researcher: John Bosco Baguri Sumani

Gender of Discussants: Female and Male Discussants in Separate Focus Group Discussion (FGD) Sessions

Number of Discussants in each Gender-Based FGD Sessions:

NB1: In facilitating FGD sessions, facilitators should always be guided by the overarching research question and the accompanying sub-questions. Facilitators may not need to ask some questions if answers are already provided by discussants in answering other questions unless there is the need for further probe for emphasis

NB2: Focus Group Discussion Facilitators must also understand that the under listed questions are only guiding questions, and as such, they can vary the order of the questions, introduce new or probing questions or even ignore some questions (if redundant) depending on the responses and circumstances, provided the questions will prompt responses that will address the research questions.

1.0 Brief Socio-Economic and Demographic Characteristics of Discussants

1.1 Estimate of discussant ages

Age Bracket	Frequency
<20	
20-30	
31-40	
41-50	
51-60	
61+	

AGRICULTURAL INSURANCE FOR CROP RISK MANAGEMENT

Record discussants' primary and secondary occupations and the accompanying frequencies in the table below.

Primary Occupation	Frequency	Secondary Occupation	Frequency
Farming		Farming	
Government work		Government work	
NGO work		NGO work	
Artisan		Artisan	
Apprenticeship		Apprenticeship	
Transport business		Transport business	
Traditional medicine/Soothsaying		Traditional medicine/Soothsaying	
Brewing of "pito"		Brewing of "pito"	
Sale of firewood/charcoal		Sale of firewood/charcoal	
Seasonal migration		Seasonal migration	
Other (s), specify below:		Other (s), specify below:	

2.0 Smallholder Farmers' Major Agricultural Risks in Northern Ghana

NB: All responses will be recorded while noting majority, minority, and contrasting views

2.1 Farmland and agricultural output ownership

Who owns the land you have been farming on?

Who also owns the agricultural output from the farmland?

Is this land different from what your husbands/wives or other household members have been farming on?

For Females FGD session: If you and your husbands or other household members cultivate separate farmlands, do you usually combine the output after harvests?

For males FGD session: If you and your wives or other household members cultivate separate parcels of farmland, do you normally combine the output after harvest?

And if yes, why?

If no, why not?

3.0 Key Agricultural Risks Confronting Smallholder Farmers in Northern Ghana

3.1 What are your key agricultural risks? List them using the table below (to be recorded by the note taker) in the order of which risks affect you most and the least.

Identification of key agricultural risks and the associated rankings		
No.	Key agricultural risks	Rankings

3.2 Which crop types do the risks mentioned above mostly affect?

How are the crops affected?

Which types of livestock do the risks mentioned above mostly affect?

How is the livestock affected?

3.3 How would you describe a bad year due to unfavorable weather or climatic events?

Why do you describe it a bad year? Ask a follow-up question, how often do bad years occur?

What causes bad years?

How can these causes be addressed?

How do bad years affect you or your farming and other livelihood activities as a person?

4.0 Smallholder Farmers' Adaptation Strategies in Northern Ghana

4.1 What do you usually do to ensure that your farming activities withstand droughts, floods, and other agricultural risks?

4.2 What normally informs the type of livestock you rear and/or crops you grow?

4.3 How do you usually cope with crop failure or bad years as a result of droughts, floods etc. (due to weather and climate variability/change challenges) and other agricultural risks?

4.4 Are these strategies effectively helping you to cope with climate, weather, and other agricultural risks?

If yes, how?

If no, why not?

4.5 What can be done to make these strategies effective coping mechanisms?

5. Smallholder Farmers' Support Systems, Safety Nets, and Welfare Programs

5.1 Have you ever received support to help you cope with adverse effects of droughts, floods or other agricultural risks during bad years?

If yes, when?

In what form (in-kind or in cash- money, food, clothing or agricultural inputs)?

From who or which organization? And for what?

And if no, why not?

Do you want it?

If yes, list and prioritize your preferred safety nets, support systems, and welfare programs.

5.2 On the average, are the support systems, e.g., safety nets, and welfare programs effective agricultural risks mitigation strategies?

If yes, why?

And if no, why not?

5.3 What can be done to make these safety nets and support systems effective or more effective coping strategies?

6.0 Index-Based agricultural insurance , Agricultural Risks Mitigation, and Determination of Farmers' Willingness to Pay (WTP) Actuarially Fair Premiums.

