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IMPLICATIONS OF PARTICIPATION IN CLIMATE CHANGE INTERVENTIONS ON WOMEN EMPOWERMENT AND LIVELIHOOD OUTCOMES OF FARM HOUSEHOLDS IN NORTHERN GHANA

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A THESIS SUBMITTED TO THE DEPARTMENT OF AGRICULTURAL AND FOOD ECONOMICS, FACULTY OF AGRICULTURE, FOOD AND CONSUMER SCIENCES, UNIVERSITY FOR DEVELOPMENT STUDIES, TAMALE IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF DOCTOR OF PHILOSOPHY DEGREE IN AGRICULTURAL ECONOMICS

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DECLARATION

I, Alhassan Issah Suhiyini, hereby declare that this thesis, "**Implications of Participation in Climate Change Interventions on Women Empowerment and Livelihood Outcomes of Farm Households in Northern Ghana**" is entirely my own work and that no part of this work has been presented for another degree in this University or elsewhere. I also declare that any quotation(s) or paraphrase(s) from published or unpublished works of any other author(s) has been duly acknowledged.

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We hereby declare that the preparation and presentation of this thesis was supervised in accordance with the guidelines on supervision of thesis laid down by the University for Development Studies, Tamale.

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ABSTRACT

Livelihood of farmers in Northern Ghana is under threat due to the effects of climate change on agricultural production. In view of this, several non-governmental and governmental organisations have intervened to ameliorate the effect of climate change on the livelihood of farm households by implementing agricultural programmes and projects to assist farm households adapt to climate change. In spite of these efforts, farmers (especially women) still battle with hunger, poverty, disempowerment and low yield, which hinders the achievements of better livelihoods as outlined in the Sustainable Development Goals (SDG). This study assessed the implications of participation in governmental and non-governmental organisations' climate change interventions on women empowerment, food security and welfare of farm households in Northern Ghana. Specifically, the study profiled and analysed the coherence of governmental and non-governmental organisations' climate change interventions with selected SDGs using descriptive statistics, content and thematic analysis; determined the effect of participating in climate change interventions on women empowerment using the Women in Agricultural Empowerment Index and Multinomial Endogenous Treatment Effect Regression Model; and the effects of participation in climate change interventions on food security and consumption expenditure using Multinomial Endogenous Treatment Effect Regression Model. Food security of households was measured using household hunger score, Minimum Dietary Diversity for Women and Household Food Expenditure Share while households' consumption expenditure was used as a proxy for welfare. The study used the USAID-Feed the Future Population Based Survey data in Northern Ghana and were complemented with focused group discussions, key informant interviews and desk review of climate change interventions. Results revealed that project activities of NGO-led climate change interventions were more focused on reducing poverty and hunger, and fostering gender equity, women empowerment and climate change adaptation than governmental interventions. Membership with social group, marital status and sex of household head significantly influence participation in climate change interventions. Results further revealed that unlike participation in only governmental interventions which have no significant effect on women empowerment and livelihood outcomes; participation in only NGO or both NGO and governmental interventions had significant positive effects on women empowerment, households' dietary diversity for women and consumption, and reduces household hunger and food expenditure. The study concludes that NGOs climate change interventions are more coherent with SDG 1 (zero poverty), SDG 2 (end hunger), and SDG 5 (gender equality and women empowerment) than governmental interventions. Participation in either only NGOs interventions or both NGOs and governmental interventions significantly improves women empowerment, food security and consumption expenditure than participation in only governmental interventions. Based on these, the study recommends that to ensure effective and efficient utilization of financial resources on climate change adaptation in Northern Ghana, an effective government – NGO partnership is required to ensure that the numerous interventions remain relevant in reducing hunger, poverty, food and nutrition insecurity as well as empowering women. Also, farmers, especially women should be sensitized to form group to foster their participation in climate change interventions. Finally, government interventions should be redirected to focus on women empowerment and gender equality, hunger and climate action at community level to achieve the SDGs on poverty, hunger and women empowerment.

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Despite the assistance of so many, I solely take responsibility for any remaining errors and omissions in this thesis.

DEDICATION

I dedicate this thesis to my wives, Rashidatu and Salima; my daughters, Neisim, Nasara and Katari; and to the entire Suhiyini family in Tamale.

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LIST OF ABBREVIATIONS

5DE	Five Domains of Empowerment
ADVANCE	Agricultural Development and Value Chain Enhancement
FtF	Feed the Future
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agricultural Organization
FDG	Focus Group Discussion
FBO	Farmer-based Organization
GASIP	Ghana Agricultural Sector Investment Programme
GCAP	Ghana Commercial Agricultural Project
GDHS	Ghana Demographic and Health Survey
GoG	Government of Ghana
GLSS	Ghana Living Standard Survey
GPI	Gender Parity Index
GSS	Ghana Statistical Service
HFES	Household Food Expenditure Share
IPCC	Inter-governmental Panel on Climate Change
METE	Multinomial Endogenous Treatment Effect
METSS	Monitoring, Evaluation and Technical Support Services in Ghana
MoFA	Ministry of Food and Agriculture
MDGs	Millennium Development Goals
MDD_W	Minimum Dietary Diversity for women

MMDAs	Metropolitan, Municipal and District Assemblies (MMDAs)
NRCC	Northern Regional Coordinating Council
NGO	Non-governmental Organization
PBS	Population Based Survey
PDO	Project Development Objective
PPP	Public-Private Partnerships
SADA	Savannah Accelerated Development Authority
SDGs	Sustainable Development Goals
SLF	Sustainable Livelihood Framework
ToC	Theory of Change
RING	Resilience in Northern Ghana
UNFCCC	United Nation Framework Convention on Climate Change
UNDP	United Nations Development Programme
WAEI	Women Empowerment in Agricultural
WFP	World Food Programme
ZOI	Zone of Influence

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Anecdotal evidence demonstrates a gross level of dissatisfaction with the service development organizations provide to farm households (Kumi & Copestake, 2022). During field interaction with farmers, they often complain of not being fairly treated by organizations that claim to assist them in the alleviation of poverty, food insecurity, hunger, and other poor living conditions which they have been battling with for ages. According to farmers, several organizations (both governmental and non-governmental) that have attempted to assist them with these conditions often come with project activities with incentives. However, these projects often end without the full realization of the goals or objectives the programmes are supposed to offer to farmers (Brinkman, 2001; Chanase, 2021; Owusu et al., 2011).

Given that over 60 percent of the active labour force in Northern Ghana is engaged in agriculture which is dominated by rain-fed systems, the pervasive erratic rainfall pattern, and high temperatures have aggravated the effects on rain-fed agriculture, worsening the livelihood sources of agriculture-dependent households (Ghana Statistical Service, GSS 2019). This has been a serious concern for development stakeholders including the media, researchers, governmental and non-governmental organizations, and other development partners. Northern Ghana has often been described as the “hub of NGOs” due to the high number of non-governmental organizations (NGOs) operating within the area, to reduce poverty, hunger, and food insecurity and improve living standards for people.

According to Prowse and Snilstveit (2010), in the early 2010s, many funds were available from international donors to finance interventions on climate change mitigation and adaptation. The requirements for these funds are such that choice and strategy of climate change programmes must be on the evidence of best practices based on experience, under what circumstances, category of end-users, and at what cost? This requirement is to ensure effective resource allocation.

The Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2001) notes that not much consideration is dedicated to the collaboration of climate change adaptation interventions with ongoing development projects and programmes. Adaptation interventions should be integrated into climate-wise development programmes, according to the World Bank (2010). Therefore, climate change adaptation actions are increasingly being included in development programmes to achieve the Sustainable Development Goals (SDGs) adopted by UN member states in September 2015. As a result, projects and programmes aimed at achieving long-term sustainability in the world's development frequently include climate change components.

In pursuance of the Sustainable Development Goals, especially SDG 13, a National Climate Change Policy Action Programme for Implementation (2015 – 2020) was drafted by the Ghana National Climate Change Committee in 2015 as a master plan to serve as a robust measure required to resolve the climate change vulnerability and consequences as contained in the SDG document. Future climate change programs and initiatives need to be established following the National

Climate Change Master Plan's guidelines (Ghana National Climate Change Master Plan, 2015). As a result, this strategic document became Ghana's primary climate change agenda, informing national climate change programmes and developmental actions of the national government.

To enhance farmers' livelihoods, the Ghanaian government established many initiatives such as the Ghana Commercial Agricultural Project (GCAP) and the Ghana Agricultural Sector Investment Programme (GASIP) in 2015. In addition, the Youth in Agriculture Programme was launched in 2013 as a response to climate change's adverse effects on agricultural production. In 2017, the programme was renamed Planting for Food and Jobs (PFJ), to provide jobs for the youth while also ensuring food security for the Ghanaian people. The Ministry of Food and Agriculture (MoFA) under the Rearing for Food and Jobs (RFJ) programme distributed domestic animals to households in Northern Ghana for free. Currently, the International Institute for Tropical Agriculture (IITA) is promoting the One-Health approach to mitigating climate change impacts on smallholder farmers with a multidimensional approach to improving water, soil, crop, and animal health. Despite several government and non-governmental interventions, farmers continue to struggle with the detrimental effects of climate change.

Owusu et al. (2011) stated that the activities of NGOs in Northern Ghana complement the government’s efforts in reducing food insecurity in Northern Ghana through its provision of rural livelihood diversification strategies by engaging farm households in non-farm income generation activities such as agro-

processing, service provision (transport, repairs, etc), charcoal production, and commerce. Agro-processing is women's dominant economic activity which is mostly done on a small-scale using traditional method. Food trading, shea nut, and peanut processing, cotton ginning, rice production, and soap production are examples of these operations. In an attempt to reach out to the large vulnerable and disadvantaged groups, the USAID and other multilateral development agencies have intervened in different sectors of various developing countries' economies. In Northern Ghana specifically, the most recent intervention and support was the Resilience in Northern Ghana (RING) and Agricultural Development and Value Chain Enhancement (ADVANCE) I and II projects purposively to enhance vulnerable households' adaptive capacity and resilience to climate variability and change.

This multi-sectorial support and initiatives conform to the Paris Agreement which seeks to strengthen human rights, gender equality, and women's empowerment in all climate actions. Hence, interventions target issues of equitable access to land, water management, disaster preparedness, rights, and wellbeing, which are central to achieving the SDG (UNDP, 2018). The need for more climate-friendly interventions exceeds the resilience of the beneficiaries and ecosystems to a reduction in GHG emissions (Bayala et al., 2021). The World Bank categorized the strategic targets for agricultural adaptation activities into three strategies: 1) assessing the effects of climate change on forests, crops, livestock, and fisheries; 2) assisting farmers and lenders in dealing with climate change threats; and 3) improving management practices and crop or livestock varieties to avoid crop and

livestock damage caused by climate change and increased pest and disease prevalence (Fernandes et al., 2012).

Many climate-smart agricultural interventions have overt targets for agricultural households to improve livelihoods through drought-tolerant crop diversity, integrated soil fertility management, water conservation methods, livestock integration into mixed crop-livestock farms, and rangeland restoration (Campbell et al., 2016; FAO, 2018; Rosenstock et al., 2019; Vanlauwe et al., 2010). However, due to the absence of baseline data against which interventions can be compared, one question that remains unaddressed in the literature is how climate change interventions progress toward achieving intended aims over time. Furthermore, the lack of contextual targets for interventions impedes the efficiency and efficacy of local, national, and international support interventions, thereby jeopardizing the achievement of specific Sustainable Development Goals. The situation is more complex in respect of climate-smart agriculture (CSA) interventions which emphasize mitigation, adaptation, and productivity within an enabling environment.

Van Wijk (2014) and Van Wijk et al. (2014) opined that directing programmes and monitoring progress through impact assessments that permit reflexive learning is the best and least addressed problem in scaling up Climate Smart Agriculture. In the literature, studies have concentrated on the evaluation of the adaptation and mitigation challenges of interventions (Richards et al., 2018; Van Wijk, 2020) without linking the program objectives to global development goals. Tahiru et al.

(2019) explored the contribution of NGO-led climate change programmes to the achievement of the National Climate Change Adaptation Strategy of Ghana. The limitation of this study is that it only assessed the objectives of NGO-led climate change programs to national development goals without considering government-led interventions and also did not link the program goals to global development goals.

Almost a third into the fifteen years after their adoption in September 2015, there is the need to assess how the SDGs on climate change are incorporated into developmental programmes and policies by governmental and non-governmental organisations to mitigate climate change effects while promoting effective adaptation. Climate change has impacted negatively on the livelihood of households in Northern Ghana, particularly among farmers. Women must be at the forefront of climate change adaptation given that they constitute more than half of Ghana's population and provide more labour for agricultural activities in Northern Ghana. Given the persistent high food insecurity, poverty levels, and poor livelihoods of farm households amid the numerous interventions in Northern Ghana by government and NGOs aimed at improving the livelihoods of farmers, this study is in response to the numerous calls by farmers on the essence of climate change interventions. Thus, this study attempts to investigate the coherence of both government and NGOs' climate change interventions with selected SDGs and their effects on women empowerment and consumption expenditure of farm households.

1.2 Problem Statement

Governments and non-governmental organizations (NGOs) have launched outreach programmes and campaigns to educate farmers and build resilience measures targeted at lowering smallholder farmers' vulnerability to the consequences of climate change (Rojas Blanco 2006; Fitzpatrick & Molloy 2014). Climate change actions hardly overcome the expected implications of climate change because they are often reactionary (GNCCAS, 2012). The extent to which these measures help to improve farmer welfare is at the centre of the adaptation study (Smucker et al., 2015).

Studies show that numerous programmes are implemented in Northern Ghana to ameliorate the effect of climate change on farm households' livelihood. Yet, hunger, poverty, and marginalisation of women are still major problems in Northern Ghana (USAID, 2015; Cooke et. al., 2016). About 1.2 million Ghanaians were considered food insecure in 2011 (UNICEF and GHS, 2011) and by 2016, food insecurity afflicted about 2 million Ghanaians, accounting for 5% of the population (Darfour and Rosentrater, 2016). Despite various initiatives by both governmental and non-governmental organizations, an average of 7 out of 10 people in Northern Ghana live in poverty and are frequently deemed food insecure (Adu et al., 2018; Adjei et al., 2012). In Northern Ghana, rural livelihoods are mainly agricultural-based and sensitive to climate change due to low adaptive and productive capacities. Erratic floods and drought also cause crop damage, soil erosion, loss of soil fertility, siltation, and other climate-induced effects resulting in

low yields. This has led to high food insecurity, low incomes, and negative effects on livelihood.

Despite the numerous climate change interventions in Northern Ghana, farm households are still deficient in climate change knowledge, remain food insecure, are less resilient to climate change, and experience low yield, low farm income, and other deleterious livelihoods due to climatic conditions (Steiner-Asiedu et al., 2017; Korbli and Acheampong, 2020). While the reality and effects of climate change are extensively visible and their causes acknowledged, mitigating the effects is only an aspect of the solution. Thus, adaptation to climate change is the focus of the SDG which requires mainstreaming issues on climate change into developmental programmes and policies.

Cook et al. (2019) revealed that in Indonesia, Peru, and Tanzania, interventions aimed at reducing greenhouse gas emissions were largely effective and successful because of the use of gender quotas in participation. Conversely, most governmental agricultural interventions implemented in Northern Ghana do not have special packages to foster women's participation and empowerment (Mabe et al., 2018). Although most organizations assume that women are central in their climate change interventions, there seems not to be any significant change in women's empowerment as women are still disproportionately affected by the effects of climate change than their male counterparts (Alhassan et al., 2019). Yet, policymakers have acknowledged the lack of gender-based data as the main challenge in taking gender issues onto the climate change agenda. Women’s viewpoints need to be included in making climate change policies at all levels

including global policymaking. Thus, given that women are mostly side-lined in decision-making and access to productive resources in Northern Ghana (Alhassan *et al*., 2018), the pressing need to evaluate the extent of women's empowerment relative to their men compatriots in adapting to climate change through interventions is undoubted as gender equality has been highlighted in the SDGs.

Northern Ghana has benefitted from numerous climate change-related projects in the past two decades, with technical and financial support from international donors or research organizations, the Government of Ghana or its mandated institutions, NGOs, and civil society (Würtenberger et al., 2011; Al-Hassan et al., 2013, Tahiru et al., 2020). The initiatives promoted through these projects focused on building farmers' capacity, creating awareness about climate change and its effects, and promoting climate change adaptation or coping strategies (Al-Hassan et al., 2013). These activities mostly aim at either building farmers' resilience or mitigating the impacts of climate variability and change. However, few works of literature exist on the evaluations of the effectiveness of these projects in achieving national and international developmental goals (Armah et al., 2019). Even though governmental organisations have access to more resources, NGO – led climate change interventions in Northern Ghana tend to be more successful in ensuring better livelihood than the former (Adjei et al., 2012).

Studies that have attempted exploring the climate change interventions – livelihood nexus have either considered only NGOs interventions (e.g. Zakaria et al., 2016; Tahiru et al., 2019; Armah et al., 2019) or only governmental interventions (Mabe et al., 2018) but not both. Despite the government of Ghana declaring the

agriculture sector as the engine of growth and realizing the role of women in the sector, few studies have examined the effects of agricultural interventions on women's empowerment. This makes it difficult to evaluate the impact of both governmental and non-governmental organisations funded programs on empowering women. Yet, existing studies have only juxtaposed outcomes of climate change interventions with the objectives of implementing organisations. Thus, these studies have not been able to fit the project activities of climate change interventions into the global development perspective to assess how such interventions are in tandem with the global development goals, hence, contributing to the achievement of the SDGs. Finally, unlike other impact evaluation studies which have used Heckman Two-Stage Sampling Selection, Endogenous Switching regression, and Multinomial Endogenous Switching Regression to account for sample selection biases, I employed the Multinomial Endogenous Treatment Effect Model which has the added advantage of taking both continuous and discrete outcome variables. In this study, all outcome variables were measured as continuous and discrete to determine the actual probability of participation in interventions on the livelihood outcomes.

The current study contributes to the literature by comparing the coherence of governmental and NGO climate change interventions' objectives with the SDGs and determining their effects on women empowerment, food security, and consumption expenditure as a measure of households' welfare. Thus, the study compared and contrasted the livelihood implications of key climate change interventions of both government and NGOs implemented in Northern Ghana and

whether the interventions are in tandem with selected sustainable development goals. Northern Ghana was selected for this study because it is the most vulnerable region to climate change in Ghana (Etwire et al., 2013a, Alhassan et al., 2018, 2019) and has received most of both government and NGOs climate change interventions in Ghana (Adu et al., 2018).

1.3 Research Objectives

The study aims at assessing the effects of government and NGOs' climate change interventions on women empowerment, food security, and consumption expenditure of farm households.

The specific objectives are to:

1. profile and analyse the coherence of government and NGOs' climate change interventions with selected SDGs (SDG 1, SDG 2, SDG 5, and SDG 13)
2. examine the factors influencing farm households' participation in government and NGOs climate change interventions
3. determine the effect of participation in government and NGOs' climate change interventions on women empowerment of farm households
4. determine the effect of participation in government and NGOs' climate change interventions on farm households' food security and consumption expenditure

1.4 Research Questions

The main research question of the study is: what are the livelihood implications of participation in climate change interventions on women's participation, food security, and consumption expenditure of farm households?

The specific research questions of the study are:

1. How coherent are government and NGO climate change interventions implemented in Northern Ghana with the SDGs?
2. What factors influence farm households' participation in government and NGO climate change interventions in Northern Ghana?
3. What are the effects of participation in government and NGO climate change interventions on women empowerment of farm households?
4. What are the effects of government and NGOs' climate change interventions on farm households' food security?
5. What are the effects of government and NGOs' climate change interventions on farm households' consumption expenditure?

1.5 Research Hypothesis

The null hypotheses of the study were:

1. H_O: Participation in only government climate change interventions has no significant effect on women empowerment (Repeated for participation in only NGO and both NGO and government interventions).
2. H_O: Participation in only government climate change interventions has no significant effect on farm households' food security (Repeated for participation in only NGO and both NGO and government interventions).

3. H_O: Participation in only government climate change interventions has no significant effect on farm households' consumption expenditure (Repeated for participation in only NGO and both NGO and government interventions).

1.6 Significance of the Study

The study looked at the various climate change interventions in Northern Ghana and how they fit into or contribute to the Sustainable Development Goals' overarching global development agenda. Thus, the findings of this study provide feedback or lessons on the implementation of future interventions to redirect the focus of climate change interventions (if necessary) to ensure that the SDGs and the Ghana Climate Change Adaptation Strategy's goals are met.

Also, the findings unearth the level to which climate change interventions have contributed to empowering women to bridge the gender gap in climate change adaptation empowerment. In Northern Ghana where the study was conducted, women have often been marginalized in terms of decision-making and leadership. This study is vital in unearthing the extent to which climate change interventions can bridge this male-female disparity toward ensuring gender equality.

The study evaluates the effect of climate change interventions on the livelihood of farm households. The difference in the success of climate change interventions by governmental vis-à-vis non-governmental organizations in improving farm households' livelihood will serve as a lesson to redirect the focus of future interventions. In this way, the findings will guide future interventions aimed at improving climate change adaptation and the livelihood of farm households.

1.7 Organization of the Study

There are nine chapters in the thesis. The introduction is presented in chapter one and provides the research background, problem statement, research aims, and study justification. Chapter Two presents a survey of relevant literature on theoretical and empirical investigations of climate change interventions and their linkage to livelihood outcomes. Chapter Three presents the SDGs and Profile of climate change interventions considered in the study. The study's research methodology is outlined in Chapter Four and covers the research design, data sources, sample size determination, sampling procedure, data collection tools, data analysis methodologies, data collection instruments' validity and reliability, and ethical considerations.

The results and discussion based on the study objectives are presented chronologically in Chapters 5 to 8. The results and discussions on the coherence of climate change policies with the SDGs are presented in Chapter 5. Chapters 6 and 7 contain the findings and discussions on the factors that influence farm households' engagement in climate change interventions, and the implications of government and NGO climate change interventions on women's empowerment. The effects of participation in government and NGO climate change interventions on livelihood outcomes are discussed in Chapter 8 (food security and consumption expenditure). The study ends with Chapter Nine, which summarizes the data, draws conclusions, makes recommendations, and makes proposals for further research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of the literature relevant to this study. The chapter includes reviews of the literature on key concepts and terminologies, the Sustainable Livelihood Framework, theoretical and empirical reviews of the Multinomial Endogenous Treatment Effect Model, women's empowerment, food security, and consumption expenditure, and reviews of factors that influence farm households' participation in climate change programmes. The chapter ends with a summary of the literature examined.

2.2 Definition of Key Concepts and Terminologies

Livelihood

The term ‘livelihood’ does not relent itself to a simple definition and has been employed to connote different things in various disciplines. It has not been possible to come up with a universally agreed definition (DFID, 2000). However, to represent the concept's complexity, various definitions have evolved via substantial learning and practice. The definition of livelihood proposed by Chambers and Conway (1992, 134) is often used in the literature. "Livelihood" is defined by them as "*people, their capacities, and their means of subsistence, including food, income, and assets*". Thus, a livelihood can be thought of as a three-part interaction in which people employ their talents to convert their assets into productive output, which can be both material (resources and storage) and immaterial (claims and access).

According to Murray (2001), livelihood encompasses the abilities, assets, and events needed for well living. Ellis (2000) summarized the assets within the context of sustainable livelihoods theory to include:

- Natural capital: refers to environmental resources like water, land, wildlife, biodiversity, and so on.
- Physical capital includes fundamental infrastructure (energy, sanitation, transportation, and communications), housing, and production machinery and equipment.
- Human capital refers to a person's skills, knowledge, health, information, and labor ability.
- Social capital: These are social resources such as trust relationships, membership in groups, networks, and access to larger institutions.
- Financial capital: This refers to the amount of cash on hand that is accessible to a person such as remittances or pensions, savings, and credit supplies.

These resources can be saved, hoarded, replaced, or exhausted and used to provide money or other benefits (Rakodi 2002). In this thesis, I relied on Murray (2001) definition of livelihood. Thus, livelihood refers to the sum of an individual's assets and capabilities that contribute to their well-being and the events that enable them to make a living.

Climate Change Interventions

Climate change interventions are carried out at diverse scales, across sectors, and through various approaches. McGray et al. (2007) classified climate change adaptation interventions into three groups, namely (1) Serendipitous adaptation interventions - these are tactics that help with adaptation without being intended particularly for it; (2) Climate proofing or mainstreaming development activities – this means altering the basic design of a current developmental intervention or re-designing developmental programmes to ensure successful adaptation to changing climate conditions (McGray et al., 2007); and (3) Discrete adaptation interventions - these are programmes that are designed expressly to address climate change with adaptation as the primary goal. In the Ghana Climate Change Vulnerability and Adaptation Assessment Report, the USAID categorizes climate change intervention into five options or types, namely, policy environment, capacity and infrastructure, information and analysis, governance and tenure, and awareness and implementation (Stanturf et al., 2011).

Climate-smart agricultural interventions are also conceptualized to mean comprehensive techniques to mitigate current climate change and assist farmers' adaptation to the negative consequences of climate change without compromising food security (Van Wijk et al., 2020). The Food and Agriculture Organization, FAO (2018) provides a more elastic and comprehensive definition of climate-smart agricultural interventions as any practice that influences at least one of the following three pillars:

i Food security pillar: sustainably improving agricultural productivity and incomes (food security);

ii Adaptation pillar: adapting and strengthening the resilience of farmers to climate change; and

iii Mitigation pillar: decreasing and/or eliminating the emission of greenhouse gas.

Following the definition of McGray et al. (2007) and FAO (2018), climate change interventions are used in this study to refer to agricultural programmes whose activities directly or indirectly, covertly or overtly influence farmers' adaptation to or mitigation against climate change, reduce food insecurity and poverty, enhance empowerment or the general welfare of farm households. Thus, such interventions may either be designed with or without the initial aim of influencing farmers' climate change adaptive capacity and/or mitigation or livelihoods, but the activities of such programmes affect climate change adaptation, mitigation, and livelihood outcomes of farmers either directly or indirectly.

Women Empowerment

The term empowerment has been defined in literature by several authors, but the popular meanings of empowerment are given by Kabeer (1999), Narayan (2002), and Alsop et al. (2006). According to Kabeer (1999), empowering a person involves strengthening his/her capacity in making strategic decisions, especially in situations where the person is deprived of these capacities. In Kabeer's view, the ability to execute strategic decisions comprises the resources (a person's current

and future access to material, social and human resources), agency (ability to participate in negotiation and decision making), and achievements (wellbeing indicators).

Empowerment, according to Narayan (2002), is defined as improving a marginalized group's assets and abilities to engage in, negotiate with, influence, control, and hold institutions responsible that have an impact on their lives. According to Narayan (2002), empowerment entails improving a person's or group's inclusion and involvement, information accessibility, accountability, and domestic organization capacity. Thus, focusing on only an individual's decisions in defining the term 'empowerment' limits the meaning of the term, especially in the socio-cultural contexts where community and mutuality significantly influence capabilities.

In the view of Alsop et al. (2006), empowerment can be described as the capacity of a person(s) to not only make effective choices but, transform his/her choices into preferred actions and results. Employing the definition of empowerment by Alsop et al. (2006), Alkire (2008) argued that this definition comprises the agency component (the capacity of a person to act on behalf of a valuable resource) and the institutional environment component (a person’s capacity to exert agency productively).

Women empowerment means increasing women’s economic, political, and legal strength to promote equal rights for all persons and make them confident (Lakshmi & Sivasree, 2020). This definition suggests that power is central to the empowerment of women and bothers confidence, self-esteem, and awareness

which can be enhanced through participation in decision-making. Thus, women's empowerment implies creating an enabling environment that ensures that women who are often the most vulnerable in society are free from all forms of mental abuse, physical, and exploitation (Lakshmi & Sivasree, 2020).

Comparing these definitions, though Kabeer (1999) and Alsop et al. (2006) include action and capability (the skill of a person to take independent decisions), Narayan (2002) provided a broader perspective to the meaning of empowerment to comprise the connection between a person(s) and organisations. This study focuses on the empowerment of women in rural Northern Ghana with agriculture as their core livelihood source. Thus, this study adapts Narayan (2002) definition of empowerment given its' multi-facet nature including family relationships, economic power, social, physical, and health dimension, which are crucial in determining women's empowerment in agrarian communities (Alkire et al., 2013).

Food security

Food security is a multi-dimensional term that does not lend itself to a straightforward definition. Initial descriptions of food security concentrated on an area's ability to provide a sufficient supply of food for its current and future populations (Mckeown, 2006). In 1974, the United Nations (UN) defined food security as the availability of sufficient food at all times to ensure a stable growth of food consumption and to balance production and price instabilities. The World Bank (1986) extended this concept by defining food security as everyone with access to enough food at all times to ensure an active and healthy life.

The lapses in defining food security called for a more elaborate definition of the term by the UN in 1996 to accommodate and reflect the complexity of the concept to include nutrition and human rights. During the World Food Submit at Rome in 1996, the FAOUN stated that food security is achieved when all persons have physical and economic access to adequate, safe, and nutritious food to meet their dietary requirements and food preferences for an active and healthy life at all times (FAO, 2006).

In the Ghanaian context, an operational definition of food security is provided by MoFA (2007). MoFA (2007) suggests that food security denotes a situation in which good quality nutritious food is hygienically packaged, aesthetically displayed, available in sufficient quantities all year, and located in the correct area at affordable prices. The four pillars of food security are all included in this formulation (food stability and access, availability of nutritious food, and the biological utilization of food) and have been acclaimed to be universally accepted in Ghana (Nkegbe et al., 2017; Aidoo and Tuffour, 2015; FAO, 2014). In this context, food security is divided into four categories: food availability, food access, food utilization, and food stability.

Food utilisation encompasses the methods of processing and storing food, information on nutrition and child care, and health and sanitation services of households (FAO, 2014; USAID, 1992). In this study, food utilization is how food is used by households. This includes the constituents and frequency of meals eaten by households. Household food access is the ability of a household to obtain

enough quality and quantity of food to satisfy the nutritional desires of all members (HLPE, 2020; USAID, 1992). Thus, a household's food access depends on its physical and financial resources, together with other social, cultural, and political factors. In this study, food access could be from own production, purchases, stocks, or through food aid from relatives, community members, the government, or other organisations. Food stability is how food production is susceptible to external shocks (food price fluctuations, economic crises, etc) and crises (droughts, pests, floods, disease outbreaks, etc.). The lack of sufficient social safety nets and disaster management platforms hinders the stability of food availability. Food availability in this paper refers to the presence of food stocks for households' consumption.

The four pillars of food security were later extended to include agency and sustainability (High Level Panel of Experts, 2020). A food agency is an individual's or group's ability to make their own decisions about what foods to produce and eat, how to produce process, and distributed the food within a food system, as well as their ability to influence policy development and governance of food systems (HLPE, 2020; Clapp, 2021). On the other hand, food sustainability is the long-term ability of food systems to provide food security and nutrition in a way that does not compromise the economic, social, and environmental bases that generate food security and nutrition for generations unborn (HLPE, 2020). In this study, though the six dimensions of food security are acknowledged, I focused on the earlier four dimensions because of data limitations.

Welfare

Welfare is a vital measure of farm households' standard of living and quality of life. The welfare economist, Sen defines the concept of welfare to include the utility of wealth and resources as well as nonmaterial causes such as social fairness and personal freedom (Sen, 2001). The welfare of an agricultural household can be defined as the utility derived by the household given its income and the prices it faces (UNECE, FAOUN, OECD, World Bank, and Eurostat, 2007). Welfare is operationalized in this study to mean the capacity of a farm household to satisfy its needs. This includes both consumable and non-consumable needs.

2.3 Sustainable Livelihood Framework

The Sustainable Livelihood Framework (SLF) is constructed around five main livelihood assets, namely physical, human, natural, financial, and social resources or capital. A vital component of the SLF is to analyse households' access to diverse kinds of capital resource and their capacity to transform these assets into productive use. By identifying who has access to which asset category and determining what variety of livelihood schemes are available and appealing to individuals, the SLF gives a mechanism for evaluating how organizations, policies, institutions, and cultural norms impact lives (Carney, 1998). The DfID, UNDP, Oxfam, and Care International Livelihood Framework models have all been reviewed and compared in developing an all-encompassing empirical conceptual framework for this study.

Care International Sustainable Livelihood Framework/Model

CARE employed the Household Livelihood Security (HLS) framework to analyse programme design, monitoring, and evaluation. The HLS is based on Chambers and Conway's (1992) description of livelihoods as a combination of human attributes (such as education, health, skills, and psychological orientation), access to material and intangible assets, and economic activity (Krantz, 2001). The interaction of these three characteristics forms the basis of a livelihood plan. The framework has made three major livelihood shifts (Drinkwater and Rusinow, 1999; Krantz, 2001):

i. Change in emphasis on food security and nutritional status from regional and national to household and the individual level.

ii. Change from a ‘food first’ viewpoint to a livelihood viewpoint, which emphasizes food production, and households’ and individuals’ ability to purchase food required for a sufficient diet.

iii. Change from a materialist view of food security based on the production of food to a social view that emphasizes the improvement of persons’ abilities to secure livelihoods.

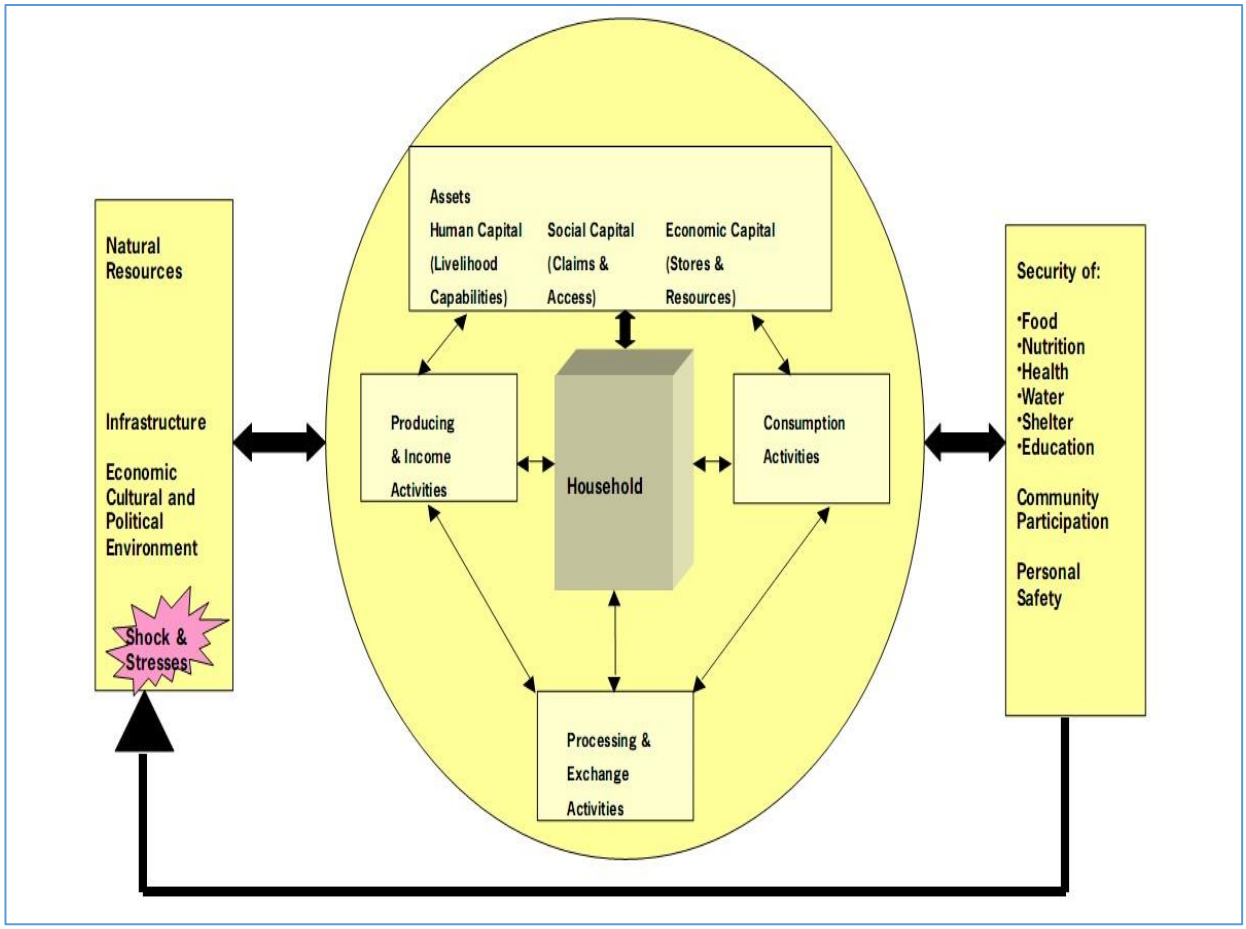

Figure 2.1: Care Model of Sustainable Livelihood Framework

Source: Kranzt, (2001)

UNDP Sustainable Livelihood Frameworks

The UNDP's Sustainable Human Development (SHD) has the mandate of promoting sustainable livelihoods through poverty eradication, employment creation, gender equality, environmental protection, restoration, and governance (UNDP, 1995). 'Livelihoods,' according to the UNDP, are the ways, events, entitlements, and assets through which individuals make a living. Natural assets comprise land, water, and flora, among others; social resources (community, social networks, and family); political resources (participation and empowerment); human

resources (education, health, and labour); physical resources (roads, markets, schools, clinics, and bridges); and economic assets include land, water, common-property resources, and flora, among others. Economically viable, ecologically sound, and socially equitable livelihoods are those that can cope with and recover from shocks and stress via adaptive coping strategies. UNDP takes an asset-based strategy for poverty reduction, stressing households' access to and long-term use of the capital on which they rely. It emphasizes the essence of understanding households' coping and adaptation strategies, which are determined by households' asset status. Moreover, UNDP specifically stresses the relevance of technological improvements as a poverty reduction strategy (UNDP, 1995).

In conclusion, the UNDP sustainable livelihood framework devises a set of comprehensive support events to increase livelihood sustainability for the poor and vulnerable groups by building their resilience and adaptation strategies. The various support events are structured in detailed sustainable livelihood programmes at a district level with implications at the community and household levels. The UNDP SLF is presented in Figure 2.2.

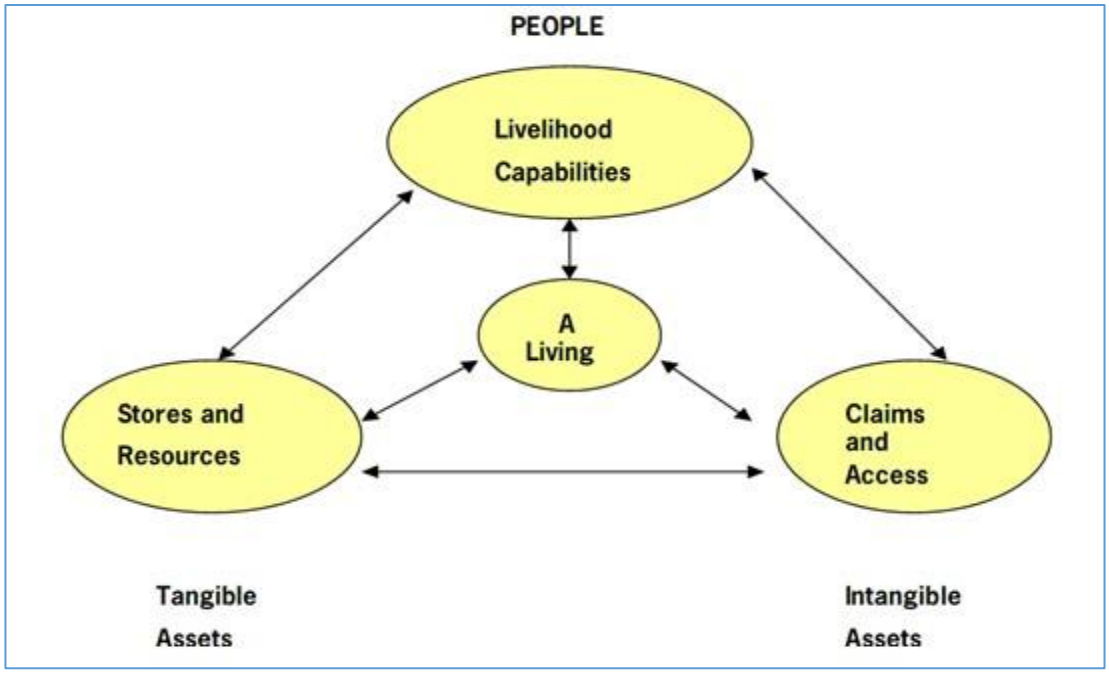

Figure 2.2: UNDP's Sustainable Livelihood Framework

Source: UNDP (1995)

DFID Sustainable Livelihood Framework/Model

Individuals operating in vulnerable situations are envisioned by the DfID SLF. The livelihood strategy was adopted by DfID. The SLF's goal is to increase the DfID's efficiency in reducing poverty by incorporating essential principles and an all-inclusive perspective into the programming of auxiliary events to guarantee that they relate to matters that are directly relevant to improving the livelihoods of vulnerable groups (Carney et al., 1999). The framework is not a replica of reality, but an analytical structure to enable a comprehensive and logical understanding of the numerous issues that hinder or boost livelihood prospects including their interactions.

According to DfID (2000), the DfID SLF inspires the use of comprehensive and systematic evaluation of the issues inducing poverty. The framework explains poverty from the perspective of the trends in shocks, institutional function and policies, or a fundamental absence of resources and the relationships among these factors. It avoids a partial analysis of poverty, instead attempting to reconcile the contributions of all sectors to the accumulation of assets from which individuals draw to support their livelihoods. DfID's SLF is built around the idea that people's access to livelihood assets enhances their ability to influence structures and processes to be reactive to their desires (Carney *et al.,* 1999).

Livelihood strategies are households' means of combining and using available assets for livelihood outcomes that meet their livelihood targets. Access to assets, services, and opportunities, which are improved or degraded by social structures, natural conditions, or institutional processes, determines the feasibility and success of livelihood strategies. The framework may also deal with complexities such as local realities, livelihood strategies, and poverty, as well as their dynamic relationships (DfID, 2000). The external environment is depicted in the vulnerability context. Trends, shocks, and seasonality all have an impact on people's livelihoods and asset availability, and they have little or no influence over them. The external environment of smallholder farmers is thought to be shaped by climate change occurrences. The DfID SLF is presented in Figure 2.3.