6.1How many of you have heard or are aware of insurance?

6.1(a) If yes to question 6.1, complete this table

Frequency:	Type of insurance heard or aware of (Health, agricultural etc.):	Type of insurance policy held e.g. health, agricultural etc.:	Source(s) of information for agricultural. Insurance (i.e., how discussants heard about it)	For how many consecutive years discussants purchased agricultural insurance policies	Will you continue to purchase agricultural insurance policies?	
					If yes, why	If no, why not?

6.1 (b) If no, especially for agricultural insurance, complete this table (Briefly, explain agric. insurance and its benefits to this category of respondents)			
Frequency:	Why didn't you purchase agricultural insurance policy or policies?	Will you now purchase agricultural insurance policy/policies?	
		If yes, why?	If no, why not?

6.2 What will be your reaction if you don't receive payout even though you hold a valid index insurance policy (The question hinges on basis risk)?

6.3 Are you a member of any group, association or cooperation?

If yes, what is the name and what does it do?	If no, will you be willing to join a cooperative that supports members during crop failure or bad years?

6.4 Existing or potential role of index-based agricultural insurance in Northern Ghana	
What is/are the existing role(s) of agricultural insurance? What problems are the agricultural insurance programs and contracts helping you to address?	What are your expectations from agricultural insurance programs and contracts? What benefits do you expect from your participation (actual or hypothetical) in agricultural insurance programs and contracts?

6.5 If you are protected from climate and other agricultural risks (e.g. through the use of agricultural insurance), what would you do differently? (Give an example if the respondent is finding it difficult to understand or answer. (E.g., I will take a loan or purchase fertilizer).

6.6 Who has been paying or will pay for agricultural risks protection services? You, your husband/wife, both or who?

6.7 For discussants who have purchased agricultural insurance policies before, in which way have you been involved in the agricultural insurance activities? (The facilitator could follow-up with the following activities if not already mentioned: design, determination or selection of indices, premiums or decisions as to which crops or livestock should be covered)

Will you like to be involved in such agricultural insurance decision-making activities?

If yes, why?

If no, why not?

6.8 What factors do you usually consider or will you consider when deciding to buy index-based agricultural insurance contracts? (If not clear prompt discussants with examples such as trustworthiness of the insurance company or product, premium rate, basis risk etc.**)**

An economic game below will be played to gauge farmers' willingness to pay actuarially fair premiums, a condition that will ensure willingness of insurers to continue to provide agricultural risks protection services in a profitable and sustainable manner.

6.9 Will you be willing to pay GH₵ 50/acre as premium (i.e., 10% of the total investment cost/acre if the total cost/acre (which is GAIP's premium rate) is GH₵ 500, i.e., 10/100* GH₵ 500= GH₵ 50) in return for GH₵ 500 as payout if the total trigger event occurs (e.g. rainfall or drought index)?

Depending on what initial **price bid** you offer to the interviewee and his/her response, **iterate** the bid **UPWARDS** if farmer's response is **YES** or **DOWNWARDS** if the response is **NO.** Continue asking/eliciting farmer's WTP for HIGHER/LOWER amounts until the respondent says NO/YES. This is shown in the table below: farmers' WTP premium (for coverage of 1 acre).

No	WTP premium (GH₵) for coverage of 1 acre	Check with a tick for YES and X for No
1		
2		

3	40	
4	45	
5	50	
6	55	
7	60	
8	65	
9		
10		

For instance, ask the farmer's WTP GH₵ 50 in order to receive a payout amount of **GH₵ 500/acre i**n the event that the insured peril or index occurs (e.g. drought)? If yes, quote a higher bit (e.g. GH₵55, GH₵ 60 etc. until the respondents say no) and if no, lower the bit (e.g. GH45 GH₵40 etc. until the respondent answers yes).

NB. This will be done in sub-groups within the FGD session or for each discussant depending on the number of participants in the group.

6.10 Are index insurance programs and contracts effective agricultural risks management strategies?		
if yes, why?	If no, why not?	What can be done to make the contracts effective agricultural risks mitigation measures?

7.0 Smallholder Farming Systems and Practices, Index-Based Agricultural Insurance and Climate Change Mitigation

7.1 What farming systems and practices have you been engaging in? (If the question is not clear, prompt discussants with examples such as slash-and-burn, mixed farming, agro-forestry etc.)