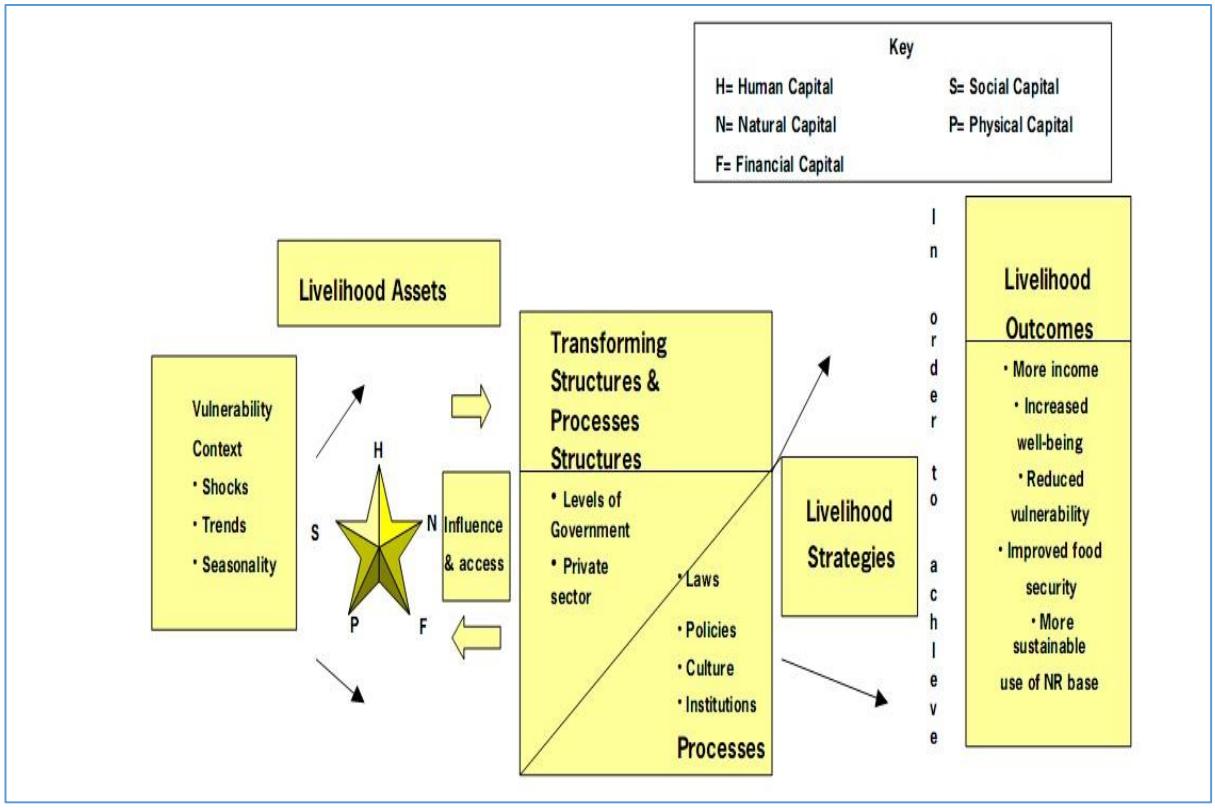

Figure 2.3: DfID Sustainable Livelihood Framework

Source: DFID (1999, 2000)

Comparison of Sustainable Livelihood Frameworks

It is difficult to state clearly the differences between the three livelihoods frameworks. All three frameworks portray sustainable livelihood as an approach to poverty reduction. The definitions of sustainable livelihoods are similar, and they all conceptualize livelihood resources beyond physical and economic assets to include human and social assets. All three frameworks emphasize the need of considering the impact of overarching policies and economic systems on the poor and vulnerable households' livelihoods. One distinction is how the agencies employ the strategy. It is used by UNDP and CARE to make project and programme planning easier. The DfID's SLF is a fundamental analytical framework and

programming procedure. It has also been employed to assess and review ongoing interventions to make them more sensitive as a reflection of the circumstances and desires of the poor and vulnerable. The DfID framework augments poverty reduction by providing diverse activities (Krantz, 2001).

Another comparison is how the three frameworks are implemented. Whereas CARE SLF focuses on the livelihood security of households within a community; the UNDP and DfID frameworks in addition to working at the community level, also stress providing enabling policy environments, reforming macro-economic indicators, and regulation as critical conditions for effective poverty reduction. Thus, for DfID, though livelihood is often analysed at the household or community level, the goal goes beyond identifying constraints or opportunities to be exploited or resolved at that level and includes understanding how policies and institutional factors impinge upon households' livelihoods but need to be resolved at higher policy levels. Two other undocumented views expressed by Carney *et al.*, (1999) and Krantz (2001) are environmental factors and specialization. UNDP and DfID in their definitions of sustainable livelihoods included environmental criteria, but CARE emphasized 'livelihood security' rather than 'sustainable livelihoods' and focuses more on the immediate subsistence needs of households relative to long-term environmental implications. UNDP focuses on the development of technology and social and economic investment, hence, tends to emphasize areas to improve the livelihoods of persons.

The current research focuses on climate change vulnerability, adaptation interventions, and farm household livelihoods. This necessitates using the Sustainable Livelihood Framework to conceptualize the effects of these climate change actions on household livelihoods. After reviewing the various Sustainability Livelihood Frameworks, this study modified the DfID, UNDP, Oxfam, and Care International Sustainable Livelihood Framework to conceptualize the study which has been discussed in Chapter Four.

2.4 Methodological Review

2.4.1 Econometric Models for Impact Evaluation

Several econometric models have been espoused to evaluate the impact of interventions or programs on livelihood outcomes. These models analyse the impacts of participation in interventions on the livelihood outcomes of households. Thus, depending on the study objective, different approaches can be used to evaluate the impacts of participation in an intervention on intended livelihood outcomes. Impact assessments in non-experimental studies (using observational data) are often limited by the problem of self-selection into participation (treatment) which makes it difficult to establish counterfactuals (control group) against which intervention impact can be evaluated (Shiferaw *et al.*, 2014). This section outlines impact evaluation econometric models applicable in a panel and cross-sectional data analysis.

In the literature, the Heckman sample selection model appears to be the pioneer sample selection bias correction model and was named after James Heckman. The

Heckman sample selection model is a two-stage modeling approach used to correct the biases arising from sample selectivity and also determine the impact of treatment on outcome variables (Heckman, 1976). The major limitation of the Heckman sample selection model is that estimates are based on limited information maximum likelihood which yields less consistent estimates compared to the full information maximum likelihood estimation. Also, the Heckman Selection model is based on the joint normality of the error terms assumption and produces inconsistent estimates when this assumption fails. Finally, the Heckman selection model cannot correct for sample selection bias in the absence of a valid instrument (Heckman *et al*., 1998).

Propensity Score Matching (PSM), Generalised Propensity Score Matching (GPSM), and Instrumental Variables are the alternative impact assessment techniques that can alleviate the difficulties associated with the Heckman sample correction model. PSM is a non-parametric estimate method that is independent of the functional form or distributional assumptions. PSM is a statistical method for comparing the observed results of a treated population to counterfactual outcomes of a non-treated (Heckman et al., 1998). With PSM, observations on the participant (treated) and non-participant (non-treated) attributes are matched and categorized based on the propensities expected from participation (Wooldridge, 2005). PSM is more recommended where the treatment (intervention) is the only determinant of the outcome variable. The main limitation of the PSM is its' inability to cater to the effect of unobserved variables on the outcome variables (empowerment of women, food security, and consumption expenditure).

The limitation of lack of attribution of changes in the outcome variable to the households' participation in climate change interventions and other unobservable factors related to the PSM resulted in the advent of the GPSM. Hirano and Imbens (2004) expanded the binary treatment effect model to create GPSM, which is a continuous treatment effect model. It employs a parametric approach to make causal inferences from observational data, which has the benefit of decreasing bias induced by non-random treatment group selection (Rosebaum and Rubin 1983). The application of the GPSM is limited by the assumption of joint independence of all potential outcomes, which does not always hold in reality.

The endogenous switching regression (ESR) model, first espoused by Lee (1983), estimates the impact of a treatment by using one or more selection models and two or more outcome models. Unlike the PSM and GPSM models, the determinants of participation in treatment by only the participant group and non-participant group (control) can be identified using the ESR model (Lee, 1983). The ESR model also has an advantage with its ability to separate and estimate the level of the effects of socioeconomic variables on the outcome variable (women empowerment, food security, and consumption expenditure) for only participants and/or only non-participants. The ESR is used where the selection equation takes a binary response dependent variable (treatment group and control group) and cannot be applied to multiple treatments.

The Multinomial Endogenous Switching Regression (MESR) and Multinomial Endogenous Treatment Effect (METE) models are applicable to multiply treatment cases with three or more groups including the control group (Deb and Trivedi, 2006a, b). Both the MESR and METE models are used to estimate the effect of two or more treatments or interventions on an outcome using two or more selection models and two or more outcome models by controlling for both observed and unobserved heterogeneity (Deb and Trivedi, 2006a, b; Teklewold, 2013). In both models, respondents are categorized into non-participants (control group) and participants (treated/participant groups) and estimated in two stages. The first stage models determinants of participation in interventions using a multinomial logit selection model which accounts for unobserved heterogeneity (Kassie, 2015, 2018; Khonje et al., 2018). The second stage models the effect of participating in intervention on outcome variables (women empowerment, food security, and welfare) using ordinary least squares (OLS) with Inverse Mills' Ratios (Khonje et al., 2018).

To model the impact of participation on livelihood outcomes of households (women empowerment, food security, and consumption expenditure), this study employed the METE but not the MESR model because the METE model in addition to modeling continuous outcome variables can be extended to model categorical outcome variables, which is not possible for MESR models (Khonje et al., 2018). The outcome variables (women empowerment, food security, and consumption expenditure) in this study are measured both as continuous and categorical variables.

2.4.2. Theoretical Review of Multinomial Endogenous Treatment Effect (METE) Model

Deb and Trivedi (2006a) espoused the METE model to evaluate the impact of an endogenous multinomial treatment on an outcome variable with nonnegative values. Deb and Trivedi (2006a) provide an extension of Cameron and Trivedi (1998) endogenous count outcome variables with endogenous regressors and nonlinear function. Deb and Trivedi (2006a) specify the METE model with a latent factor structure that tolerates idiosyncratic effects on individuals' decisions to participate in treatment to influence outcomes. This enables differentiation between selection on unobservable and observable variables.

The multinomial treatment variable is presumed to be structured along a multinomial logit, and the outcome variable is presumed to follow a negative binomial distribution conditional on treatment. In this context, the inclusion of latent variables into the equations for treatment and outcome by Deb and Trivedi (2006a) has two major advantages compared to other approaches to estimating correlated errors. First, because the suitably adjusted latent factors are included in the equations with observed covariates, they may be understood as proxies for unobserved covariates, and the corresponding factor loadings can be interpreted similarly to the coefficients of the observed covariates. Second, even though joint distribution does not generally have a closed-form representation, latent factors are often used to integrate conditional and marginal distributions to estimate joint distributions. The correlation between endogenous variables due to latent factors has an upper bound of less than one, which could be a disadvantage. Deb and

Trivedi (2005) and Deb and Trivedi (2006b) define other applications of the model. As a simpler but less efficient strategy, Lee (1983) suggested a two-step approach for a model with multinomial treatment and an outcome with an exponential mean. Furthermore, whereas the latent factor technique may be easily adapted to models with different statistical structures for treatment and outcome, Lee's approach necessitates event-by-event equations.

In specifying the treatment effect model, each individual *i* selects one treatment from three or more alternatives, including a control group. This makes it a multinomial choice model. If EV_{ij}^{*} represents the indirect satisfaction expected to be derived from participating in j^{th} treatment (j = 0, 1, 2, 3,..., J), Deb and Trivedi (2006a,b), then,

$$EV_{ij}^{*} = z_i'\alpha_j + \delta_j l_{ij} + \eta_{ij} \qquad (1)$$

where z_i represents exogenous factors with associated parameters α_j and η_{ij}, which are independently and identically distributed error terms. l_{ij} denotes a latent factor with unobserved characteristics common to individual *i's* treatment participation and outcome. According to Deb and Trivedi (2006a), it is assumed that the l_{ij} is independent of η_{ij}.

If an individual decides not to participate in any treatment (j=0), they will constitute the non-participant group $EV_{ij}^{*} = 0$. If c_j is a dummy denoting the observed treatment participation and $c_i = (c_{i1}, c_{i2}, \ldots, c_{iJ})$ with $li = (l_{i1}, l_{i2}, \ldots, liJ)$, then, the probability of an individual *i* participating in treatment is given by:

$$\Pr\left(c_i \left| z_i, l_i \right.\right) = g(z_i'\alpha_1 + \delta_1 l_{i1}, z_i'\alpha_2 + \delta_2 l_{i2}, ..., z_i'\alpha_j + \delta_j l_{ij}) \quad (2)$$

Where g is a multinomial probability distribution and assumed to be a mixed multinomial logit (MMNL), defined as

$$\Pr\left(c_i \left| z_i, l_i \right.\right) = \frac{\exp\left(z_i'\alpha_j + \delta_j l_{ij}\right)}{1 + \sum_{k=1}^{J} \exp\left(z_i'\alpha_k + \delta_k l_{ik}\right)} \quad (3)$$

The outcome is a count variable (y_i = 0, 1, 2,... N). The expected outcome equation for individual i (i = 1,2..., N) is given by

$$E\left(y_i \left| c_i, X_i, l_i \right.\right) = X_i'\beta + \sum_{j=1}^{J} \gamma_j c_{ij} + \sum_{j=1}^{J} \lambda_j l_{ij} \quad (4)$$

where X_i is a set of exogenous variables with associated parameter vectors β and γ_j is the effect of treatment compared to the non-treatment/control group. Each of the latent variables l_{ij}, has a function denoted by $E\left(y_i \left| c_i, X_i, l_i \right.\right)$. Thus, the outcome is influenced by unobserved variables which intend influences selection into treatment. When the factor-loading parameter (λ_j) is positive (or negative), treatment and outcome are positively (or negatively) correlated through unobserved characteristics, implying a positive (or negative) selection, with γ and λ being the associated parameter vectors, respectively. Deb and Trivedi (2006a) assumed a negative binomial density (f), given as:

$$f\left(y_i \left| c_i, X_i, l_i \right.\right) = \frac{\Gamma(y_i + \psi)}{\Gamma(\psi)\Gamma(y_i + 1)} \left(\frac{\psi}{\mu_i + \psi}\right)^{\psi} \left(\frac{\mu_i}{\mu_i + \psi}\right)^{y_i} \quad (5)$$

Where $\mu_i = E\left(y_i \left| c_i, X_i, l_i \right.\right) = \exp(X_i'\beta + c_i'\gamma + l_i'\lambda)$ and $\psi = 1/\alpha(\alpha > 0)$ is the over dispersion parameter.

The MMNL parameters are identified up to a limit; hence, the latent factor scale needs to be normalized (Deb and Trivedi, 2006a, b). Also, the model is identified if $Z_i = X_i$, and including variables in Z_i that are not included in X_i is required. Thus, identification via exclusion restrictions using instrumental variables is a more appropriate approach. Deb and Trivedi (2006) proposed that the estimation of METE for the joint distribution of treatment and outcome variables is conditioned on the common latent factors and estimated as the product of the marginal densities. The problem with this estimation arises because the unobserved characteristics are unknown and infinite. However, this problem was resolved through simulation-based estimation (Gourieroux and Monfont, 1996). Also, the METE Model in addition to modelling continuous outcome variables can be extended to model categorical outcome variables, which is not possible for MESR models (Khonje et al., 2018).

2.4.3 Measurement of Livelihood Outcomes

Three livelihood outcomes are considered in this study. These are women empowerment, food security, and wellbeing.

2.4.3.1 Women Empowerment

Although empowerment is experienced at the individual level, its measurement especially for gender and/or women in the literature has often been at national or

regional levels using indices computed from aggregate data. The Social Institutions and Gender Index (SIGI) was espoused by the Organisation for Economic Co-operation and Development (OECD) to measure gender equality for nations using five legal and social institutions. The indicators used in computing the SIGI include the ratios of girls to boys in primary, secondary, and tertiary education; the share of women in wage employment; and the proportion of women in the national parliament (Ferrant et al., 2020). These indicators are a mere proxy for gender equality rather than a direct measure of the empowerment of individual women.

Given the limitation of the SIGI, the United Nations Development Programme (UNDP) proposed the Gender Development Index (GDI), Gender Empowerment Measure, and the Gender Inequality Index (GII) (UNDP, 1995). However, these approaches to measuring women's empowerment are limited in scope and lack critical components of empowerment such as women's participation in decision-making and resource use at the community and household levels (Schüler, 2006; Syed, 2010). For example, the computation of the GDI relied on imputed wage data and lacks accuracy (UNDP, 2010). Thus, it is not possible to measure empowerment by social groups such as gender, and age, among others using the existing indices (Alkire et al., 2013). A more important limitation of these measures of empowerment is the absence of women resource control or agency in the agricultural sector, knowing that women constitute 43 percent of the labour force of the agricultural sector in less developed countries (FAO, 2011). Given these limitations, new women empowerment indicators were included in measuring women empowerment, and also many other measures and matrices were developed

(Charmes & Wieringa, 2003; Sell and Minot, 2018). Hausmann et al. (2012) proposed the Gender Gap Index to measure gender inequalities among nations. But these indices were also for comparing gender equality among countries rather than measuring individual empowerment (Alkire et al., 2013).

As a remedy to the limitations of aggregation and exclusion of resource control or agency by the previous measurements of empowerment, the Women's Empowerment in Agriculture Index (WEAI) was espoused as a multidimensional empowerment index to measure the overlapping achievements in different domains for each man and woman. The WEAI uses individual-level data and can be decomposed by social groups such as gender, age, religion, and region. The WEAI also introduced the Gender Parity Index which makes it possible to examine intra-household inequality between men and women. The WEAI has been employed by Malapit et al. (2015), Malapit and Quisumbing (2015), and Malapit et al. (2019) to measure women empowerment in Ghana, Nepal, and Bangladesh.

2.4.3.2 Food Security

The definition of food security portrays it as a multidimensional concept that cannot be measured using a simple or singular approach. Given this, several approaches have been developed in the literature to measure one or more dimensions of food security but not all (availability, affordability, access, stability, utilisation agency, and sustainability). Food security can be measured at various levels: individual, household, community, and national (Agbadi et al., 2017). Although several approaches have been developed to measure food security, not

all have been validated and there exist some commonalities among some of these food security measurement approaches. In this study, the household food expenditure share, household hunger scale, and minimum dietary diversity for women have been selected for the measurement of all dimensions of food security because they have been validated by the FAOUN (Deitchler et al., 2010; GFSI, 2016; HLPE, 2020; Maxwell et al., 2013).

Household Food Expenditure Share

The HFES measures the proportion of a household's total income (proxy by total expenditure) spent on food within a given period. The poorest and most vulnerable households have higher HFES (INDDEX, 2018). This is Engel's law, which states that when household income rises, food expenditure rises as well, although other expenditures rise even faster, resulting in a drop in the proportion of total income spent on food. The HFES is useful in assessing food stability given the effect of fluctuation in food prices on households' food consumption.

If a change in the price of foodstuffs brings about a greater change in the proportion of total household expenditure on food, then, the household can be more food insecure due to resource-constrained emanating from food price increases. Thus, based on the type of foods, very poor households will be unable to swap cheaper foods for expensive foods, forcing them to spend extra on essential staples, diminish the quality of their diets, or even reduce the quantity of least-cost foods consumed, while simultaneously reducing non-food expenditures on basic needs (Lele et al., 2016).

The proportion of a household's total expenditure spent on food can be used as an indicator of vulnerability to shocks emanating from a change in food prices (Lele et al., 2016). The World Food Programme (WFP) often uses HFES together with other indicators in assessing households' food security and vulnerability to shocks (Rose, 2012). It is also a common indicator used by national governments and NGOs in assessing food security trends (INDDEX, 2018). This approach has been used by Tambo & Wünscher (2016), Ogundari (2017), and Manda et al. (2021) to measure farm households' food security status.

Household Hunger Scale (HHS)

The HHS was developed by the Food and Nutritional Technical Assistance (FANTA) and validated for measuring food security at household-level by focusing on severe food insecurity to compare hunger (severe food insecure) among households, within a country or across countries (INDDEX, 2018). The HHS is an experience-based food insecurity scale derived directly from the household food insecurity access scale (HFIAS) and measures hunger-related aspects of insecure food access and is culturally invariant across multiple sociocultural contexts, which makes it possible for cross-country comparisons (Deitchler et al., 2010).

The HHS technique includes a 30-day recall period and two sets of questions: three questions about food insecurity incidence and three questions about food insecurity occurrence frequency. Respondents are first asked to say "yes" or "no" if they have ever had a specific ailment during the data-gathering stage. If "yes",

the frequency question is then addressed using the options “rarely, sometimes, or often”. Household responses can be converted into either a continuous or categorical hunger score. Each of the six questions is scaled from 0 to 2 to calculate the HHS as a continuous variable, with 0 denoting "did not occur," 1 denoting "rarely and sometimes," and 2 denoting "often." The scales for each of the three items are then added together, and the total HHS spans from 0 to 6, indicating the severity of food insecurity. Households are divided into three categories when measuring HHS as a categorical variable: "little to no hunger (0-1), moderate hunger (2-3)," and severe hunger households (4-6) (Ballard et al., 2011).

The HHS approach does not measure food consumption and also does not include diet quality. Doing so will require the use of other approaches to measuring food security such as the minimum dietary diversity score for women (MDD-W) to ascertain a picture of the "adequacy" component of diet quality (INDDEX, 2018), which has been considered in this study. The advantages of HHS are that it takes a long time to implement and enables valid comparisons across time, space, and socio-demographic groupings (Deitchler et al., 2010). The HHS has been used by Nkegbe et al. (2017) to measure the food security of households in northern Ghana using the USAID FtF data. It has also been used to assess food security by Adubra et al. (2019) in Mali, Akbar et al. (2020) in Pakistan, Butaumocho and Chitiyo (2017) in rural Zimbabwe, Maxwell et al. (2014) in Tigray, and Tambo & Wünscher (2016) in Ghana.

Minimum Dietary Diversity for Women (MDD-W)

The MDD-W was developed by FAO, WHO, and USAID as a simple food-based measure of dietary diversity and micronutrient adequacy of women between the reproductive age of 15 to 49 years (FAO & FHI, 2016; Moursi et al., 2008). It is a validated indicator of nutrient adequacy for measuring the dietary diversity of individual women among persons with starchy staple diets with a high likelihood of micronutrient deficiency (Ruel, 2003). The predominant approach in measuring a household's or individual's dietary diversity involves determining the diverse food groups consumed within a specified recall period. However, information on the number of foods consumed is neglected, which is the main limitation of the MDD_W. The MDD_W measure of dietary diversity is a useful impact evaluation measure for interventions intended to resolve malnutrition through agricultural pathways. The MDD_W was used by Adubra et al. (2019) and Chakona and Shackleton (2019) to determine households' food and nutrition security in rural Mali and South Africa respectively.

2.4.3.3 Wellbeing (Consumption Expenditure)

Over the years, wellbeing analysts have relied mainly on consumer surplus (income approach) proposed by Harberger (1971) to measure the effects of changes in prices and incomes on the wellbeing of consumers. The validity of the consumer surplus in measuring welfare was questioned by many authors due to the volatility in prices of consumable goods which affects real income (Slesnick, 1998). Vartia (1983) proposed the expenditure approach to estimate the

expenditure of households within a given period as a valid tool to effectively measure the wellbeing or consumption expenditure of the household.

A valid measure of wellbeing, according to Hentschel and Lanjouw (1996), should reflect the entire utility gained from the consumption of all goods and services. The per capita consumption expenditure of households is used as a measure of household welfare in this study. When compared to the household income approach to measuring wellbeing, the household consumption expenditure approach reflects effective household consumption, gives information on households' wellbeing, and is a more accurate welfare indicator with fewer measurement errors (Asfaw et al., 2012, Deaton, 1997). Mekonnem (2017), Danso-Abbeam et al. (2020) and Tambo & Wünscher (2016), Asfaw et al. (2012), and Izuchukwwu (2019) have relied on the household expenditure approach to measure farm households' wellbeing in Ethiopia, Ghana, Tanzania, and Nigeria respectively.

2.5 Empirical Review

2.5.1 Empirical Reviews on the Use of Multinomial Endogenous Treatment Effect Model

After the advent of the METE model by Deb and Trivedi (2006a, b), several studies have employed the technique in analysing the determinants of both participation and adoption and the effect of treatment on livelihood outcomes and welfare. Manda (2016) employed the METE model to analyse factors influencing the adoption of sustainable agricultural practices (SAPs) and their effects on maize

yield and income among smallholder farmers in Zambia. The results revealed that the gender of the household's head (male), access to off-farm income, trust in government support and distance to the output market had a significant negative effect on farmers' adoption of SAPs while education, total household size, farm size owned, group membership and age had a significant positive effect on farmers' adoption of SAPs.

Khonje et al. (2018) also employed the METE model to assess the welfare effect of adopting multiple agricultural technologies among farmers using both balanced and unbalanced bi-panel data from 810 households and 1, 412 maize plots in Eastern Zambia. The results showed that farmers' participation and adoption of multiple agricultural technologies were influenced by gender, education, land tenure, rainfall, distance from home to farm, and access to market information. The results further showed that farmers who participated in agricultural programs and adopted multiple agricultural technologies significantly increase their yield and income more than non-participants or non-adopters.

2.5.2 Coherence of Climate Change Interventions with Development Goals

Adu et al. (2018) employed a systematic review to assess the effects of governmental and non-governmental organisational interventions implemented in northern Ghana between 2006 and 2016 on reducing food insecurity and poverty. The study used the Campbell Collaboration protocol to select 20 interventions gathered through an online search and project reports retrieved from visits to implementing organizations. Adu et al. (2018) found that most interventions were

on farm input supply while few interventions focused on enhancing market access for agricultural produce, provision of storage facilities, capacity building, and water and irrigation. The study concluded that the impact of interventions on food security and poverty was weak, hence, did not contribute significantly to reducing poverty and hunger. The limitation of the study is that findings were not disaggregated between NGO and governmental interventions.

Matsvai (2018) assessed the role of various international and local NGO interventions toward the achievement of selected SDGs in Zimbabwe using primary data and descriptive statistics. The study revealed that NGOs complement the government's quest for sustainable livelihoods and rural development by contributing enormously to eradicating poverty (SDG 1), fostering food availability through increased agricultural productivity (SDG 2), and promoting women empowerment activities (SDG 5).

Karki et al (2021) reviewed and assessed 76 climate change adaptation interventions implemented in Nepal between 2010 and 2020. Data was sourced through key informant interviews and online searches on the websites of project-implementing organizations. The interventions were identified through an online search and visit to offices of organisations that implemented the interventions for project reports and analysed using content and thematic analysis. The results showed that most of the interventions were community-based initiatives while few were ecosystem-based interventions from organisations. Karki et al. (2021) revealed that most of the interventions focused on capacity building and awareness

creation with little focus on reducing climate change vulnerability and risk. The limitation of this study is that the study focused on the coherence of the interventions with the Nepal Adaption Plan without any reference to how these projects are contributing to international development goals and also did not separate the interventions of non-governmental organisations from governmental organisations.

2.5.3 Factors Influencing Participation in Climate Change Interventions

Manda et al. (2021) employed the MESR model to assess the effects of farmers' participation in single and multiple agricultural markets introduced by the African RISING project on welfare (measured using households' expenditure approach) and food security (measured using households' food expenditure and HFIAS) of smallholder farmers in Tanzania. The results showed that completion of at least primary school education, farm size, access to credit, and location had a significant positive effect on households' participation in NGO projects while access to the market and the number of adults in a household had a significant negative effect on farmers' participation. However, the sex of household head and off-farm had no significant effect on farmers' participation in the project.

In the literature, marital status, years of education, sex, non-farm engagements, membership with the farmer-based organisation, farm size, land tenure, access to credit, extension contacts, age, ethnicity, location, institutional capability, farmer experience, access to information, the distance between home and farm or meeting place, household size, off-farm income, occupation, and household income have

been reported to have a significant positive effect on farmers' participation in agricultural programmes in Ghana, Nigeria, and Swaziland (Abdallah et al., 2021; Lambongang et al., 2019; Martey et al., 2013; Martey et al., 2014; Sani, 2018; Sithole et al., 2014). Yet, some studies in Ghana and Swaziland also found that education, age marital status, and distance had a significant negative effect on farmers' participation in climate change intervention (Etwire et al., 2013b; Martey et al., 2013; Martey et al., 2014; Sithole et al., 2014). However, Abdallah et al., 2021; Etwire et al., 2013a; Lambongang et al., 2019; Martey et al., 2013; Martey et al., 2014; Sani, 2018; and Sithole et al., 2014 reported that age, sex, household size, marital status, distance, membership with associations, farm size, land tenure, farming experience, location, decision making in farming, market access, extension contacts, and non-farm income have no significant effect on participation in climate change interventions.

2.5.4 Effects of Climate Change Interventions on Women's Empowerment

Lakshmi & Sivasree (2020) examined the effect of government policies on the economic empowerment of rural women in India using secondary data and analysed using descriptive statistics and thematic analysis. The finding showed that rural women contribute significantly to the national labour force in India but participation in national government projects has no significant improvement in the empowerment of women due to high unemployment rates among rural women relative to urban women. The main limitation of this study is that it equates women's empowerment to economic empowerment without considering social, political, and other components of empowerment.

Bryan and Garner (2020) investigated the effects of participation in small-scale irrigation interventions on women empowerment in northern Ghana using qualitative primary data. Data were analysed using thematic and content analysis in Nvivo. The study revealed that women are empowered through access to productive assets and highlighted the potential of small-scale irrigation on women's empowerment when up-scaled. However, the study revealed that the success of small-scale irrigation on women's empowerment was hindered by men's dominance in the control of productive resources such as land and decision-making at the household level. Bryan & Garner (2020) further revealed that most women could not access motor pumps for irrigation and a few women relied on their husbands to decide how the pumps should be used.

Anderson et al (2021) conducted a systematic review on empowering women in agriculture through interventions. Anderson et al. (2021) investigated the impact of interventions on women's empowerment by considering interventions with a focus on eliminating female-male differences in productive resources and leveraging gender risk, time, and social preferences in resource allocation. About 367 papers reporting the impact of support interventions on women empowerment, mostly in Sub-Saharan Africa were reviewed and used for analysis. The results showed that most studies did not compute the economic impact of interventions on women's empowerment. Yet, in studies that estimated the benefits of leveraging differences in decisions between men and women, improvements in women's decision-making at the household level could not be attributed to their participation in interventions, especially for government projects. The main limitation of the study was that the

heterogeneity of the studies, interventions, and indicators made it difficult to summarize empirical evidence of women's empowerment across interventions and locations.

2.5.5 Effects of Climate Change Interventions on Livelihood and Consumption Expenditure

The impact of government-led agricultural interventions on the welfare of rural farm households in Africa is mixed. Whereas some empirical works reported the positive contribution of the various governmental agricultural interventions on the livelihoods of farm households by way of improved consumption, food security, asset acquisition, and welfare (Asfaw et al., 2012; Bezu et al., 2014; Kassie et al., 2018; Wossen et al., 2017; and Tesfaye and Tirivayi, 2018); other empirical findings showed evidence of a weak effect of government agricultural programmes on households' poverty, consumption, and nutrition (Annim et al., 2011; Coleman, 2006; Larsen & Lilleør, 2014 and Ragasa and Mazunda, 2018, Prince, 2020).

Chirwa et al. (2017) examined the effects of Malawi's government Farm Income Diversification Program on the welfare of households using the Propensity Score Matching technique on cross-sectional data collected from 3008 beneficiary and non-beneficiary farmers. The study found that participation in the program had a significant positive effect on farmers' food security and incomes through income diversification. This study did not consider the contribution of NGO interventions to farmers' wellbeing and the PSM technique employed in the study is limited by the Conditional Independence Assumption.

Armah et al. (2019) employed PSM analytical method to assess the effects of 241 smallholder farmers' participation in AGRA's climate change project in Ghana. The results revealed no significant difference in the income, yield, and resilience to climate change of participant and nonparticipant farmers. The limitation of this study was that for impact studies, baseline and end-line data for both participants and non-participants are required to determine the effect of farmers' participation in the project on livelihood outcomes given most projects take time before any significant impact on participants can be achieved.

Manda et al. (2021) employed the MESR model to assess the effects of farmers' participation in single and multiple agricultural markets introduced by the African RISING project on wellbeing (measured using households' expenditure approach) and food security (measured using households' food expenditure and HFIAS) of smallholder farmers in Tanzania. The results revealed significant improvement in the welfare and food security of farmers who participated in either single or multiple markets relative to non-participant farmers.

Masanyiwa et al. (2013) assessed the impact of the World Vision Area Development Programme on the food security of farm households in Igunga District in Tanzania using the Chi-Square test of Bi-Variate analysis and qualitative analysis. The results showed that beneficiary farm households were more food secure in terms of food availability, stability, and utilization than non-beneficiary households. The major limitation of this study was that its attribution of improved food security to the intervention was too basic as the effects of other interventions and unobservable factors were not considered in the analysis.

Teka and Lee (2020) evaluated the effects of farmers' participation in government-supported agricultural programs on the welfare (food security, income, asset building, and expenditure per adult) of households in rural Ethiopia using fixed effect instrumental variables on balanced panel data of 789 households. The study found that though consumption expenditure, income, and asset per capita increased among beneficiary households during the period, only improvement in food security and caloric intake of households could be significantly attributed to participation in government agricultural programs but not income and assets acquisition. This study did not consider the role of non-government organizations which contribute significantly to complement national governments' efforts in improving the livelihoods of rural farm households in most Less Developed Countries including Ghana.

2.5.6 Determinants of Women's Empowerment

Abbas et al. (2021) examined the determinants of women empowerment in Pakistan using binary logistic regression on secondary data. The results showed that age, staying in urban areas, female household headship, paid job employment women's education, higher educational level of husband, and access to information had a significant positive effect on women's empowerment. Cinar and Kose (2018) employed a multilevel regression to analyse factors influencing women's empowerment in Turkey. The results showed that women's empowerment was significantly and positively influenced by married women, education, religion, and household income. However, age and household size significantly reduce women's empowerment.

Assad et al. (2014) assessed the determinants of women empowerment in Egypt using ordinary least squares regression on the Egyptian 2012 Labour Market Panel Survey. The results revealed that age, higher education of women, women employment (public sector and informal private sector wage employment self-employment), female-headed households, number of children in household, and high educational level of husband improved women empowerment significantly. On the other hand, women's empowerment was significantly reduced with the age squared of women, the age gap between men and women, and unpaid women. Thus, women become less empowered as they get older and when the age difference between the primary male and primary female in a household is high. Maligaliga et al. (2019) revealed that off-farm employment and leisure time had a significant positive effect on women's empowerment while farming experience reduces women's empowerment significantly.

Lope et al (2021) assessed the determinant of women's empowerment in Mozambique using principal component analysis and logistic regression with secondary data. The results showed that women's age, education, access to media, current employment status, and polygamous marriages significantly influence women's empowerment in terms of violence against women, decision making and control over sexuality and safe sex (Lope et al., 2021).

2.5.7 Determinants of Food Security

Nkegbe et al. (2017) used the USAID FtF baseline data to assess the food security of farm households in the Savannah Zone of Ghana using an ordered probit with a hunger scale approach of measuring food security. The results showed that

household heads with a higher level of education and higher crop yield experienced higher. On the other hand, households resident in a rural area and that cultivated multiple crops experienced lower hunger. In other studies conducted in Sekyere Afram Plains and Northern Ghana, farmers' level of education, crop output, family size, age, and marital status increased households' hunger significantly (James et al., 2013; Mustapha et al., 2016). On the other hand, being in a rural area, household size, age, access to credit, farm size, off-farm, and is located in the rural area reduces household hunger significantly (Mustapha et al., 2016; James et al., 2013).

Gyimah et al. (2021) assessed the determinants of dietary diversity among pregnant adolescent girls in Ghana using minimum dietary diversity for women based on primary data collected from 460 women. A binary logit regression was used to determine the factors influencing women's dietary diversity. The results showed that being in a rural area and age have a significant negative effect on pregnant women's dietary diversity. In other literature, wage employment, a secondary level of education, household income, land ownership, age, nuclear family, access to a refrigerator, household income, home gardening, ownership of farmland, women's education and employment, and access to dietary information have a significant positive effect on women dietary diversity (Gitagia et al., 2019; Kiboi et al., 2017; Kundu et al., 2020; Drammeh et al, 2020; Saaka et al., 2021). Rural residence, occupation, and family size significantly reduce women's dietary diversity (Kundu et al., 2020; Gitagia et al., 2019).

2.5.8. Determinants of Farm Households' Consumption Expenditure

Manyaja et al. (2018) investigated the factors contributing to the consumption expenditure of rural farm households in South Africa using primary data. Data were analysed using Poisson regression. The results revealed that access to credit, age, marriage, farm income, and single-crop cultivation decrease consumption expenditure (welfare) significantly while access to land and extension contacts increase households' consumption expenditure (welfare) significantly.

Mahama and Nkegbe (2021) examined the welfare (measured as real daily consumption expenditure per adult) effect of livelihood diversification among households in Ghana using the Ghana Living Standard Survey Round 6 data from the Ghana Statistical Service. Data was analysed using an instrumental variable estimation approach. Mahama and Nkegbe (2021) showed that livelihood diversification, education, married household head, urban residence, religion, and household sex ratio had a significant positive effect on households' welfare. On the other hand, household size, age, and single employment decrease households' welfare significantly.

2.6 Conclusions on Literature Review

Most studies on climate change interventions focused on identifying the interventions rather than placing their project objectives in the wider context of the SDGs as a whole. Most studies only evaluated the success of the agricultural programme in achieving project objectives, without examining the coherence of the objectives and activities of such interventions with national and global development goals. This is necessary since national governments and international

organizations require 'value for money[1] for the resources committed to achieving these SDGs adopted by all nations as the basis for upscale interventions.

Also, in the literature, studies that explored the effects of households' participation in climate change programmes on livelihoods have often not disaggregated the interventions into government and NGOs. Instead, either a single intervention by NGO or government is studied using PSM or all interventions are merged. These do not provide an explicit effect of each intervention on livelihood to guide donors' decisions for up-scaling approaches. Besides, there are limited studies on the effects of both governmental and non-governmental interventions on the empowerment of women who play a major role in agriculture from planting to harvesting and marketing of agricultural output. Most studies have only attempted to examine the gender dimension of farmers' participation in climate change intervention using descriptive statistics or qualitative analytical tools without exploring the effects of such interventions on gender empowerment for adaptation. These are critical gaps in the literature filled by this study.

[1] Value for money means efficient utilization of resources

CHAPTER THREE

CLIMATE CHANGE INTERVENTIONS AND SUSTAINABLE DEVELOPMENT GOALS

3.1 Introduction

This chapter presents selected SDGs and climate change interventions considered in the study. Section 3.2 presents the targets and indicators of selected SDGs while Section 3.3 presents selected climate change interventions considered for the study. The conclusions of the chapter are presented in Section 3.4.

3.2 Sustainable Development Goals

The SDGs are an integral component of the 2030 Agenda for Sustainable Development which was adopted by UN Member States in September 2015 as a guide to development in the next 15 years ending in 2030. The SDGs consist of 17 broad developmental goals and 169 targets to be achieved by all member nations by the end of 2030. In this study, five (5) SDGs are of interest, and Table 3.1 presents the targets and indicators of these selected SDGs which constitute the themes for assessing the coherence of climate change interventions with SDGs.

Table 3.1: Targets and Indicators of Selected SDGs

Target of SDG	Indicator
Goal 1: End poverty	
Eliminate extreme poverty for all persons	Percentage of people with daily income of less than $1.25 (international poverty line)
Reduce poverty levels by at least half.	1. Percentage of persons (by sex and age) with income below the national poverty line 2. Number of persons living in poverty by national definition
Device suitable social protection structures and actions for all people and achieve significant coverage of the vulnerable and poor	Percentage of persons covered by social protection measures/programmes
Guarantee access to economic resources, basic services, and other assets and natural resources for the poor and vulnerable	1. Percentage of persons who have access to essential services. 2. Percentage of adult persons with secure land tenure rights and legal documentations, by sex and tenure type
Strengthen the poor and vulnerable persons' resilience, lessen persons exposure and vulnerability to climate change shocks including economic, social, and environmental risks	1. Number deaths, and people affected by disasters per 100,000 persons 2. Percentage of local governments that are undertaking risk reduction initiatives on a local level which are in accordance with national disaster risk reduction policies.

Target of SDG	Indicator
Goal 2: End hunger, achieve food security, and improved nutrition	
Eliminate hunger and enhance poor and vulnerable people have safe, healthy, and enough food.	1. Occurrence of undernourishment 2. The occurrence of food insecurity
Eradicate malnutrition and achieve the global goals on stunting and wasting in children below 5 years, and ensure the nutritious needs of young females by 2025	1. Occurrence of stunting among children below 5 years 2. Occurrence of malnutrition for children age below 5 years
Increase productivity in the agriculture sector and incomes of smallholder food producers by 100% especially females through equitable and secure access to productive resources, knowledge, inputs, markets, credit, and promote prospects for value addition and off-farm jobs.	1. Quantity of output per labour unit for farming/pastoral/size of forestry enterprise 2. Average smallholder food producers' income
Enhance sustainability of food production through resilient agricultural technologies aimed at improving productivity and production, conserve ecosystems, promote climate change adaptation capacity, and increase quality of land and soil	Percentage of agricultural lands used for sustainable agricultural production
Preserve different seeds genetics, indigenous plants and domestic animals and their associated wild species via seed and plant banks, increase access to and equitable distribution of benefits accruing from genetic and related indigenous knowledge	1. The number of animal and plant genetics required for long-term and medium-term food security and agricultural conservation. 2. Percentage of local breeds at risk, not at risk or unknown risk level of extinction

Target of SDG	Indicator
Goal 5: Ensure gender equality and empowerment of women and girls	
Eliminate discrimination especially against females in the world	Enactment of legal frameworks to ensure, enforce and monitor gender parity and fairness against both sex
End violence against women and girls, as well as human trafficking, and sexual assault in both the public and private spheres	1. Percentage of females aged 15 years and above experiencing sexual, physical, or psychological violence by partner in the past 12 months. 2. Percentage of women and girls above 15 years who experience sexual violence from persons other than their partners within the past 12 months.
Eradicate all detrimental practices, including forced and early marriage as well as mutilation of female genitals.	1. Percentage of females between 20 – 24 years who got married under 15 years 2. Percentage of females between 15–49 years whose genitals were mutilated
Promote women's effective involvement in making decision on economic, political and public life and equal opportunities for leadership.	1. Percentage of women in national, local governments or community level leadership 2. Percentage of women in decision-making positions
SDG 13: Take urgent action to combat climate change and its impact	
Strengthen people's adaptive capacity and resilience to climate-induced risks and natural calamities	1. Per 100,000 people, the number of persons directly affected by disasters. 2. Percentage of domestic institutions employing local policies to reduce risk of disaster outlined in the national disaster risk reduction strategies.
Increase awareness-raising, education, and capacity building of individuals and institutions on issues associated with climate change early warning, mitigation, impact minimization, and adaptation	1. Incorporation of adaptation, mitigation, reduction of impact and climate change early warnings into primary, secondary and tertiary levels curricula. 2. Consolidation of individual and institutional capacity-building to ensure implementation of adaptation, mitigation and transfer of technology for development

Source: UN (2015)

3.3 Climate Change Interventions Implemented in Northern Ghana

The climate change interventions were categorized into governmental and non-governmental organisations. The categorization was based on the organization that led the implementation of the program. The target climate change interventions were those whose implementation spanned beyond 2015 and had similar project activities to warrant comparison.