7.2 If discussants mentioned agro-ecological farming systems in answer to question 7.1, follow-up with the question: What is your motivation for engaging in these agro-ecological farming systems and practices?

7.3 Will you be willing to continue to or tailor your farming activities to include agro-ecological, CSA, and sustainable farming systems and practices if provided with subsidized agricultural insurance contracts?

If yes, why?

If no, why not?

7.4 What is/are your source(s) of energy for cooking either at home or on the farm?

7.5 What can your household, community or you as an individual do to prevent or reduce indiscriminate bushfires, tree felling (e.g. to reduce the smoke and dust we have been emitting into the atmosphere) , droughts, floods and the associated adverse impacts?

Do you know the impact of the smoke and dust we normally emit into the atmosphere on your farming and other livelihood activities?

If yes, let discussants enumerate them.

8.0 Miscellaneous Information

Capture additional information, comments, observations, suggestions, and stories relevant to the main research question and accompanying sub-questions that cannot fit into any of the above themes in the space provided below.

THANKS FOR PARTICIPATING IN THIS STUDY. YOU ARE ALSO WELCOME TO ASK QUESTIONS IF THERE ARE ANY.

Appendix VII: Sample Key Informant Interview Guide

Antioch University New England (AUNE), Environmental Studies Department (ES)

Interview Guide on the Potential of Index-Based Agricultural Insurance for Climate-Induced Agricultural Risks Management among Smallholder Farmers in Northern Ghana

All the necessary National, International, Institutional, Legal, and Regulatory requirements, including AUNE's Institutional Review Board Terms and Conditions, have been met.

Introductory Remarks

This interview results will be strictly used for my dissertation research project with identities and responses of the study participants to be treated anonymously and confidentially. There are adequate strategies to deal with other ethical issues.

Participation in this interview is voluntary. If you consent to participate in this survey, indicate your agreement by signing in the space provided below.

Signature……………………………………………… Date …………………………………..

Name of Interviewer…………………………………………ID……………………………

Date……………………………………………

Region……………………….. District………………………………………………………

Community…………………………………………………

Cell Phone Number of informant if he or she is willing to give it out………………………….

Time started………………………………………………Time ended…………………………

N.B1: In conducting this key informant interviews, research assistants should always be guided by the overall research question and the accompanying sub-questions. Research assistants may not need to ask some questions if answers are already provided by interviewees in answering other questions unless they are follow-up and probing questions for emphasis.

NB2: Interviewers must also understand that the under listed questions are only guiding questions, and as such, they can vary the order of the questions, introduce new or probing questions or even ignore some questions (if redundant) depending on the responses received and circumstances.

A: Brief Socio-Demographic Characteristics of Key Informants

Affiliated organization or community:	Gender:	Status in the organization or community (e.g. head, Designation, community leader etc.):	Highest Level of Education:

B: Technical Information

AGRICULTURAL INSURANCE FOR CROP RISK MANAGEMENT

Number/ Theme	Question	Response
1	Job title of informant	
2	Brief outline of their role , experience and affiliated organization/community	
3	How does informant's work relate to agriculture (including agricultural insurance)?	
Theme 1	Key Agricultural Risks in Northern Ghana	
1	Who owns and controls agricultural land and	

	output in your area of operation?	
2	What are the key agricultural risks or challenges confronting smallholder farmers in your area of jurisdiction? How are these risks affecting the farmers? Which crops are mostly affected?	

	Which livestock is mostly affected? How can the key agricultural challenges identified above be overcome?	
3	How would you describe a bad year (especially due to unfavorable weather or climatic events)? How often do bad years occur?	

	How do bad years affect smallholder farmers? What can smallholder farmers do differently If they are protected from climate and other agricultural risks (e.g. through the use of agricultural insurance)?	
Theme 2	Smallholder Farmers’ Adaptation Strategies	
1	What do smallholder farmers normally do to ensure that their agricultural activities can withstand?	

	i. Droughts ii. Floods, and iii Other agricultural risks?	
2	What considerations usually influence farmers' decision to rear or grow a particular type of livestock and crops? How do farmers usually cope with crop failures	

	during bad years as a result of droughts, floods (climate variability/change) or other agricultural risks?	
3	Are these adaptation strategies helping smallholder farmers to cope with climate, weather, and other	

	agricultural risks effectively? If yes, how? If no, why not? What can be done to make these strategies effective coping measures?	