3.3.1 Government Climate Change Interventions

Two governmental climate change projects implemented in Northern Ghana were considered to assess their effects on households' women empowerment, food security, and consumption expenditure in this study. These are the Ghana Commercial Agricultural Project (GCAP) and Ghana Agricultural Sector Investment Programme (GASIP). The reason for the choice of these Government of Ghana Projects is that the programme activities and periods of implementation were similar to those of USAID – Feed the Future Projects. This makes it possible to compare their impacts on households' livelihoods. Details of project objectives and activities are discussed below.

Ghana Commercial Agricultural Project (GCAP)

The GCAP is a Government of Ghana Project, funded by a World Bank credit of US$150 million with co-funding from the USAID with a grant of US$16.95 million (World Bank, 2020; MoFA, 2018). The USAID grant was administered through the World Bank under a Trust Fund arrangement. The Project started on April 8, 2013, and was implemented in the Accra Plains and the Savanna zones or

Northern Development Authority areas. The Project Development Objective (PDO) was to increase agricultural production and productivity of smallholder and nucleus farmers in the GCAP catchment areas through the benefit from improved access to land, private sector finance, input, and product markets as a result of commercial agriculture's private-public partnerships. The GCAP was a 5-year project from 2012 to 2017 but was later extended to December 2020 after it started effectively in April 2013 (World Bank, 2020). The GCAP was implemented by the MoFA in collaboration with the Ghana Irrigation Development Authority, Lands Commission, and Irrigation Company of the Upper Region.

GCAP comprised four main components: (1) Promoting infrastructural investments and land access security. GCAP improved a secure investment environment by simplifying and supporting the rights and obligations of stakeholders such as the government, investors, and affected communities, and ensuring improved strategies to facilitate access to land by lowering the cost of searching for potential investors by expanding the database of land suitable and available for investors, as well as developing nascent avenues for actively linking potential investors to available lands. (2) In the Savannah Accelerated Development Authority (SADA) Zone, securing public-private partnerships (PPPs) and smallholder linkages. (3) Programme management, monitoring, and evaluation. This module of the GCAP provided funds for the operations of the agencies responsible for programme implementation.

Though the GCAP was implemented in the Accra Plains and SADA areas, the emphasis of this study is on the SADA areas. In the SADA zone, the GCAP area lies between latitudes 8^{o} and 11^{o} N and longitude 1^{o} E and 3^{o} W (MoFA, 2018), just like the ZOI for the USAID – FtF projects. GCAP under its' Matching Grants Scheme implemented the Nasia-Nabogo Inland Valley (NNIV) project in the Northern Region, the Tono Irrigation Scheme in Upper East Region, and also provided support to nucleus farmers and out-growers on land development, warehouses, irrigation infrastructure, access roads, and capacity building. At the Nasia-Nabogo Inland Valley (NNIV), GCAP identified 10,000ha of land suitable for inland valley rice production and developed a total of 600ha with contour bunds for rice cultivation by both smallholder farmers and large-scale investors (MoFA, 2018).

Ghana Agricultural Sector Investment Programme (GASIP)

The GASIP is one of the Government of Ghana's long-term programmes implemented at a national scale but with more focus on Northern Ghana's agriculture. GASIP was funded through an IFAD loan facility of US$76.6 million, a grant of US$10.00 million from Adaptation for Smallholder Agriculture Programme (ASAP), participating financial institutions' contributions of US$17.5 million, US$7.6 million from the national government of Ghana, districts contribution of US$1.7 million and beneficiary contribution of US$4.6 million (IFAD, 2016; 2019). GASIP was implemented by the MoFA in cycles of three years with the initial two cycles (six years) spanning between May 2015 and June 2021. The GASIP had development activities on value chain development based

on a demand and market-driven approach. Even though the programme had four value chains at the national level, in Northern Ghana, cassava, rice, fruit, and vegetables were the targeted crop for value chain development. The target beneficiaries of GASIP were smallholder rural farmers, entrepreneurs, and resource-poor people, especially women, youth, and young adults.

The ASAP component of the grant targeted households that are vulnerable to climate change, particularly in the Savannah Zone or Northern Ghana by integrating FBOs into supported value chain programmes that benefit farmers directly. GASIP aimed at reducing rural poverty in Ghana, especially in the SADA zone. The Project Development Objective was to increase climate change resilience and profitability of agribusinesses, including smallholders. The components of GASIP include (i) Development of the Value Chain; (ii) Rural Value Chain Infrastructure and (iii) Awareness creation.

The value chain development component has three sub-components. The first sub-component is agribusiness linkages development with the aim of formalizing agreements with farmers to foster their access to reliable markets. The project activities to achieve this objective were building the capacities of MoFA staff and Farmer-Based Organisations FBOs, on value chain approaches. The second sub-component is value chain financing to ensure sustainable access to and use of both short-term and long-term finances for value chain businesses. Farmers were clustered to build their capacity and linked to selected financial institutions for easy access to affordable credit. Under the Matching Grant Facility, under-capitalized

financial institutions were assisted to improve the value chain linkage by providing financial support towards outreach activities of GASIP's target groups such as women, youth, and poor rural farmers; smallholder farmers' expenses on climate change adaptation; acquisition of equipment needed by smallholder farmers; and affordable interest rates to smallholder farmers. Climate change resilience is the third sub-component of the first component, and it was designed to mainstream climate change resilience across chosen agricultural value chains through a broad promotion of technology. This sub-component was financed directly from the funds of the ASAP contribution to GASIP implementation. Under this sub-component, smallholder farmers were trained on conservation agricultural practices using demonstration fields at selected locations. Also, beneficiaries were trained on efficient water use at the various irrigation schemes in Northern Ghana, climate change awareness and sensitization, and options for adaptation.

The second component of GASIP was rural value chain infrastructure which had the objective of optimizing benefits from crop value chains by providing the requisite finances for essential commercial and public infrastructural development. The third component of GASIP was Knowledge management, policy support, and coordination. The objective of this component was to promote knowledge sharing and dissemination of information collected during the implementation of GASIP.

3.3.2 NGO Climate Change Interventions

This study used the USAID - FtF Population-Based Survey data, which was collected from the Zone of Influence in Northern Ghana to evaluate the impact of

three of its projects: The Agricultural Development and Value Chain Enhancement (ADVANCE) I and II, and the Resilience in Northern Ghana (RING).

Resilience in Northern Ghana (RING)

The RING project was a US$60 million USAID Ghana and Feed the Future-funded five-year integrated project that contributed to the Government of Ghana's (GoG) and the FtF initiative (Davidson & Adams, 2018). The goal of the project was to help needy households in Ghana's former Northern region (now consisting of Northern, Savannah, and North–East regions) better their livelihoods and nutritional status by focusing on districts in the most food-insecure parts of the North East, Savannah, and Northern Regions. The target of the RING project was to contribute to the four goals of Feed the Future by reducing wasting, stunting, underweight, and anemia among children under five (CU5) by 20 percent and also double the income of more than 80 percent of beneficiaries households. In pursuance of these project targets, the RING project set three objectives, which were deemed as the project components, namely: enhanced access to and consumption of a variety of high-quality foods by target households, particularly mothers and children under 5 years; enhanced behaviours on nutrition & hygiene for women & children; and strengthened domestic support networks focusing on the current (nutrition & livelihoods) needs of vulnerable persons.

The Project's interventions were carried out by the Assemblies in the former Northern region (now Savannah, North – East and Northern regions), the Northern Regional Coordinating Council (NRCC), and its decentralized units and

departments, with technical support from Global Communities Inc., a non-governmental organization based in the United States. Using data and a criteria-based approach to select communities and the target households, approximately two thousand five hundred (2,500) vulnerable households were selected from each of the 17 partnering MMDAs as beneficiaries (METSSGIS METSS, 2019). Implementation was funded either through direct awards (i.e., Project Implementation Letters or PILs) from USAID or through a subcontract from Global Communities.

The RING project supported over 96,000 poor households in cultivating diverse and nutritious food crops such as orange-fleshed sweet potatoes, leafy vegetables, and soybeans for both consumption and income (METSSGIS METSS, 2019). Through its capital mobilization package known as Village Savings and Loans Associations (VSLAs), the RING project assisted vulnerable women to embark on personal savings as a source of cheap loans to diversify their livelihood by venturing into businesses and other income generation avenues. Finally, the project formed, trained, and supported over 1,700 mothers' groups to enable the best nutrition techniques for complementary feeding, weaning, and illness control and prevention shared among pregnant and nursing mothers (METSSGIS METSS, 2019).

Agricultural Development and Value Chain Enhancement (ADVANCE) Project I & II

The ADVANCE was a USAID-funded project implemented in 17 districts within Northern Ghana to increase the competitiveness of maize, soybeans, and rice through increased smallholders' agricultural productivity, access to market and trade as well as local capacities for advocacy and activity implementation (ACCUGEOSPATIAL & METSS GHANA, 2019). The implementation approach was based on a value chain where over 127,000 nucleus and smallholder farmers and aggregators were linked to the input and output market and financial institutions and built the capacity of out-grower farmers.

The ADVANCE project was implemented in two phases with an extension of the second phase. The first phase of the ADVANCE project was implemented from 2009 to 2014. The second phase was implemented between 2014 and 2018 and was extended by one year from May 2019 to April 2020. The area of ADVANCE interventions included strengthening market linkages, improving maize and soybean productivity, climate-smart agriculture, promoting crop insurance, mitigating fall armyworm, empowerment of women and the youth in agriculture, promoting information and communication technology innovations in agriculture (ACCUGEOSPATIAL & METSS GHANA, 2019).

ADVANCE II aimed at improving the livelihoods of 113,000 farmers by enhancing the productivity of maize, rice, and soybean value chains (Brand, 2017). The ADVANCE II project was executed by ACDI/VOCA in partnership with

TechnoServe, ACDEP, and PAB Consult (ACDI/VOCA, 2016). The programme also trained beneficiary households, especially women on the culture of saving.

3.4 Conclusions

The targets of the SDGs are the objectives to be achieved before or by the end of 2030 while the indicators are the outcomes of milestones to be used in assessing whether the set objectives have been achieved or not. In this study, it is assumed that even if an intervention was not originally designed to achieve the objectives spelled out in the SDGs, its operational activities are likely to contribute to the achievement of the objectives either directly or indirectly. The targets of the SDGs constitute the themes for assessing the coherence of reviewed climate change interventions with SDGs.

The project activities of the selected government interventions (GCAP and GASIP) and NGO interventions (ADVANCE I & II and RING) were implemented within similar periods and had similar project activities such as access to market (output and inputs), training on climate-smart agricultural practices, climate information, afforestation, livestock rearing, financial support, income diversification, and sensitization and advocacy. It is on this basis that a comparison of the impact on livelihoods of farm households between government and NGO interventions is possible.

CHAPTER FOUR

RESEARCH METHODOLOGY

4.1 Introduction

This chapter presents the research methodology of the study. The chapter begins with a description of the study area, leading to a description of the research design, research approach, sources of data, sampling of respondents for the study, methods of data analysis, and ethical issues.

4.2 Description of Study Area

The study was conducted in Northern Ghana, specifically in the Zone of Influence of the USAID-FtF interventions. Northern Ghana is in the semi–arid climatic Guinea Savanna Ecological Zone located in a semi-arid climatic region and is the food basket of the nation with the highest percentage of its active labour force engaged in agriculture. Since 2019, Northern Ghana consists of five regions; Northern, North-East, Savannah, Upper West, and Upper East Regions (Ghana Statistical Service, 2021). The annual average minimum and maximum temperatures of the region are 14^0C at night and 40^0C during the day (GSS, 2014). Over 60% of the active labour force is engaged in agriculture, and 90% of agriculture in Northern Ghana is rain-fed (FAO, 2015; Ghana Statistical Service, 2012, 2014; Yaro et al. 2015).

Northern Ghana accounts for over 40 percent of the national poverty, with 6 out of 10 persons in Northern, Savannah, and North–East regions being poor while 8 out of 10 persons and 9 out of 10 persons in Upper East and Upper West regions

respectively are reported to be poor (GSS, 2019). There are several non-governmental and governmental organizations implementing interventions on poverty alleviation, livelihood, climate change mitigation and adaptation, and gender empowerment. The broadly defined ZOI for Ghana covers the five regions in Northern Ghana including northern parts of the Bono region which are above the 8^{th}-degree parallel (METSS, 2012; Guvele et al., 2016).

The districts in the regions include the Savannah Region which encompasses the Bole, Sawla/Tuna Kalba, Central Gonja, West Gonja, and East Gonja districts; the Northern Region including Kpandai, Nanumba South, Nanumba North, Zabzugu, Tatali, Mion, Yendi, Tamale metropolis, Sagnarigu, Tolon, Kumbungu, Savelugu Municipal, Nanton, Karaga, Gushegu, Saboba districts; North – East Region comprising of Chereponi, Bunkpurugu Yonyo, West Mamprusi, East Mamprusi districts; Builsa, Kasena Nankana East, Kasena/Nankana West, Bolgatanga, Talensi/Nabdam, Bongo, Bawku West, and Garu Tempane districts in the Upper East Region; Upper West Region consisting of Wa West, Wa East, Wa, Sissala East, Jirapa, Nadowli, Sissala West, Lambussie Karni, and Lawra districts; and Bono region comprising of Jaman North, Tain, Banda, Wenchi, Municipal, Pru, Sene East, Kintampo South, Kintampo North, and Sene West districts.

The main crops cultivated in Northern Ghana include rice, maize, groundnuts, yam, soybeans, and cowpea. Livestock such as cattle, sheep, goats, guinea fowls, and fowls are reared by households in Northern Ghana (GSS, 2014). Culturally, people in Northern Ghana practice a patrilineal system of inheritance which often deny

women the required access to resources and marginalization in decision-making (Nkegbe et al., 2017). Figure 4.1 presents a map of Ghana depicting the FtF interventions' ZOI where the study was conducted.

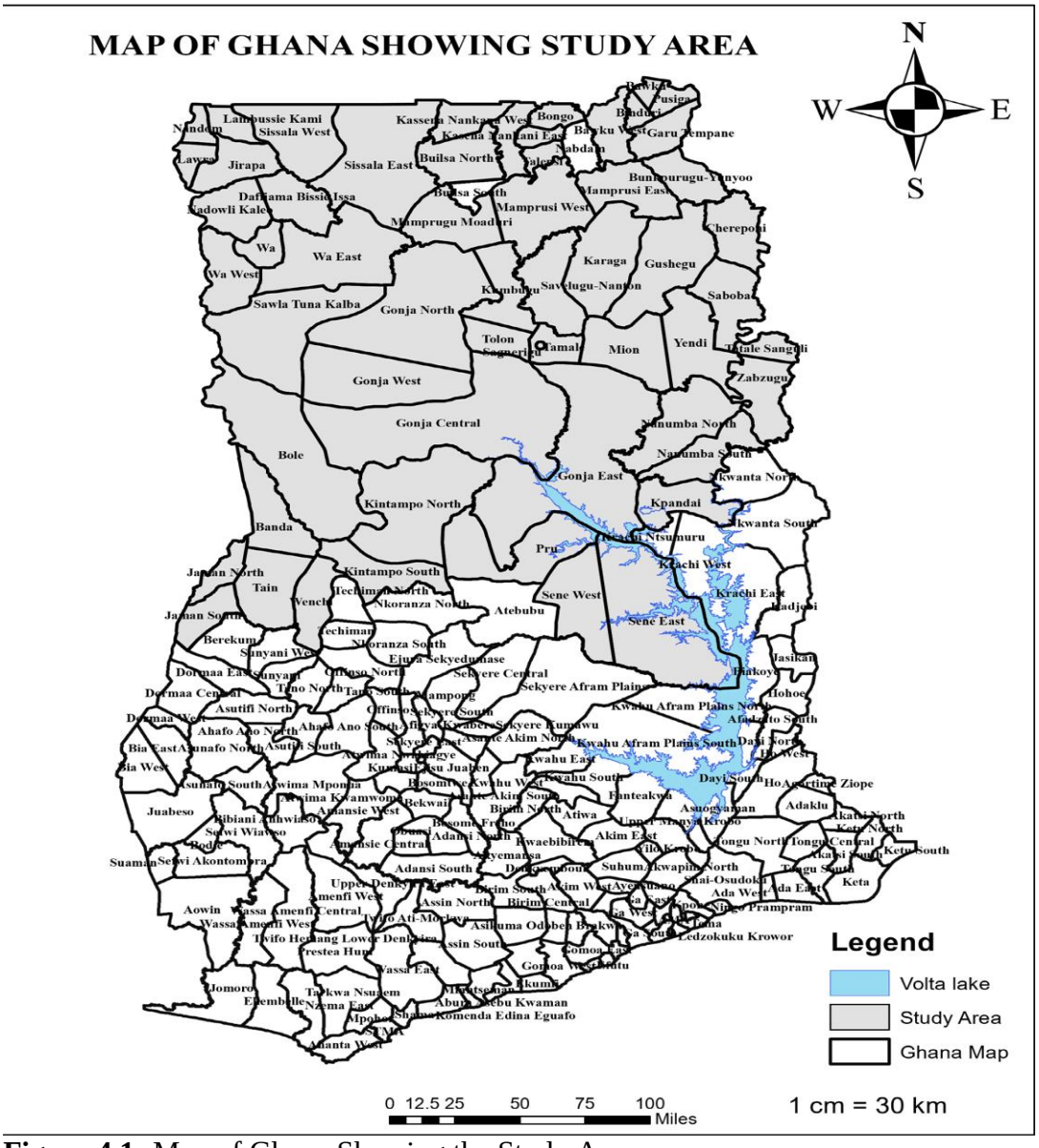

Figure 4.1: Map of Ghana Showing the Study Area

Source: Department of Geography and Resource Development, University of Ghana, 2021

4.3 Research Design

The study is designed to assess the effects of government and NGOs' climate change interventions on the livelihood outcomes of farm households within the FtF ZOI in Northern Ghana. The study is an evaluative study of climate change interventions and was based on the pragmatist research paradigm[2], hence the use of survey and case study research designs. The case study design allows for a deeper probe into the intricacies of climate change interventions and livelihood nexus through the triangulation of data to ensure the validity of findings. The survey approach allows for the generalization of the research findings. The study also employed an experimental research approach to explain the differences in livelihood outcomes of households that participated in NGOs and government interventions vis-à-vis households that have not participated.

In this study, a sequential mixed approach was adopted to enable the generalization of the findings and predict likely future situations of similar projects as well as provide a holistic understanding of the complexities in the effects of participation in interventions on households' livelihoods. Thus, the qualitative data was collected after the quantitative data. Given this, the FtF baseline, midline, and end-line data were the source of quantitative data for the study while follow-up interviews with households, Focus Group Discussions, and key informant interviews were also conducted to provide qualitative data and also to ascertain households' participation in government interventions. The qualitative research approach is

[2] The pragmatist research paradigm proposes that researchers should employ methodological approaches that work best in investigating a given research problem.

required to explore climate change interventions and examine if their objectives are in tandem with the selected SDGs as well as provide explanations for some of the quantitative results. A quantitative research approach is required to explain the effects of climate change interventions on households' livelihood outcomes.

4.4 Types and Sources of Data

Both quantitative and qualitative data were collected from both primary and secondary sources. Data on climate change interventions implemented in Northern Ghana were gathered from both primary and secondary sources. The secondary source included reports on climate change interventions sourced through the internet and reports of organisations that implemented(ing) climate change interventions. Information gathered on reports of climate change interventions was complemented by interviews with staff of these organisations that have implemented(ing) climate change interventions. The household-level data were sourced from the FtF Population-Based Survey (PBS). The baseline data was collected in June – July 2012, the midline in June-July, 2015, and the end-line was collected in July – August 2019. The data covered the five Northern Regions and some Northern parts of the Bono region.