Theme 3	Smallholder Farmers' Support Systems, Safety Nets, and Welfare Programs in Northern Ghana
1	Are there safety net and welfare programs targeted at helping smallholder farmers cope with adverse effects of droughts, floods, and other agricultural risks in your area of operation? If yes, have smallholder farmers been receiving these support and welfare services? If yes, when, what was received, and from who or which organization? If no, why have they not been receiving these supporting welfare aids and safety nets?

2	By your own assessment and your interactions with farmers, are these support systems effectively helping smallholder farmers to cope with their agricultural risks? If yes, how? And if no, why not?
3	What can be done to make these safety nets and support systems effective or more effective?

Theme 4	Index-Based Agricultural insurance agricultural insurance , Agricultural Risks Mitigation, and Determination of Farmers' Willingness to Pay (WTP) Actuarially Fair Premiums
1	Are smallholder farmers aware of index-based agricultural insurance? If yes, estimate the proportion of the farmers you are dealing with who are aware of agricultural insurance.
2	Are you aware of instances where insured farmers with active contracts did not receive payout even though they suffered losses (effects of basis risk resulting from index-based insurance contracts)? If yes, what was their reaction? (You may give an example of reactions to help informants understand the question)

	What can be done to mitigate the unprotected or uncovered risks (as a result of the basis risk)?
3	What is/are the existing role(s) of agricultural insurance?

	What problems are the agricultural insurance programs and contracts helping smallholder farmers to address? What are your expectations from agricultural insurance programs and contracts What benefits do you expect from (actual or hypothetical) agricultural insurance programs and contracts?
4	What agricultural insurance activities have you been involved in? i. Have insured farmers been involved in? (Interviewer may cite design, selection of indices, and determination of premiums or decisions as to which areas, crops or livestock should be covered as examples to guide informants if these activities are not already cited)
5	Some key challenges confronting agricultural insurance is a lack of widespread availability and high premiums with the concomitant decrease in take-up rates. In your opinion, what can be done to make agricultural insurance policies accessible and affordable to small-scale farmers?

6	What factors do farmers usually consider or will you consider (if you were a farmer) when deciding to buy index-based agricultural insurance contracts? What factors will you consider (if you were a farmer) when deciding to buy index-based agricultural insurance contracts? (If the question is not clear, prompt key informant with examples such as trustworthiness of the insurance company or product, premium etc.)
7	If you were a farmer, will you be willing to pay GH¢50, i.e., 10% (10% is GAIP's premium rate) of the total agricultural investment costs/acre (e.g. if the total cost/acre is GH¢ 500 (10/100* GH¢500= GH¢50) in order to receive 100% (GH¢ 500) of the total investment costs if the trigger event or threshold occurs? If the informant says yes, continue to increase the premium gradually until he or she says no (i.e., GH¢ 55, GH¢ 60, GH¢ 65 etc.), and if no, decrease it gradually until the respondent says yes (i.e., GH¢ 45, GH¢ 40, GH¢ 35 etc.).
8	Are index insurance programs and contracts effective agricultural risks mitigation strategies?

	If yes, why? If no, why not?
Theme 5	Farming systems and practices, index-insurance and climate change mitigation
1	What farming systems and practices have smallholder farmers in your operational area been engaging in? (If the question is not clear, prompt interviewees with examples such as slash-and-burn, mixed farming, agro-forestry etc.)?
2	What is your motivation for engaging in these farming systems and practices?
3	Do you think it is right for the government to subsidize index-based agricultural insurance programs and contracts for smallholder farmers? If yes, why? If no, why not?

4	Will smallholder farmers be willing to tailor their farming activities to include agro-ecological, CSA, and sustainable farming systems and practices if provided with subsidized agricultural insurance contracts? If yes, why? And if not, why not?
5	If you were a farmer (if the informant is not a farmer), will you be willing to tailor your farming activities to include agro-ecological, CSA, and sustainable farming systems and practices if provided with subsidized agricultural insurance contracts? If yes, why? And if not, why not?
6	What can smallholder farmers do to reduce the emission of greenhouse gasses (no matter how little it may be), especially CO_2 into the atmosphere (to control/prevent global warming and climate mitigation)?

7	Do you think it is a good idea to bundle agricultural insurance with climate change mitigation activities? If yes, why? If no, why not?
Theme 6	Additional information, comments, observation, suggestions, and stories relevant to the main research question and accompanying sub-questions that cannot fit into any of the above themes.

THANK YOU FOR PARTICIPATING IN THIS STUDY. YOU ARE WELCOME TO ASK QUESTIONS IF THERE ARE ANY.

Appendix VIII: Sample Questionnaire for Survey Respondents

Antioch University New England (AUNE), Environmental Studies Department (ES)

Survey on the Potential of Index-Based Agricultural Insurance for Climate-Induced Agricultural Management among Smallholder Farmers in Northern Ghana

All the necessary National, International, Institutional, Legal, and, Regulatory requirements, including AUNE's Institutional Review Board Terms and Conditions, are met.

Introductory Remarks

The survey results will be strictly used for my dissertation research project with the identities and responses of the study participants to be treated anonymously and confidentially. There are also adequate strategies to deal with other potential ethical and moral issues.

Survey Questionnaire for National Level Non- Farmer Participants and Researchers

Date of receipt of questionnaire………………Date of submission of questionnaire…………….

Cell phone Number of respondent for possible follow-up contact………………………………..

Respondents have the option and right not to give out their cell phone numbers.

Section A: Socio-Economic and Demographic Characteristics of Respondents

Tick the corresponding category

A1 Brief Socio-Economic and Demographic Characteristics of Respondents (Tick or record as appropriate in table A1 below)

Gender F= Female M=Male	Highest level of education	Age Bracket	Classification of Participant	Geographic scale of operation
1. M 2. F		1.< 21 2. 21-30 3. 31-40 4. 41-50 5. 51-60 6. 61+	1. Insurer 2. Insurance Regulator 3. MOFA 4. GMET 5. Research Scientist/Academic 6. Project/NGO, Specify……………….. ………………………………… …………………… Other(s), Specify………………………… …………………………………... ………………………………… …………………………………...	1.Regional 2.National 3. Zonal 4. Other(s), Specify…… …………… …………… …………… …………… …………… …………… …………… …………

A2 Briefly describe your work or research in relation to agriculture and index-based agricultural insurance in Ghana in the space provided below.

Section B: **Key Agricultural Risks Confronting Smallholder Farmers in Northern Ghana**

B1 Has the weather and climate in Northern Ghana been varying and changing over the years?

1. Yes [ ] 2. No [ ] 3. To some extent [ ] other(s),

Specify……………………………………………………………………………...

…………………………………………………………………………………………

…………………………………………………………………………………………

B2 If yes to B1, briefly indicate below at least 5 manifestations of the varying/changing weather/climate.

1……………………………………………2……………………………………………

3……………………………………………4………………………………………………

5……………………………………………6………………………………………………

B3 Rank the under listed sources of agricultural risks from 1st, 2nd, 3rd etc. with 1st being the most important and last rank being the least contained in table B3.

Source of agricultural risk	**Ranking**
1. Pests/diseases/insects infestations	
2. Droughts	
3. Floods	
4. Input price fluctuation	
5. Output price fluctuation	
6. Market/demand uncertainties	
7. Weather/climate	
8. Soil infertility	
9. Plant genetic potential	
10. Indiscriminate bushfires	
11. Loan/credit inaccessibility	
12. Yield decline	
Other risk(s), specify below:	
13.	
14	
15	

B4 Why are smallholders the most vulnerable to weather and climate variability, climate change, and other agricultural risks? Complete table B4 below.

Causes of smallholder farmers’ vulnerabilities:	Rank the 5 most important causes making farming

	households vulnerable to climate variability and change (i.e., from 1st to 5th).
1. Poverty	
2. Poor choice of crop and livestock varieties	
3. Unfavorable government policies	
4. Lack of agriculture extension advice and services	
5. Lack of weather and climate information	
6. Lack of credit	
7. lack of insurance services	
8. Erratic rainfall patterns	
9. Geographic location	
10. Lack of livestock & poultry birds to sell	
11. Weak communal support	
12. Lack of capital to engage in petty trading activities	
12. Lack of collateral security/guarantees for loans	
13. Lack of irrigation facilities	
14. Lack of alternative job openings	
Specify other causes of farmer vulnerabilities in the rows below:	
15.	
16.	

17.	
18.	

B5 Rank the following Impacts of weather/climate variability/change (e.g. droughts, floods) and other agricultural risks on smallholder farming and livelihood activities in Northern Ghana captured by table B3 below.