4.5 Sampling Procedure, Data Collection Methods, and Instruments

Four different sampling procedures were employed in the study: 1) Sampling of climate change interventions, 2) sampling of households 3) sampling of participants for Focused Group Discussions, and 4) sampling of experts for key informant interviews.

4.5.1 Sampling of Climate Change Interventions

The sampling of climate change interventions to be examined in this study was based on the Campbell Collaboration as employed for similar studies by Adu et al. (2018) and Bodnar et al. (2011). Climate change interventions were sourced through 1) a desk review which involved an online search for literature from scientific databases, and 2) official visit to organizations for reports on climate change interventions that are either unpublished or challenging to obtain.

Initially, a list of organizations involved in climate change activities was generated based on the Ghana Agriculture Sector Development Partners' catchment areas map. The list serves as a starting point for literature searches on the computer and visits to organizations in search of unpublished or difficult-to-find information. Snowball sampling of other organizations and extraction of other relevant information were also possible during the visits to the organizations.

The first aspect was the desktop search, which was obtained through peer-reviewed scientific journals with likely titles, keywords, logical operators, and filtering methods. "Climate change interventions in Northern Ghana" was the search string for key phrases in the title and topic. I also searched the 'grey literature' for project evaluation reports of listed organizations and institutions, including donor government portals, to reduce positive-result publishing bias and offer comprehensive data. The second aspect of data was obtained through visits to organizations for unpublished literature such as programme evaluation reports,

annual reports, and other unpublished documents on NGOs' and local government interventions in Northern Ghana.

Knowing that not all information retrieved through an online search and visit to organizations will be relevant to this study, a criterion for inclusion or exclusion was developed based on the evaluation of the content and quality of documents. Thus, all documents gathered were assessed and included for further analysis if they fulfilled *a prior* eligibility criterion required to accomplish the aims of the study. Thus, the quality of information extracted from documents on climate change is of the essence and was assessed through a four–stage process using inclusion and exclusion criteria. The inclusion criteria for retrieved documents included: 1) has a climate change component in the project activities; 2) the Project implementation catchment area must include a location in Northern Ghana; 3) The implementation of the intervention must span beyond 2015; 4) Must be original project report. The exclusion criteria included: 1) a report on climate change interventions not relevant to Northern Ghana; 2) Climate change interventions whose implementation ended before 2016; 3) Documents that did not have enough information required for the study; and 4) Documents on interventions that did not address the study objectives.

Based on the quality of information, documents were categorized into three: 1) Good; 2) Sufficient; or 3) Insufficient. A document was deemed to be 'Good' if it was a comprehensive report and contained all required information (clear description of intervention including project name, objectives, activities, donors or

implementing organisation, period of implementation, and catchment area). A document was categorized as ‘Sufficient’ if it was comprehensive and contains a profile of the project, if possible, with aims and/or activities and the year the intervention ended. A document was considered 'insufficient' if it had a vague description of interventions without details/summary of project objectives, activities, implementation period, and region/district/communities needed for the study objective. In this study, only documents categorized as ‘good’ or ‘sufficient’ were used for further screening for analysis. Documents deemed to be ‘insufficient’ were rejected. A total of 112 interventions were rated as good and/or sufficient for inclusion for further analysis to answer the research question on the coherence of climate change interventions with selected SDGs. This consisted of 78 NGO interventions and 34 government interventions. Given that the sample frame was not large, all 112 interventions identified were used for the analysis. Figure 4.2 presents a flow chart showing the process involved in selecting eligible climate change interventions for the study.

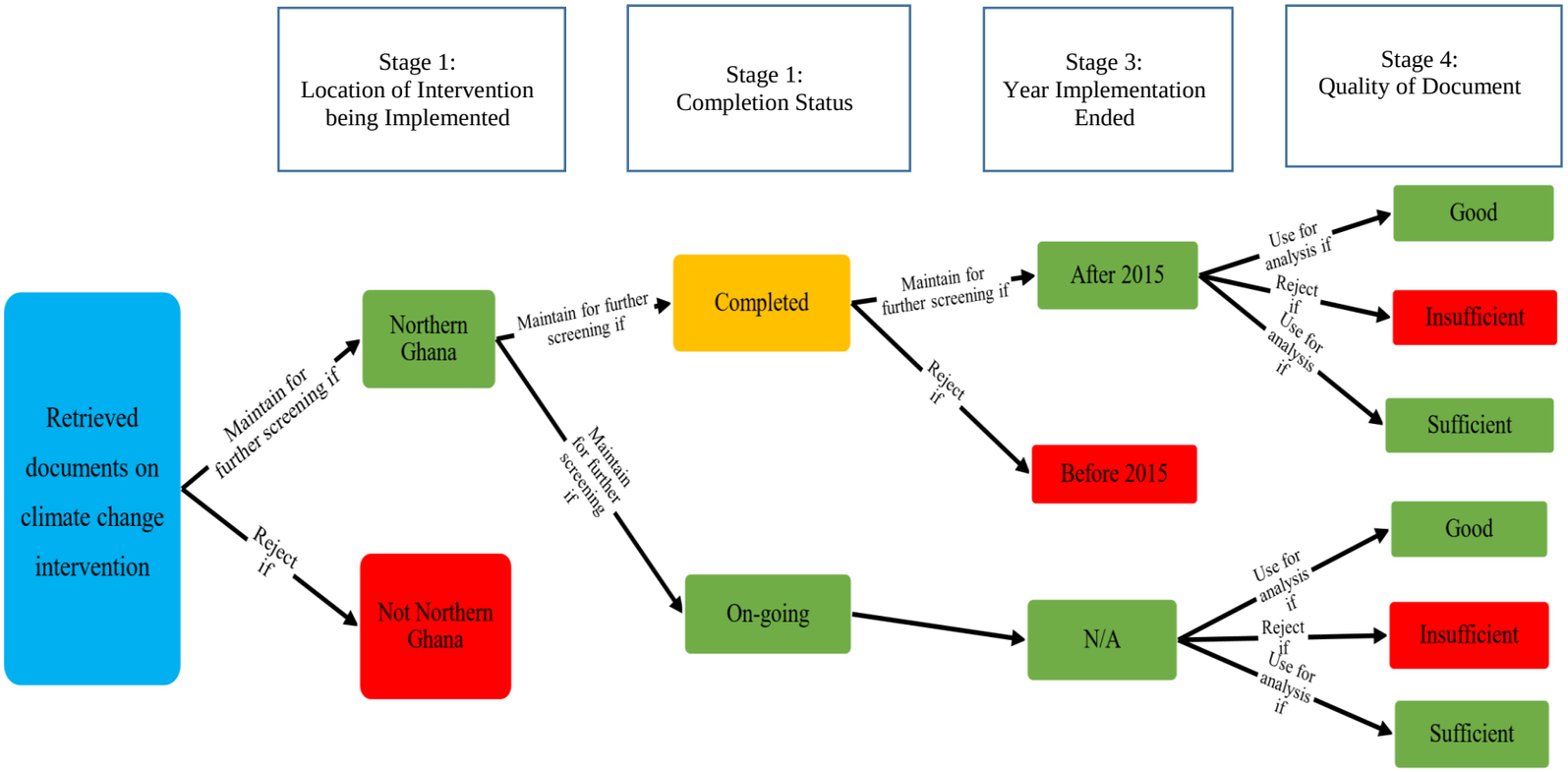

Figure 4.1: A flow chart showing the criteria for inclusion/exclusion of climate change intervention report document

Source: Adu et al. (2018) and Author's construction, 2021

4.5.2 Sampling of Households

Given that the household level data was collected earlier by USAID, the households for this study were sampled during the Population-Based Survey (PBS) from the FtF Zone of Influence (ZOI) in Northern Ghana. In the course of this study, a follow–up visit to households that participated in the baseline and end-line was made to administer an interview guide with households on their participation in other government climate change interventions (GCAP and GASIP) within the study period and their perceptions on the effectiveness of NGOs and government climate change interventions. About 4600 households were sampled in each of the three rounds of the PBS, totalling 13, 800 households (METSS, 2012; Guvele et al., 2016).

For this study, knowing that the data was collected from households in the effective ZOI as a whole, the enumeration areas were stratified into four strata. The first stratum represented areas within the ZOI with RING nutrition/agriculture interventions and/or ADVANCE. The second stratum consisted of areas with only government interventions (GCAP and/or GASIP). The third stratum represented areas with both NGO interventions (RING and ADVANCE) and Government of Ghana interventions (GCAP and/or GASIP). The fourth stratum represented areas with only agriculture activities without NGO and/or GoG interventions. The sampling frame consisted of four groups of respondents:

1) Households that have participated in only NGO interventions including the USAID FtF interventions (ADVANCE and RING),

2) Households that participated in only government intervention (GCAP and GASIP),
3) Households that participated in both NGO (ADVANCE and RING) and government interventions (GCAP and GASIP) and
4) Households that have not participated in either NGO or government intervention (non-participants).

Thus, the stratification of the ZOI above is critical for a true reflection of the effect of interventions. In each of the baseline (2012), midline (2015), and end line (2019), the survey instruments (questionnaire) were administered to 4600 households in 230 enumeration areas from the five regions of Northern Ghana, totaling 13, 800 households for the three phases.

4.5.3 Sampling of Participants for Focus Group Discussions

Focused Group Discussions (FDGs) were conducted separately for male and female farmers in selected communities in each district. The reason for the separate FGDs for males and females is that the cultural practices in Northern Ghana do not allow the female to express themselves in the presence of their male counterparts who are perceived to be the mouthpiece of the household, hence, denying both children and women the opportunity to speak out their peculiar views on the effects of participating in climate change interventions on livelihoods. Each FGD had a membership of eight to ten.

Male FGD comprised of a community development chairman, community chief or his representative, farmer-based organizations member(s), beneficiary, and non-

beneficiary household members. Females FGDs consisted of the 'magazie' (women leaders), women representatives of FBOs, the youth, and both beneficiary and non-beneficiary female farmers. The role of each research team member was for one to ask the questions, two persons documented answers, and the fourth person took pictures. A checklist was used to collect data from the FGDs. The FGDs were to solicit each community's view on the climate change interventions implemented by the government and NGOs in their communities. A total of 28 FGDs (16 male FGDs and 12 female FGDs) were conducted.

4.5.4 Sampling of Key Informants

Expert opinions on climate change interventions were sought from key informants. The key informants were selected from both government and non-governmental organisations that had vital knowledge of climate change interventions in Northern Ghana. Questions were asked on interventions implemented by their organizations, their views on the effectiveness of these interventions, project objectives, and activities, the period of implementation, and the challenges in implementing climate change interventions. The key informants were staff of NGOs, and government organizations (regional and district MoFA, district assemblies, Northern Development Authority, Savannah Agricultural Research Institute of the Council for Scientific and Industrial Research, CSIR – SARI). A total of 53 key informants were selected and interviewed using a semi-structured interview guide.

4.6 Theoretical Framework

One economic theory that could be suitable for explaining the effects of agricultural programs on the livelihood outcomes of farmers is the Theory of Agricultural Household Models. In a typical agricultural household, decisions about how much land to cultivate, how much labour to allocate to farming, what crops to grow, and how to allocate income generated from agricultural activities are considered under the complex interactions between the household, the farm, and the market (Barnum & Squire, 1978; Tambo & Wunscher, 2014). This helps to identify the factors that influence household decision-making regarding production, consumption, and investment. This model has been widely used to assess the effects of agricultural programs on household livelihoods, as it allows researchers and policymakers to understand how different policies and interventions may affect households' decision-making processes and overall well-being as well as identify the most effective interventions (Abdulai & Delgado, 1999; Barrett et al., 2001; Haggblade et al., 2010; Quisumbing & Pandolfelli, 2010).

One way the agricultural household model can be applied is to simulate the potential impact of agricultural programs on household livelihoods (Barnum & Squire, 1978). Researchers can use data on household characteristics, resource endowments, and market conditions to model the impact of different policy scenarios on household production, consumption, and income. This can help policymakers to identify the most effective programs and policies for promoting agricultural development and improving household welfare. For example,

Dorward et al. (2009) employed the theory of the agricultural household model to examine the impact of a maize seed subsidy program on decisions regarding crop production, consumption, and investment in other livelihood activities among smallholder farmers in Malawi. The results of the study showed that the subsidy had a positive impact on household food security and income, but also had some unintended consequences, such as reducing the diversity of crops grown and increasing reliance on external inputs. Also, Hoddinott et al. (2003) evaluated the Food for Education program in Bangladesh using the TAHM. This program provided free school meals to children in exchange for their regular school attendance. The program increased household food consumption, improved child nutrition, and increased school attendance, which could have positive long-term effects on women's empowerment and household welfare (Hoddinott et al., 2003). Another example is the Fertilizer Subsidy Program in Malawi, which provided subsidized fertilizer to smallholder farmers. The program led to increased agricultural productivity and food security, as well as increased investment in education and health (Dorward et al., 2017).

Another way the agricultural household model can be applied is to identify the barriers that households face in accessing agricultural markets and resources. By analysing the factors that influence household decision-making, researchers and policymakers can identify the constraints that limit household productivity and identify potential solutions for improving access to resources and markets. Agricultural programmes can affect household decision-making through various channels, including changes in input prices, access to credit, technology adoption,

and market linkages (Tschirley et al., 2016). For example, a program that provides subsidized inputs such as fertilizers or seeds may increase the profitability of farming, leading households to allocate more labour and land to agriculture. Alternatively, a program that provides training on improved farming practices may increase productivity, leading to higher incomes and improved livelihoods.

The Theory of Agricultural Household Models emphasizes the importance of considering the heterogeneity of households and the various factors that influence their decision-making (Tschirley et al., 2016). It also recognizes that households may have multiple income sources and may engage in non-farming activities, such as wage labour or small-scale businesses. Therefore, agricultural programs may need to be designed in a way that accounts for these complexities and seeks to maximize the overall impact on household livelihoods.

This thesis employed the Theory of the Agricultural Household Model (TAHM) to assess the effectiveness of participation in climate change interventions on women empowerment, food security, and consumption expenditure of farm households. The TAHM views the household as a decision-making unit that allocates resources among various activities, including agricultural production, consumption, and investment. This decision-making process is influenced by household resources, production function, consumption function, market imperfections, and other external shocks. Household resources include the endowments of the household, such as land, labour, and capital, as well as the household's preferences and tastes. Production function describes how the household combines its resources to

produce agricultural output. The consumption function describes how the household allocates its agricultural output and other income to various consumer goods, including food. Market imperfections include issues such as imperfect information, market power, and transaction costs, which can affect the household's production and consumption decisions. External shocks include events such as changes in weather, prices, and policies, which can affect the household's welfare.

The effect of participation in climate change interventions on household food security, women empowerment, and consumption expenditure can be depicted through the activities of these interventions. For example, a programme that provides training and inputs to women farmers (as in the case of GASIP and ADVANCE) could increase their productivity, which would increase household income and improve food security. This could also lead to increased decision-making power for women within the household, contributing to their empowerment.

4.7 Conceptual Framework

The study is based on the effects of government and non-government climate change interventions on farm households' livelihoods. This necessitates using the Sustainable Livelihood Framework to conceptualize the consequences of these climate change actions on household livelihoods. This study is conceptualized on the basis that farm households are vulnerable to climatic shocks and their ability to adapt depends on their access to livelihood assets. As stated in the SLF in Chapter

Two, the SLF is constructed based on the five livelihood assets (physical, human, financial, natural, and social).

As a result, determining people's access to various sorts of resources and their capability to put them to productive use is a crucial aspect of the analysis. The framework presents an approach to assess climate change interventions by both governmental and non-governmental organisations on livelihoods, determine how these interventions increase access to different assets and defines the sort of livelihood strategies that are open and attractive to vulnerable farm households (Carney, 1998).

Climate change interventions emanate from government and non-government organisations and provide livelihood strategies aimed at improving livelihood outcomes of farm households such as income, food security, consumption, and social equity including women empowerment. The first study objective is to review the program activities and objectives in terms of gender equity and women empowerment, poverty alleviation, fight against hunger, and climate actions of farm households, which are among the cardinal development goals of the member states of the United Nations.

In the conceptual framework, access to climate change interventions (governmental and NGOs) by vulnerable households is deemed to be an external factor capable of influencing or changing the livelihood of vulnerable households through livelihood strategies. The intensity of exposure to climate vulnerability context and access to livelihood assets and climate change interventions are influenced by gender and

power dynamics such as gender relations, social differentiation, and cultural practices. The second study objective is to examine the effects of government and NGO interventions on empowering women to participate in decision-making and also have equitable access to productive livelihood resources. In northern Ghana, cultural practices often marginalize women and deprive them of access to essential resources. Sensitisation programmes of government and NGOs have in the recent past influenced households' views on women and children's marginalization.

According to Antwi-Agyei et al. (2012a, b), institutional climate change interventions are usually intended at enhancing the adaptive capacity of vulnerable farm households by supporting their livelihood strategies in the form of on-farm and non-farm activities as alternatives. Interventions on climate change for households' on-farm livelihood strategies take the form of improved crop varieties, access to weather information, access to market, access to farming equipment, irrigation, conservation agriculture, and training on climate-smart agriculture. Interventions in the form of on-farm activities aim at boosting the yield of farming households in the occurrence of climatic stressors such as floods, droughts, and increased temperatures. Off-farm support by climate change interventions takes the form of supporting farm households to engage in other livelihood strategies on the agri-food chain such as processing of agricultural products, soap making, and other livelihood diversification except farming.

According to DFID (1999, 2000), the importance of utilizing the SLF is that it inspires users to study the relationships between the elements that generate poverty.

It does not take a sectorial approach to poverty, instead attempting to balance the contributions of all sectors to the accumulation of assets from which people draw to support their livelihoods. According to DFID, people's access to assets makes them reactive to their desires which influence the structures and procedures (Carney et al., 1999). This environment has an impact on livelihood strategies, which are how people combine and employ assets to achieve favourable livelihood outcomes that fulfil their own goals (Carney et al., 1999). The availability of resources, services, and prospects, which can be boosted or harmed by natural variables, social structures, or institutional processes, determines the feasibility and success of livelihood strategies. This accessibility can be observed from the perspective of smallholder land access before and after government and non-government involvement.

The Framework may also deal with the intricacies of local circumstances, livelihood strategies, and poverty results, as well as their dynamic interrelationships (DFID, 2000). The external setting is framed by the vulnerability context. Critical trends, shocks, and seasonality have a significant impact on people's livelihoods and asset availability. Smallholder farmers' external environment is shaped by climate change actions. As a result, the SLF is employed in this study to examine how governmental and non-governmental climate change actions affect the livelihood of beneficiary farm households. The study's conceptual framework is shown in Figure 4.3.

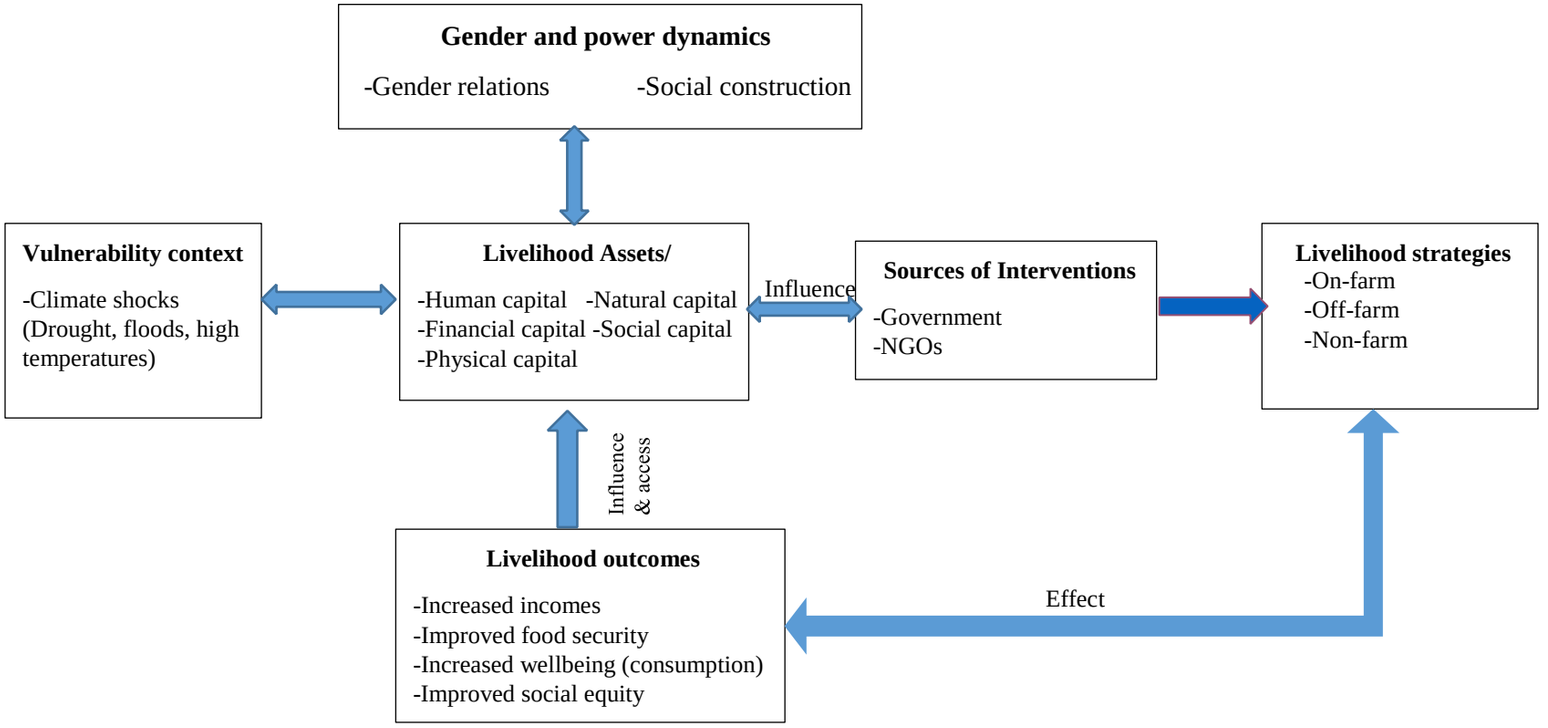

Figure 4.2: Conceptual Framework Guiding the Study

Source: Author's Construction, 2021

4.8 Methods of Data Analysis

4.8.1 Profile and Review of Climate Change Interventions

Given that the SDGs are a continuum of the MDG which ended in 2015, climate change interventions whose implementation started before the adoption of the SDGs in 2015, but span beyond 2015 were also considered in this study since such projects still have relevance to poverty and hunger reduction as well as climate change adaptation in current time to improve farm households' livelihoods. The study explored climate change interventions of both governmental and non-governmental organizations implemented in Northern Ghana. The first objective was to assess the nexus of the objectives and activities of climate change interventions with selected SDGs (SDG 1 – no poverty, SDG 2 – zero hunger, SDG 5 – gender equality and women empowerment, and SDG 13 – climate action).