Impacts	Tick as appropriate	Rank the applicable impacts in the order of 1st, 2nd, 3rd etc.
1. Loss of crops		
2.Loss of livestock		
3.Unable to pay loans		
4.Unable to feed household		
5.Unable to send children to school		
6.Suffering from hunger-related diseases		
7.Water scarcity		
8. Resource-related conflicts		
9. Other(s), Specify in the rows below		
10.		
11.		
12.		

13.		
14.		
15.		

C: **Section Smallholder Farmers' Existing Adaptation Strategies**

C1 Table C1 below contains some of the strategies smallholder farmers have been employing to cope with adverse effects of droughts, floods, and other agricultural risks. Rank the under listed coping strategies below.

Coping strategies:	Tick the appropriate category	Rank the 5 most important coping strategies (i.e., 1st to 5th)
1. Use of grains stored from previous year or years' harvest		
2. Buying grains		
3. Selling livestock/poultry birds		
5. Engaging in off-farm jobs		
6. Withdrawal of children from school		
7. Migration to other regions with favorable weather/climate		
8. Reliance on food aid and disaster relief supplies		
9. Reliance on fruits, vegetables etc. from the wild		

10. Reliance on food from agro-forestry practices		
11. Reduction in consumption		
12 .Borrowing from neighbors		
13. Reliance on support from neighbors and social networks		
14. Remittance from relatives and friends		
15. Engaging in barter trade		
15. Agricultural insurance		
16. Reliance on Savings		
17. Borrowing from financial institutions		
18. farm and crop diversification		
19. Mixed farming		
20. Use of drought-resistant and improved crop and livestock varieties		
Other coping measures and alternative livelihood options, list in the rows below:		
21.		
22.		
23.		
24.		
25.		

C2 Do you think the above-enumerated strategies are effectively helping smallholder farmers to cope with adverse effects of weather variability and climate change?

1. Yes [ ] 1. No [ ] 3. To some extent [ ] 4. I don't know

C3 If yes to or to some extent to C2, in which way(s) are they effective?

…………………………………………………………………………………………………

…………………………………………………..………………………..………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

C4 If no to C2, in which way(s) are they ineffective?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

……………………………………………………………………………………………...

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

C5 What factors usually influence farmers' decision to grow and rear particular crops and livestock varieties? Rank the first 5 decisions in table C2 below with 1st being the most influential factor and 5th the least.

Factors influencing farmers' decisions to grow/rear particular crop varieties	Ranking
1. Yield	
2. Prevailing market Price	
3. Drought and flood tolerance capacity	
4. Food security considerations	
5. Agro-meteorological advice	
6. Loan requirement and repayment	
7. Agro-input requirements	
Other considerations, list them in the rows below:	
8.	
9.	

D: Smallholder farmers' support systems, safety nets, and welfare programs

D1 What Safety nets and social welfare programs have been put in place to help smallholder farmers to cope with adverse effects of climate variability/change and other agricultural risks in Northern Ghana? Record your response in table D1 below.

Safety nets and welfare programs	Indicate name of organization providing assistance
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	

D2 Cumulatively, do you think the above-enumerated safety nets and welfare programs are effectively helping smallholder farmers to cope with adverse effects of climate variability/ change and other agricultural risks in Northern Ghana?

1. Yes [ ] 2. No [ ] 3. To some extent 4. I don't know

Briefly, explain the choice of your answer

below…………………………………………………………………………….

……………………..

....

D3. In your opinion, what can be done to assist vulnerable and marginal smallholder farmers to cope with weather/climate and other agricultural risks effectively?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

………………………………………………………………………….…………………..

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

Section E: Index-Based Agricultural Insurance and Agricultural Risks Mitigation

Table E1: Effectiveness of index-based agricultural insurance

Do you think agricultural insurance is an effective tool that can help smallholder farmers cope with adverse effects of climate change and other agricultural risks? Record your responses in table E1	
Response status (Tick as appropriate)	Give reasons for your selected response
1. Yes	1……………………………………………………………………….. 2……………………………………………………………………….. 3…………………………………………………………………………
2. No	1……………………………………………………………………….. 2……………………………………………………………………….. 3…………………………………………………………………………
3. To some extent	1……………………………………………………………………….. 2……………………………………………………………………….. 3…………………………………………………………………………
4. I don't know	

E2 Are you aware of any insurance law/Act or regulation? Yes [ ] No [ ]

E3 If yes, which insurance Law/Act/Regulation?

E4 Are you also aware of the Insurance Act, Act 724 (2006)? Yes [ ] No [ ]

E5 If yes to question E4, is the Act 724 (2006) in its current form accommodative of agricultural insurance? 1. Yes [ ] 2. No [ ] 3. To some extent [ ] 4. I have no knowledge of Act 724

(2006) [ ]

E6 If no to E5, what can be done to make the Act accommodative of agricultural insurance?

1……………………………………………………………………………………………

2……………………………………………………………………………………………

3……………………………………………………………………………………………

4……………………………………………………………………………………………

E7. Rank the under listed possible benefits of agricultural insurance contracts on a scale of 1 to 10 or beyond with 1 and 10 representing the most important and least important values in table E7 below.

Possible benefits of index-based agricultural insurance contract	**Scale**
1.Yield protection	
2.Revenue protection	
3.Price protection	
4.Market/demand protection	
5.Family security and safety net	

6.Agri-business and value change linkage benefits	
7.Provision of collateral security for access to loans/credit	
8. Access to agro-inputs	
9.Peace of mind	
10. Cash flow	
Other benefits, specify below without ranking:	
11.	
12.	
13.	
14.	

E8. Indicate your level of agreement with the under listed statements which have the potential to motivate demand for and supply of agricultural insurance services. Record your responses in table E8 below.

Agricultural insurance companies should collaborate with other agencies to provide :	Extent of agreement or disagreement with the under listed statements				
	Strongly disagree	Disagree	No Opinion	Agree	Strongly agree
Agro-meteorological advisory services (early warning systems,					

weather forecasting, when to plant, etc.)					
Agricultural extension services					
Farmers with agro-inputs directly or link them (farmers) with agro-input dealers and markets (agri-business value chain),					
Guarantees for farmer loans or bundle crop insurance contracts with credits					
Investments in mobile telecommunication technology-based marketing/information dissemination (use of SMS)					
Accept payment of premiums and claims using mobile money systems					

Section F: The Role of Index-Based Agricultural Insurance for Climate Change Mitigation

F1: As an insurer or stakeholder in the index-based agricultural insurance industry, how have you been or how can you contribute to climate change mitigation?

1…………………………………………2…………………………………………….

3…………………………………………4…………………………………………….

5…………………………………………6…………………………………………….

F2. Will you be willing (for insurers) or do you think it is a good idea (for Non-insurer participants) to provide the following agricultural insurance services? Record your responses in table F2 below.

	Response categories and reasons for response			
Variable categories	Yes	Briefly, state the reasons for your responses	No	Briefly, state the reasons for your responses
Are you in support of or willing to:				
Incorporate agricultural risk protection contracts into mainstream insurance businesses				

Provide subsidized crop insurance contracts for farmers engaging in climate mitigation and disaster risk reduction activities.				
Provide “green” and climate friendly insurance policies.				

Formulate and implement climate smart policies to guide insurance businesses				
Incorporate climate awareness creation activities into mainstream insurance business activities				
Reward farmers engaging in climate mitigation activities (agro-forestry, agro-ecological and CSA practices, zero tillage, cover cropping, non-burning practices etc.				

F3. Index-based agricultural insurance schemes and contracts have the potential to contribute to climate mitigation through the under listed activities and systems contained in table F3 below.

AGRICULTURAL INSURANCE FOR CROP RISK MANAGEMENT

Kindly indicate your extent of agreement and rank these activities and practices on a scale of 1-5, where 5 attracts the highest importance value and 1 the least. **Tick and rank as appropriate.**

Potential climate mitigation activities	Extent of agreement					Rank these climate mitigation activities
Index-insurance employed to promote:	Strongly disagree	Disagree	No opinion	Agree	Strongly Agree	
1. Agro-ecological farming systems e.g. agro-forestry, cover cropping, crop rotation etc.						
2. Climate smart agriculture practices e.g. zero tillage, mulching, mixed farming, agric. intensification etc.						
3. Non-burning practices (avoidance of indiscriminate burning/bushfires)						
4. Non-clearance or destruction of socio-cultural and ecological sites e.g. sacred groves, local/community forests and river banks etc. mainly as abodes of ancestral gods						

5. Afforestation and reforestation			

F4. Do the designs of current and proposed Ghanaian agricultural insurance programs and contracts provide for climate mitigation? Yes [ ] No [ ] To some extent [ ] I don't know [ ]

Briefly, explain your choice of response in the space provided below

F5. Are you in support of existing insurance companies and new ones being formed to engage in the provision of agricultural insurance services (table F5)? 1. Yes [ ] 2. No [ ] 3. Undecided [ ]

If **yes**, give your reasons below	If No, give your reasons below

F6. Will you accept in-kind premium payments (insurers) or do you think acceptance of in-kind premium payments (Non-insurer participants) may increase farmer's take-up rates for agricultural insurance contracts? Record your responses in table F6 below. Tick as appropriate.