The first objective was analysed using both qualitative (thematic and content analysis) and quantitative analytical tools (descriptive statistics and Non-parametric tests). The climate change interventions identified were profiled in terms of project objectives, activities, duration, and source of interventions. The objectives and activities of these interventions were reviewed along the objectives of selected SDGs (SDG 1 – no poverty, SDG 2 – zero hunger, and SDG 13 – climate action) to ascertain their coherence with, relevance, and contribution to achieving these SDGs. The activities of climate change interventions were categorized into themes based on SDGs objectives and coded for thematic analysis using Ms. Excel 2016. Responses from FGDs and key informants were analysed using content analysis to confirm the results of the thematic analysis. Finally, households were used to rank

the effectiveness of governmental and NGO interventions using a Likert Scale from 1 (most effective) to 5 (least effective). Kendall's Coefficient of Concordance was used to test for agreements among households.

4.8.2 Econometric Model for Determining the Effects of Participation in Climate Change Interventions on Women's Empowerment, Food Security, and Consumption Expenditure

In the face of non-randomness in the decision to participate in climate change interventions, analysing the effect of participation can be problematic. Thus, the problem of sample selection bias is a major limitation in the non-randomness of participation in climate change interventions of government and NGOs. The solution to this sample selection bias associated with non-random participation decisions is the matching approach. In the matching approaches, participant households are compared with non-participant households (control group) with similar observable features. Knowing that selection into treatment is based on observable features, Rosenbaum & Rubin (1983), Cattaneo (2010) and Imbens (2000) indicated that households of different treatment groups but with similar features can be compared as if participation was random. Participant households are compared with non-participant households (control group) with similar features in the matching approach.

Given that this study deals with four categories of respondents (non-participant households, households that participated in only government interventions, only NGO interventions, and both government and NGO interventions), the standard

propensity score technique, the Heckman Two Stage or the Endogenous Switching Model are not appropriate because there are more than two groups. Another approach that could have been applied in this analysis is the multivalued treatment based on an efficient influence function estimator (EIF). However, this approach relies on the Conditional Independence assumption, which requires randomness in participation decisions and control for households' characteristics (Cattaneo, 2010). Thus, given that respondents' participation in interventions in climate change is often non-random, this study adopts a more flexible modelling approach that does not require randomness in households' participation in climate change interventions.

In this study, respondents' participation in climate change interventions (government, NGO, and both government and NGO) and the effects of participation on women empowerment and livelihood outcomes (food security and consumption expenditure) were modelled using the METE model espoused by Deb and Trivedi (2006a, b). The METE models the treatment equation (mixed multinomial logit model) and the outcome equation simultaneously. Thus, both the determinants of households' participation in interventions and the participation effect on women empowerment and livelihood outcomes (food security and consumption expenditure) of households were modelled concurrently. The main advantage of the METE model in evaluating programme impact is that in addition to accounting for selection bias of observed (through individuals' features) and unobserved heterogeneity (through latent variables), the METE model in addition to modeling continuous outcome variables can be extended to model categorical

outcome variables, which is not possible for MESR models (Khonje et al., 2018). The outcome variables (women empowerment, food security, and consumption expenditure) in this study were measured both as continuous and categorical variables, hence, the METE model best fit the data set than the MESR model.

Following Deb and Trivedi (2006a, b), let c_{it} denote dummy variables for the observed participation in climate change intervention (treatment) by household *i*.

$$c_{it}(T_i) = \begin{cases} 1, & if \ T_i = t \quad (t=0,1,2,3) \\ 0, & otherwise \end{cases} \tag{6}$$

The probability of participating in a climate change intervention is given by:

$$\Pr\left[c_{it} \,|\, z_i, l_i\right] = z_i'\alpha_t + \sum_{k=1}^{T} \delta_{tk} l_{ik} + \varepsilon_{it} \tag{7}$$

Where ε_{it} is the error term, and $\Pr\left[c_{it} \,|\, z_i, l_i\right]$ denotes the multinomial logistic function *g*, *z* represents exogenous variables with related coefficients α_t, l_{ik} denotes unobserved features (unobserved heterogeneity) peculiar to farm household *i*'s participation decision and outcome such as motivation or level of awareness/information on intervention. It is assumed that l_{ik} are independent of ε_{it} and $t = 0$ represents the control/untreated group (non-participant households). Thus, estimates from the mixed multinomial logit regression could be inconsistent if the unobserved factors are correlated with the explanatory variables (Khonje et al., 2018). This was addressed by following Mundlak (1978) and Wooldridge (2010) approaches of using all time-varying variables technique.

A set of constraints is placed to identify the model. First, it is assumed $\delta_{tt} = 0 \ \forall \ t \neq k$, that is, each household's participation decision is influenced by a specific unobserved factor. Second, it is assumed that $\delta_{tt} = 1$, indicating that the degree of impact of an unobserved factor is normalized and equal to 1 in the treatment or participation equation (Deb and Trivedi 2006a, b).

The outcome (women empowerment, food security, and consumption expenditure) equation is as follows:

$$y_i = x_i'\beta + \sum_{t=1}^{T} \theta_t c_{it} + \sum_{t=1}^{T} \pi_t l_{it} + \varepsilon_i \qquad (8)$$

ε_i is the error term, y_i is assumed to be normally distributed, x is the exogenous variables with estimated coefficients β, θ_t and are the treatment effects (participation in climate change interventions) relative to the control (non-participation). The outcome variables (women empowerment, food security, and wellbeing), y_i is affected by unobserved features (l_{it}) which influence selection into treatment (participation in intervention). If π_t is positive (or negative), treatment (participation) and livelihood outcomes are positively (or negatively) correlated through unobserved characteristics. That is, there is a positive (or negative) selection.

Deb and Trivedi (2006a, b) indicated that l_{it} are empirically non-observed and assume to be independent and identically distributed (*i.i.dmunl*), drawn from a normal

distribution and their joint distribution *h* can be integrated out of the joint density distribution of selection and outcome variables as follows:

$$\omega\left(y_i, c_{it} \left| x_i, z_i\right.\right) = \int \left\{ f\left(y_i \left| x_i, c_{it}, l_{it}\right.\right) * g\left(z_i, l_i\right)\right\} h\left(l_{it}\right) cl_{it} \qquad (9)$$

In specifying *f, g,* and *h*, the integral form of equation (9) does not have a closed-form solution.

After that, a simulated-based estimation framework is used to complete the full estimation of equations (8) and (9). The parameters that optimize the simulated log-likelihood function associated with a joint density distribution of both the selection and outcome variables are found using this method (equation 10). The simulated log-likelihood maximization is identical to maximizing the log-likelihood maximization for a large number of simulations (S) (Train, 2009).

$\omega\left(y_i, c_{it} \left| x_i, z_i\right.\right)$ has a simulated log-likelihood function given as:

$$lnL\left(y_i, c_{it} \left| x_i, z_i\right.\right) = \sum_{t=1}^{N} ln\hat{\omega}(y_i, c_{it} \left| x_i, z_i\right.) = \sum_{t=1}^{N} ln\left(\frac{1}{s}\sum_{s=1}^{s}\left\{ f\left(y_i \left| x_i, c_{it}, l_{its}\right.\right) * g\left(z_i, l_{its}\right)\right\}\right) \qquad (10)$$

Where l_{its} is the sth draw (from a total *S* draws) of a pseudo-random number from the density *h*.

The outcome variables (women empowerment, food security, and wellbeing) were all measured in two ways: continuous and categorical. The continuous variables were assumed to follow a normal (Gaussian) distribution function, and the models were estimated with the Maximum Simulated Likelihood (MSL) approach using

Deb (2009) Stata command *mtreatreg* at 500 simulation draws as used by Manda et al. (2015).

Although the model parameters can be identified even if the independent variables in the treatment and outcome equations are identical, Deb and Trivedi (2006a) advocate using exclusion criteria or instruments for more reliable identification. This means that regressors from the treatment equation are not included in the outcome equation. In actuality, obtaining a valid instrument is frequently difficult.

In this study, households' access to information on or awareness of climate change interventions (measured as a dummy: yes if a household has access to information on climate change interventions and zero if otherwise) was used as an instrument. Though the main source of information to farmers is usually through extension officials and NGO staff, and access to extension services may correlate with the perceived effectiveness of these climate change interventions, households' perceptions of interventions' effectiveness were used as an instrument for extension contacts. Access to information on and perceived effectiveness of climate change interventions is likely to influence farming households' participation in climate change intervention but not the outcome variables (women empowerment, food security, and consumption expenditure. As a result, if households believe climate change actions are beneficial, they are more likely to participate than if they do not.

Adegbola and Gardebroek (2007) revealed that access to information on agricultural technologies or programmes significantly influences farmers'

decisions to participate in and adopt practices promoted by such programs. Several studies such as Di Falco et al., (2011) and Di Falco and Veronesi, (2013) have used access to information as a valid instrumental variable for programme participation and technology adoption studies in Africa. The validity or admissibility of access to information on climate change intervention as an instrument was established through a falsification test. Di Falco et al. (2011) and Di Falco and Veronesi (2013) stated that an instrument is valid if it has a significant effect on the selection variable(s) (households' participation in climate change interventions) but not on the outcome variable(s) (women empowerment, food security, and consumption expenditure).

The results of the falsification test show that access to information on climate change interventions has a significant influence on households' participation decisions (refer to Table 6.4) but not on the outcome variables - women empowerment, food security, and consumption expenditure (refer to Appendix A1). Hence, it is considered a valid instrument. The other aspect of selecting an instrument is its relevance. In reality, households participate in an intervention if they have information on the existence of such intervention and also perceive participation to be beneficial or effective.

4.8.3 Measurement of Outcome Variables

4.8.3.1 Women Empowerment

The Women Empowerment in Agriculture Index (WEAI) was the indexing tool used in determining the empowerment level of women of farm households vis-à-vis

their male counterparts. This index has been chosen because of its ability to measure agency which is one of the three dimensions of empowerment largely ignored by other indices.

The WEAI was espoused to track changes in women's empowerment as a direct or indirect effect of initiatives under FtF, the United States' global hunger and food security project. The WEAI is a ground-breaking new tool that combines two sub-indices: an assessment of the five domains of empowerment (5DE) and a gender parity index (GPI) of households. The GPI evaluates gender parity in household empowerment, while the 5DE assesses the five areas of empowerment for women. The WEAI assesses women's control over key aspects of their lives such as the household, community, and economy. It enables us to identify women who are powerless and learn how to provide them with more autonomy and decision-making power in crucial areas. The WEAI can also be used to track improvement in gender equality.

The 5DE measures how empowered women are in their households and communities across five domains (production, resources, income, leadership, and time). We start by calculating a disempowerment index (M_0) across the five domains and then calculate 5DE = (1 – M_0). The construction of 5DE can be described using one of two comparable notations. One examines the proportion of empowered women and the inadequacies of the disempowered. The other metric is the percentage of women who are disempowered and the proportion of domains

they are underachieving. The second notation was employed in this study since it is compatible with the M_0 measurement (Alkire and Foster 2011).

In calculating the 5DEs, all adequacy indicators are coded 1 if the household is lacking in that indicator. Each household is given an inadequacy score based on its inadequacies across all indicators. Each household's inadequate score is derived by adding the weighted inadequacies experienced, resulting in an inadequacy score that ranges from 0 to 1. The score rises as the number of inadequacies in the household rises, reaching a maximum of 1 if a household fails to meet all ten criteria. A household with a C_i score of 0 has no adequate on any of the indicators. C_i is computed as,

$$C_i = w_1 I_1 + w_2 I_2 + ... + w_d I_d \qquad (11)$$

Where $I_i = 1$ for a household with inadequate achievement in indicator i and $I_i = 0$ if otherwise, and w_i is indicator i weight with $\sum_{i=1}^{d} w_i = 1$.

The disempowered are identified using another cut-off. The disempowerment cut-off, represented by k, is the proportion of inadequacies that a woman must have to be termed disempowered. Those whose inadequacy score is less than or equal to the disempowerment cut-off, k, are replaced by 0, and any existing inadequacies are not taken into account in the "censored headcounts." This is "censoring the empowered inadequacies". We use $C_i(kk)$ for the censored inadequacy score to distinguish it from the original inadequacy score. It is worth noting that if $C_i > k$, $C_i(k) = C_i$, but if $C_i \leq k$, $C_i(k) = 0$. Compared to Alkire and Foster (2011) where the

cut-off ($C_i > k$) was weak; in this study, the disempowerment cut-off in computing the WEAI is defined as strict ($C_i > k$).

M_0 combines two main indicators: (1) the percentage of households (within a population) with weighted inadequacies greater than *k*, and (2) the degree of inadequacies – the average percentage of (weighted) inadequacies, following the structure of Alkire and Foster (2011)'s Adjusted Headcount measure.

The *f* disempowered headcount ratio (Hp) is the first component and is calculated as:

$$H_p = \frac{q}{n} \tag{12}$$

Here, *q* is the number of households that are disempowered and *n* is the total number of persons. The degree of disempowerment (A_p) is the second component and is the average inadequacy score of disempowered households. The number of disempowered households is *q*, and the total population is n. The intensity of disempowerment is the second factor (Ap) and is the average inadequacy score of disempowered households. It is written as:

$$A_p = \frac{\sum_{i=1}^{n} C_i(k)}{q} \tag{13}$$

Where $C_i(k)$ is the censored inadequacy score of households *i* and *q* is the number of disempowered households.

$$M_O = H_p \times A_p \quad (14)$$

Finally, 5DE is computed as:

$$5DE = 1 - M_o \quad (15)$$

The 5DE is also computed as:

$$5DE = H_e + H_p \times A_e \quad (16)$$

Where H_e represents the empowered headcount ratio (1 – *Hp*) and A_e represents the average adequacy score of disempowered households (1 – A_p). Thus, increasing the percentage of empowered women or boosting the adequacy scores of those women who are not yet empowered can improve the 5DE score.

A greater disempowerment cut-off indicates fewer disempowered women households, resulting in a higher empowered headcount ratio and 5DE. The empowerment cut-off, according to Alkire et al. (2012), is equal to 80 percent disempowerment. We have explained identification in this study using a disempowerment cut-off. This is the same as stating that a woman is empowered if she meets or exceeds 80 percent of the criteria. Knowing that the WEAI's main tenacity is to track adjustment in the empowerment of women, it is critical to define a disempowerment cut-off with reasonable room for enhancement. A higher cut-off could lead to very few persons being viewed as disempowered (and possibly limited possibility for upgrading). A lower cut-off could imply that empowerment is very easy to attain, resulting in an indicator with little possibility for upgrading. The study used the disempowerment cut-off of 20% after examining the sensitivity

of the empowerment categorization for various cut-offs. If a woman's inadequacy score is more than 20%, she is disempowered in her household. This is equivalent to declaring that a person is empowered in 5DE if she has acceptable achievements in four of the five domains, adequacy in some combination of weighted indicators totaling 80% or more, or an adequacy score of 80 or higher. The capacity to be broken into sub-groups based on the sampling design is a key characteristic of the 5DE and the M_0 (Alkire et al., 2012).

The Gender Parity Index (GPI) is the WEAI's second component, and it evaluates the percentage of women who have gender parity as well as the disparity in women's and men's empowerment within households that must be closed to attain gender equality. The GPI, according to Alkire et al. (2011), integrates two important aspects of women's empowerment. These are the proportion of women without empowerment or gender parity in comparison to their male counterparts, and the severity of the imbalance between these women and the men with whom they live. The fraction of households with insufficient gender parity is defined by the first component (H_{GPI}):

$$H_{GPI} = \frac{h}{m} \tag{17}$$

h represents the number of households without gender parity and m represents the number of dual-adult households.

The second component is formally known as the average empowerment gap; it is the average difference between the censored insufficiency scores of women and men living in households with gender parity (*IGPI*):

The average empowerment gap (*IGPI*) is the difference in censored inadequacy scores between men and women living in households where there is no gender parity. The average empowerment gap (*IGPI*) is the difference in censored inadequacies scores between men and women living in households where gender parity is lacking.

$$I_{GPI} = \frac{1}{h}\sum_{j=1}^{h}\frac{C'j(k)^{w} - C'j(k)^{M}}{1 - C'j(k)^{M}} \tag{18}$$

where $c'j(k)W$ and $c'j(k)M$ are the censored inadequacy scores of the primary woman and man, respectively in household j, and h is the number of households without gender parity.

Mathematically, GPI is calculated using equation (19).

$$GPI = 1 - (H_{GPI} \times I_{GPI}) \tag{19}$$

The GPI score can thus be improved by rising the proportion of women with gender parity (lowering the H_{GPI}) or closing the empowerment gap between males and females (reducing I_{GPI}). The GPI is a 0-to-1 ratio. The greater the gender parity in a household, the higher the GPI score.

The 5DE and GPI sub-indices have 90 percent and 10 percent weightings, respectively. WEAI is calculated using equation (21), which is based on the weighted averages of 5DE and GPI.

$$WEAI = 0.9(5DE) + 0.1(GPI) \quad (20)$$

The 5DE, GPI, and WEAI scores range between 0 and 1. The higher the score, the higher the empowerment of women in the household; and the lower the score, the lower the empowerment of women. Table 4.1 presents the weights of indicators of the 5DEs used in computing the WEAI.

Table 4.1: Weights of indicators of the 5DE in the WEAI

Domain	Indicator	Weight
Production	Inputs in a decision on production	1/10
	Production autonomy	1/10
Resources	Ownership of assets	1/15
	Purchase, sales and transfer of assets	1/15
	Access to and decision on credit	1/15
Income	Control over income utilization	1/5
Leadership	Membership with group	1/10
	Public speaking	1/10
Time	Workload	1/10
	Leisure	1/10

Source: Adapted from Alkire et al. (2012)

4.8.3.2 Food and Nutrition Security

There is no uniform approach for measuring food and nutrition security because it is complex and multidimensional (Pinstrup-Andersen, 2009). To ensure that all six food security dimensions are represented in the measurement of food security, this study uses three methodologies: Household Hunger Scale (HHS), Minimum Dietary Diversity for Women (MDD_W), and Household Food Expenditure Share (HFES).

Household Food Expenditure Share (HFES)

The HFES is the proportion of a household's total consumption expenditure spent on food within a given period. The expenditure on food is a component of the total household consumption expenditure. According to the INDDEX (2018), HFES is computed as:

$$HFES(\%) = \frac{Expenditure\ on\ food\ for\ time\ i}{Total\ household\ expenditure\ for\ time\ i} \times 100 \qquad (21)$$

Households that spend a high proportion of their income on food are more likely to be food insecure, especially during price increases (Smith & Subandoro, 2007). Because the majority of residents in the research region are subsistence farmers, engagement in climate change interventions is likely to affect household food consumption. The food gap/deficit is a subjective indicator of food security that denotes the number of months in the previous 12 months when a household was unable to meet its food demands due to the exhaustion of its food stockpiles or an inadequate financial resource to purchase food. The months of insufficient household food provisioning (MIHFP) is another name for this metric (Bilinsky &

Swindale, 2005). Rainfall is highly unpredictable in the study location (Northern Ghana), and farming is primarily rain-fed. This study adapted Smith and Subandoro (2007) classification of food expenditure share to categorize households' level of food security (see Table 4.2).

Table 4.2: Categorization of Household Food Expenditure Share

Household Food Expenditure Share (%)	Level of Food Security
> 75	Extremely food insecure
65 ≤ HFES ≤ 75	Highly food insecure
50 ≤ HFES < 65	Medium food insecure
< 50	Low food insecure

Source: Smith and Subandoro (2007)

Households were further categorized into food secure and food insecure using their food expenditure share. Households with a food expenditure share of above 50 percent (medium, high, and extreme food insecurity) were categorized as food insecure while households with less than 50 percent of food expenditure share were categorized (low food insecurity) as food secure.