	Response status (Tick as appropriate)			
Types of in-kind payments	Yes	No	To some extent	Give reasons for your acceptance or rejection of the type of in-kind premium proposed.
Contribution of labor for climate change mitigation and disaster risk reduction activities				
Payment with grains or yields, livestock, fowls etc.				

F7. Do you think government subsidization of index-based agricultural insurance programs and contracts is a good idea? Record your responses in table F7 below.

Variable categories	Category of response: Tick as appropriate			
	Yes	To some extent	No	I don't know
Reason for choice of response				

F8. Describe your level of agreement with the following statements in table F8.

Indicate your level of agreement with the following statements. Record 1, 2, 3, 4, or 5 in the appropriate cell if you strongly disagree, disagree, have no opinion, agree or strongly agree with the under listed statements respectively.					
	Extent of agreement or disagreement with the statements				
Statements	Strongly disagree	Disagree	No Opinion	Agree	Strongly agree

Insurance companies, programs , and government should reward farmers engaging in climate mitigation activities (such as agro-forestry, agro-ecological and CSA practices, zero tillage)					
Government should provide reinsurance as well as reimburse insurance companies with administrative and operation (A&O) costs for undertaking climate mitigation activities					
Government, insurance companies, and the relevant agencies should collaborate with insurance companies and programs to access climate adaptation and mitigation funds from UNFCCC and other related initiatives e.g. REDD+, CDMs etc.to support climate mitigation and adaptation activities					

F9. Indicate your extent of agreement or disagreement with proposals to amend Ghana's Insurance Act 724 (2006) to accommodate new demands of agricultural insurance (table F9).

Indicate your extent of agreement or disagreement with the under listed opinion statements					
The Insurance Act 724 (2006) should be explicitly amended to:	Strongly disagree	Disagree	No Opinion	Agree	Strongly Agree
1. Make incorporation of agricultural insurance into insurance business voluntary for all insurance companies.					
2. Make incorporation of agricultural insurance into insurance business compulsory for all insurance companies.					
3. Make participation in agricultural insurance programs voluntary for all farmers					
4. Make participation in agricultural insurance programs compulsory for all farmers					
5.Make purchase of insurance contracts a pre-requisite for receipt of relief supplies and aid, especially from the National					

Disaster Management Organization (NADMO)					
6. Compel government to set up a solely public owned and run agricultural insurance program					
6. Compel government to establish public/private partnership agricultural insurance corporation					

F10. Can agricultural insurance programs and contracts provide comprehensive agricultural risks coverage?

1. Yes [ ] 2. No [ ] 4. I don't know [ ]

F11. If no to F10, give 4 ways the residual agricultural risks (i.e., basis risk) can be mitigated.

1……………………………………………………………..…………………………………

2…………………………………………………………………………………………………….

3…………………………………………………………………………………………………

4……………………………………………………………………………………………….

F12. Some key challenges confronting agricultural insurance is a lack of widespread availability and high premiums with the concomitant decrease in take-up rates. What do you think can be done to make agricultural insurance policies accessible and affordable to small-scale farmers, especially in Northern Ghana? Give your suggestions below:

1………………………………………………………………………………………………

2………………………………………………………………………………………………

3………………………………………………………………………………………………

4………………………………………………………………………………………………

Section G: Miscellaneous Information

You may record any comment, observation, further contribution, suggestion or recommendation in the space provided below……………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

THANK YOU FOR PARTICIPATING IN THIS SURVEY. YOU ARE WELCOME TO ASK QUESTIONS IF THERE ARE ANY.

Appendix IX: Permission granted me to access and use Field Pictures

Re: permission to use pictures3
Yahoo/Inbox

Jambadu Lazarus <xxxxxxxxxxxx@xxxxx.com>
To: xxxxxxxxxxx @xxxxx.com
Jun 19 at 4:34 PM
Dear Mr. Sumani,

I write to grant you permission to access and use the field pictures I took, when I supported you during your field works in Ghana.

Best regards,

Lazarus Jambadu.