Household Hunger Scale

Another perception-based measure of food insecurity used was the HHS and is best used in places where food insecurity is high, such as Northern Ghana (Ballard et al. 2011). The HHS is a subset of USAID's Food and Nutrition Technical Assistance (FANTA) project's Household Food Insecurity Access Scale (HFIAS). In contrast to the HFIAS, the HHS has been cross-culturally verified (Ballard et al. 2011). The

HHS is based on three questions and is connected to the food access dimension of food security. That is, how many times in the last 30 days: 1) was there no food in the house; 2) did a member of the household go to bed hungry; and 3) did a member of the household go a complete day without eating? 0 = never, 1 = once or twice, 2 = once a month, 3 = a few times a month, 4 = roughly once a week, 5 = a few times a week, and 6 = every day were the codes for each question. The HHS score is calculated by taking the average of these responses from households, which runs from 0 (no hunger) to 6 (extreme hunger) (severe hunger). Thus, the HHS was first measured as a continuous variable ranging from 0 to 6 (following Akbar et al, 2020). The HHS was further categorized into levels of food security (Nkegbe et al., 2017) as presented in Table 4.3.

Table 4.3: Categorization of Households' Hunger Scale

HHS Score	**Household's level/category of Food security**
0 – 1	Little to no hunger
2 – 3	Moderate hunger
4 – 6	Severe hunger

Source: Ballard et al., (2011): Food and Nutrition Technical Assistance Project III

The HHS was used to further categorize households into food secure and food insecure. Households who experienced little to no hunger were deemed to be food secure while households experiencing moderate to severe hunger were categorized as food insecure. The household survey was conducted between June and August in both the baseline and end-line surveys. These periods fall within the peak period of the lean season in Northern Ghana when food has either not been planted or planted

but not harvested yet, therefore, a suitable time to apply the HHS as a measure of severe food insecurity level.

Minimum Dietary Diversity for Women

The dietary diversity indicator is a proxy for measuring households' food access, utilization, and nutrition security was measured using the Minimum Dietary Diversity for Women (MDD_W). The MDD_W examines if possible enhancement in food production or income of households as a result of participation in climate change interventions translates into higher quality nutritious diets for households. The MDD_W bothers on the consumption of 12 food groups by women in a household aged 15 to 49 years during the past 24 hours (Swindale and Bilinsky 2006). The food groups include: 1. Grains (cereals, bread, rice, and pasta) 2. Roots and/or tubers (potatoes) 3. Vegetables 4. Fruits 5. Dairy and/or eggs 6. Meat and/or fish seafood 7. Nuts and/or legumes (and/or derivatives, tofu, etc) 8. Milk and milk products 9. Oil/fats 10. Sugar/honey 11. Meat/poultry/offal 12. Miscellaneous. In computing the MDD_W at the household level, the number of food groups consumed by women aged 15 to 49 years within the households were divided by the total number of food groups (12). This is shown in the equation below.

$$DDS_w = \frac{Number\ of\ food\ groups\ consumed\ by\ women\ aged\ 15\ to\ 49\ years\ in\ household\ i}{Total\ number\ of\ food\ groups(12)} \quad (22)$$

The MDD_W is a fraction and ranges between 0 (no food group consumed) to 1 (all 12 food groups consumed). A household that consumed at least 6 out of the 12 food groups ($DDS_w \geq 0.5$) was considered to have an adequate balance diet, hence, food

secure while households that consumed less than 6 out of the 12 food groups (DDS_w < 0.5) were considered to have an inadequate balance diet, hence, food insecure. It is assumed that the more food groups consumed by women in a household, the more dietary diversity and hence, the more the household is food secure.

Swindale & Bilinsky (2006) argue that during data collection, enumerators ensured that no exceptional events, such as funerals or fasting, had occurred within the sample households in the previous 24 hours, which could have influenced their food consumption pattern. Thus, the MDD_W is a ratio ranging from zero (for households consuming no food) to 12 (for households consuming at least one food in all 12 food groups). The more food groups consumed by women in a household, the more diversified their dietary and hence, the more they are food secure. In this study, MDD_W was first measured as a continuous variable using a scale of 0 to 12. In the second scenario, it was measured as a categorical variable with women in households consuming at least 6 out of the 12 food groups deemed to be food secure households while households with women who could not consume at least 6 out of the 12 food groups were categorized as food insecure.

4.8.3.3 Household Consumption Expenditure

Although welfare can be measured using household income, consumption expenditure is frequently more dependable and preferred since it is less susceptible to periodic variations and measurement errors (Deaton, 1997). Household participation in climate change interventions is projected to boost household yields or outputs, resulting in greater consumption of farm products or higher income

from product sales for consumption of other items in this study. Participation in climate change measures may potentially cause changes in consumption expenditure due to resource allocation effects.

Households' expenditures on food, housing, transport, energy, communication, health, and educational expenses, expenditures on various consumer durables and non-durables, and household transfer payments are all part of the consumption expenditure. The value of household consumption was calculated using purchases, home production, and all items received in kind, according to the survey questionnaire. The non-purchased items were valued at market price in the area. For food expenditure, a 7-day recall time was employed, followed by a 30-day recall period for similar acquired items or services and non-durable goods, and a 12-month recall period for durable things and transfer payments. The individual sub-components were combined to obtain total household consumption spending, expressed per annum after all the recall durations were standardized to one year.

4.8.4 Independent Variables Used in the Multinomial Endogenous Treatment Regression Model

Access to Credit

This is access to either financial or input credit by farm households. Access to credit is expected to have a positive effect on households' participation in interventions, women empowerment, food security, and wellbeing (Chirwa et al., 2017).

Access to Market

This is access to input and/or output market to buy farm input or sell agricultural produce. Access to the market is hypothesized to have a positive effect on households' participation (Chirwa et al., 2017)

Membership with Groups

Being an active member of a group also influences households' participation in interventions. Group membership (farmer-based organisations, forest groups, and other groups) is expected to have a positive effect on farmers' participation in climate change intervention (Narayan and Pritchett, 1999; Isham, 2002; Kassie et al., 2013; Manda et al., 2015).

Farm Income (Crop Revenue):

In Northern Ghana, maize is a stable crop and most farmers rather use maize produce for domestic consumption and sell other cash crops such as rice, soybeans, yam, and cassava, among others. Higher revenue generated from the sales of farm produce can be used to purchase more farm inputs, other foodstuffs, and household needs. Thus, income accruing to households from the sales of farm produce is expected to have a positive effect on women's empowerment (Dinada et al., 2019), food security, and welfare.

Off-farm Employment:

This includes other households' income-generation activities outside the farm. Engagement in off-farm activities diversifies households' income and is expected to increase women's empowerment (Maligaliga et al., 2019), food security, and

welfare (Mahama and Nkegbe, 2021; Danso-Abbeam et al., 2020; Martin and Lorenzen, 2016). However, Akukwe (2020) reported that off-farm income increases households' food expenditure, though not significantly.

Education:

The effect of formal education on participation in climate change interventions can be positive (Abdallah et al., 2021; Nigussie et al., 2017) or negative (Etwire et., 2013b; Martey et al., 2013, Martey et al., 2012; Daxini et al., 2018) depending on the target group or objectives of the intervention. It is expected that educated women will have more knowledge and skills, hence will be more empowered than uneducated women (Abbas et al., 2021; Didana, 2019; Amanuel et.al., 2016; Alkire et al., 2012; Aregu et al., 2017; Cinar and Kose, 2018; Khalid, 2014; and Njega 2015). Education is expected to have a positive effect on women's empowerment and food security (Akukwe, 2020).

Household Size:

The effect of household size on food security is mixed in the literature. Some studies reported a positive effect (Akbar, 2020) whiles others reported a negative effect on food insecurity (Chirwa et al., 2017).

Dependency Ratio:

A higher dependency ratio is expected to have a positive effect on households' food insecurity (Akukwe, 2020).

Female Population:

The proportion of household members who are female is expected to have a positive effect on women's empowerment (Assaad et al., 2014).

Access to Information/Awareness:

Access to information is hypothesized to have a positive effect on women's empowerment (Didana, 2019), and their participation in decision-making (Vaughan and Dessai, 2014; Singh et al., 2016; Mapanje et al., 2020, Oduniyini and Tekana, 2021).

Age of Household Head:

The age of the household head can have either a positive effect (Chirwa et al., 2017; Lambongang et al., 2019; Asante et al., 2014; Anang, 2019) or a negative effect (Martey, et al., 2013, 2014; Sithole et al., 2014; Zakaria et al., 2020; Arytal et al., 2018) on households' participation in climate change interventions.

Sex of Household Head:

The sex variable reflects the difference in the likelihood of households' participation in climate change interventions between male-headed and female-headed households. The effect of household head sex on participation in climate change interventions can either be positive (Lambongang et al., 2019; Etwire et al., 2013b; Tesfaye et al., 2016) or negative (Abdallah et al., 2021; Anang et al., 2020; Anang and Asante, 2020; Mabe et al., 2018). Female-headed households do not often participate in the agricultural programme due to household chores (Martey et al., 2013) and the lack of strategic programmes targeted at women's inclusion in

developmental interventions (Mabe et al., 2018). The heading of households by females is expected to influence women's empowerment positively (Assaad et al., 2014).

Participation in Decision-Making:

This is the household's head stake in decisions taken by the community. Respondents who participate in decision-making are expected to positively influence households' participation in climate change interventions more than respondents who do not participate in households' decision-making (Martey et al., 2014; Samaddar et al., 2019; Hiwasaki et al., 2015; Okada et al., 2013).

Type of Location/Location:

Cultural practices vary across space (location) and depending on the geographical location and level of urbanisation, could have a positive or negative effect on women's empowerment, food security, and consumption expenditure (Abbas et al., 2021; Sell and Minot, 2018).

Perceived Effectiveness:

The expectation is that farm households will participate in an intervention if they think the programme will improve their livelihoods than if they perceive the intervention to be ineffective (Kwon et al., 2019; Manda et al., 2016; Drews and van den Bergh, 2016).

Table 4.4: Description and measurement of Independent Variables Used in the METRM

Variable	Measurement	A prior expectation			
		Participation	Women empowerment	Welfare	Food security
Participation	Categorical: 0 =non-participant, 1 = only gov't, 2 = only NGO, 3 = Both gov't & NGO	N/A	+	+	+
Access to credit	Dummy: 1 = yes, 0 = otherwise	N/A	+	+	+
Access to market	Dummy: 1 = yes, 0 = otherwise	+	+	+	+
Group membership	FBO (yes =1/No =0), forest group (yes =1/No =0), multiple groups (yes =1/No =0)	+	N/A	N/A	N/A
Engagement in off-farm activities	Dummy: 1 = yes, 0 = otherwise	N/A	N/A	+	+
Sex*Engagement in off-farm activities	Dummy: 1 = yes, 0 = otherwise	N/A	+	N/A	N/A
Sex of HHH	Dummy: 1 = female, 0 = male	-/+	-/+	-/+	-/+
Age of HHH	Years	-/+	N/A	N/A	N/A
Marital status	Dummy: 1 = married, 0 = otherwise	-/+	-/+	-/+	-/+
Education	Years	-/+	N/A	N/A	N/A
Sex*Education	Years	N/A	+	N/A	N/A
Crop revenue	GHS	N/A	N/A	+	+
Sex*crop revenue	GHS	N/A	+	N/A	N/A
HH female population	%	N/A	+	N/A	N/A
Perceived effectiveness	Dummy: 1 = effective, 0 = otherwise	+	N/A	N/A	N/A
Dependency ratio	Ratio	N/A	N/A	-	-
Decision maker	Dummy: 1 = male, 0 = otherwise	+	N/A	N/A	N/A
Type of locality	Dummy: 1 = urban, 0 = otherwise	N/A	+	+	+
Access to information	Dummy: 1 = yes, 0 = otherwise	+	N/A	N/A	N/A

CHAPTER FIVE

RESULTS AND DISCUSSIONS

COHERENCE OF CLIMATE CHANGE INTERVENTIONS WITH SUSTAINABLE DEVELOPMENT GOALS

5.1 Introduction

Chapters Five to Eight present results and discussions on the study objectives. This Chapter presents the results and discussions of the coherence of climate change interventions with selected Sustainable Development Goals. Sections 5.2, 5.3, and 5.4 of this chapter present results and discussions on the activities of climate change interventions, the perceived effectiveness of climate change interventions, and their coherence with the SDGs respectively.

5.2 Climate Change Interventions by Government and NGOs in Northern Ghana

To examine the coherence of climate change interventions with SDGs, the activities of climate change interventions of both governmental and non-governmental interventions toward achieving the SDGs were examined. The study revealed that most interventions had a component of training farmers on climate-smart agricultural practices (CSAPs) with 85 percent of NGO interventions having these components in their project activities compared to 67 percent of government projects. Also, about 72 percent of NGO interventions were into sensitization and advocacy activities relative to 41 percent of government interventions. Capacity building of farmers through training on climate change adaptation activities is critical when analysing the coherence of climate change interventions with SDGs.

For instance, training mostly demonstrates to farmers the climate change pattern and how it affects agricultural land and environmental qualities. Farmers learn to have in-depth knowledge and skills on the effects of severe drought, flood, bushfires, rain variability, and adaptation strategies to climate change through training.

The significant role of training in fighting climate change and its impact on farm productivity and food insecurity made it a top priority for both governmental and non-governmental organizations in Northern Ghana. Similarly, farmers' awareness of the degree of climate change's impact on agriculture and food systems is achieved via training in various capacity-building programmes (Climate-ADAPT, 2019). Training farmers to build their awareness of climate change and its impact on agriculture and food systems which assists farmers to develop a practical knowledge of identifying climate change adaptation strategies. It also provides practical skills to assess risks and opportunities in the face of climate change (GIZ, 2013; Karki et al., 2021).

Results further revealed that about 52 percent of NGOs' interventions are in the dissemination of climate information to farmers compared to 41 percent of government interventions. Thus, there are more NGO interventions providing information on local-level climate to farmers than government interventions. It was gathered during focus group discussions and key informant interviews that the information provided to farmers includes expected start and end dates of rains, daily updates on rains and temperature, and also when to and not to plant. These

climate information services have been useful to farmers in planning their seasonal farming calendar given that farming in northern Ghana is mono-seasonal and highly rain-fed. The importance of climate information to farmers has been stressed by Popoola et al. (2020) who reported that farmers in rural areas access climate information to cope and adapt to the impact of climate change through donor-funded agricultural projects than government-initiated programs. The reason had been that most NGOs motivate their extension agents through incentives such as fuel and motorbikes to reach out to farmers regularly for community outreach programmes. The result is also consistent with Moser & Ekstrom (2010) and Mwingira et al. (2011).

Turning to farm input delivery to farmers, results indicate that more NGO interventions (62%) assisted farmers with farm inputs than government interventions (56%). The farm inputs from government interventions are mainly inorganic fertilizers and seeds. On the other hand, in addition to inorganic fertilizers and improved or certified seeds, NGO interventions assisted beneficiary farmers with weedicides, and pesticides and also conduct soil tests of farmlands of beneficiary farmers to determine the components and level of nutrients in the soil. This was to determine the type and amount of inorganic fertilizer needed to augment soil productivity. This finding confirms Adu et al (2018) who reported that over 80 percent of agricultural interventions implemented in Northern Ghana between 2006 and 2016 focused on farm inputs delivery to farmers to improve productivity.

Also, results indicate that more NGO interventions (59%) linked farmers to both inputs and output markets than government interventions (34%). Thus, aside from delivering farm inputs to farmers, most NGO interventions often have input dealers whom beneficiary farmers are linked to access farm inputs such as ploughing, harrowing, and fertilizer. Noticing the lack of buyers of agricultural produce, most interventions (especially NGOs) linked farmers to agricultural produce-buying companies to provide a ready market for their produce. This is consistent with Adu et al. (2018) who reported that about 42 percent of governmental and non-governmental interventions in Northern Ghana assisted beneficiary farmers to access the market for their agricultural outputs.

Results of the study further revealed that NGO interventions were more into agro-processing (35%), afforestation (45%), and income diversification (43%) than governmental interventions. However, less than 30 percent of both governmental and NGO interventions assisted beneficiaries with direct financial support and livestock rearing in the study area. This is consistent with Pilato et al. (2018) who reported that NGO interventions embark more on livelihood diversification and climate change mitigation activities such as afforestation because they have access to external donor support than the government. The finding also confirms Naab et al. (2019) who revealed that government policies on climate change provided limited activities compared to NGO interventions. Figure 5.1 presents the results of climate change intervention activities of governments and NGOs.

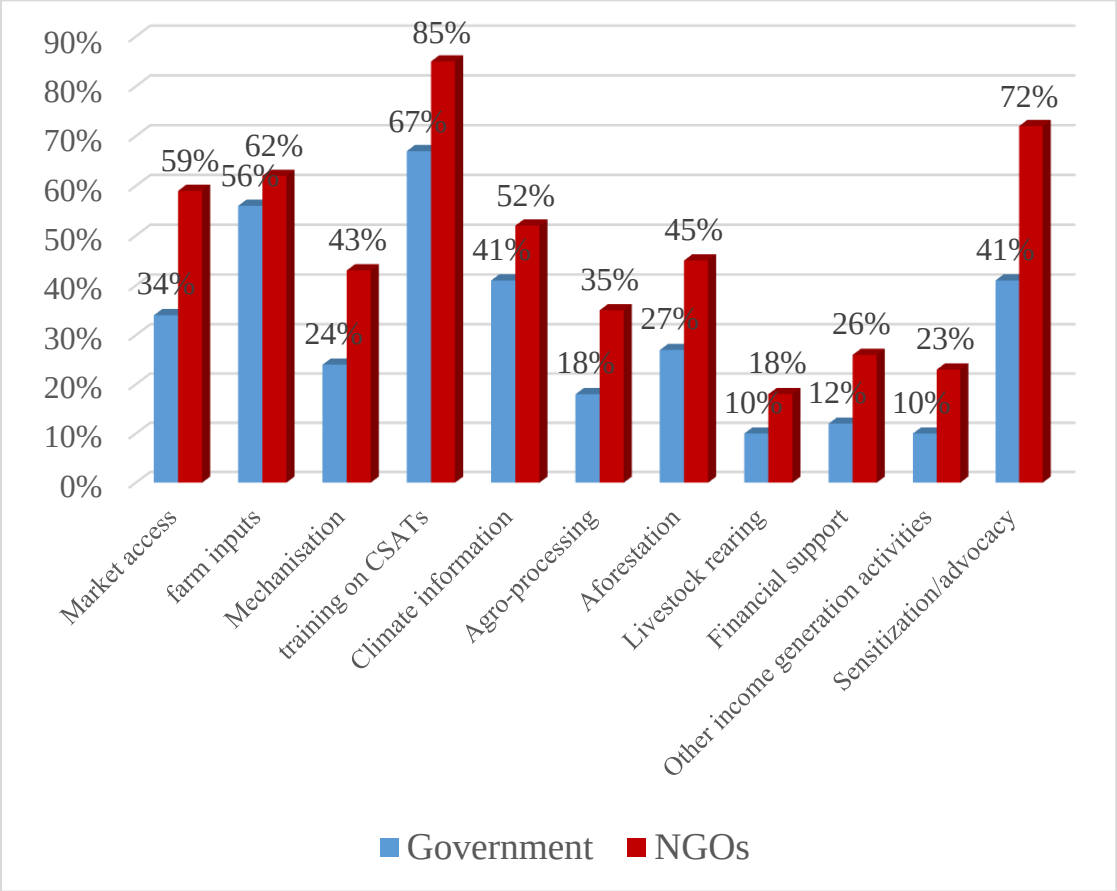

Figure 5.1: Climate Change Interventions by Governments and NGOs

Source: Author's Analysis of Field Data, 2021

5.3 Perceived Effectiveness of Government and NGOs' Climate Change Interventions

The effectiveness of government and NGO climate change interventions in achieving programme objectives (climate change mitigation and adaptation and improved productivity) was examined by interviewing key informants and farm household heads on their perceptions of the effectiveness of delivering programme activities. Results showed that about 95 percent of key informants and 85 percent of farm households perceived NGO interventions to be more effective in their

implementing project activities or achieving project objectives. The reasons for NGOs' effectiveness could be attributed to the need to meet donor expectations for further funding; effective community mobilization (trust from the community), effective monitoring and supervision, effective collaboration with state institutions, linking farmers to farm inputs and outputs markets, and implementation of social interventions.

However, only 10 percent of key informants and 21 percent of household heads perceived government interventions to be effective in implementing its' project activities or achieving project objectives. Most key informants with governmental organizations accepted that NGOs' interventions are more effective in achieving objectives than government interventions. The mean ranks show that both households and key informants perceived NGO interventions to be more effective in achieving project objectives than government interventions. The Kendall's Coefficient of Concordance results show 81.2 percent and 65.7 percent significant agreements among households and key informants respectively in ranking the effectiveness of interventions (Table 5.1). On the other hand, the results of the two –sample *t*–test show significant differences in both households' and key informants' perceptions of the effectiveness of NGO and government interventions (Table 5.1). The reasons for the poor effectiveness of government interventions in implementing project activities included change in government, poor supervision, poor monitoring and evaluation framework, poor extension service provision, no innovativeness, and bureaucracy. Figure 5.2 presents result of respondents' perceived effectiveness of governmental and NGO climate change interventions.

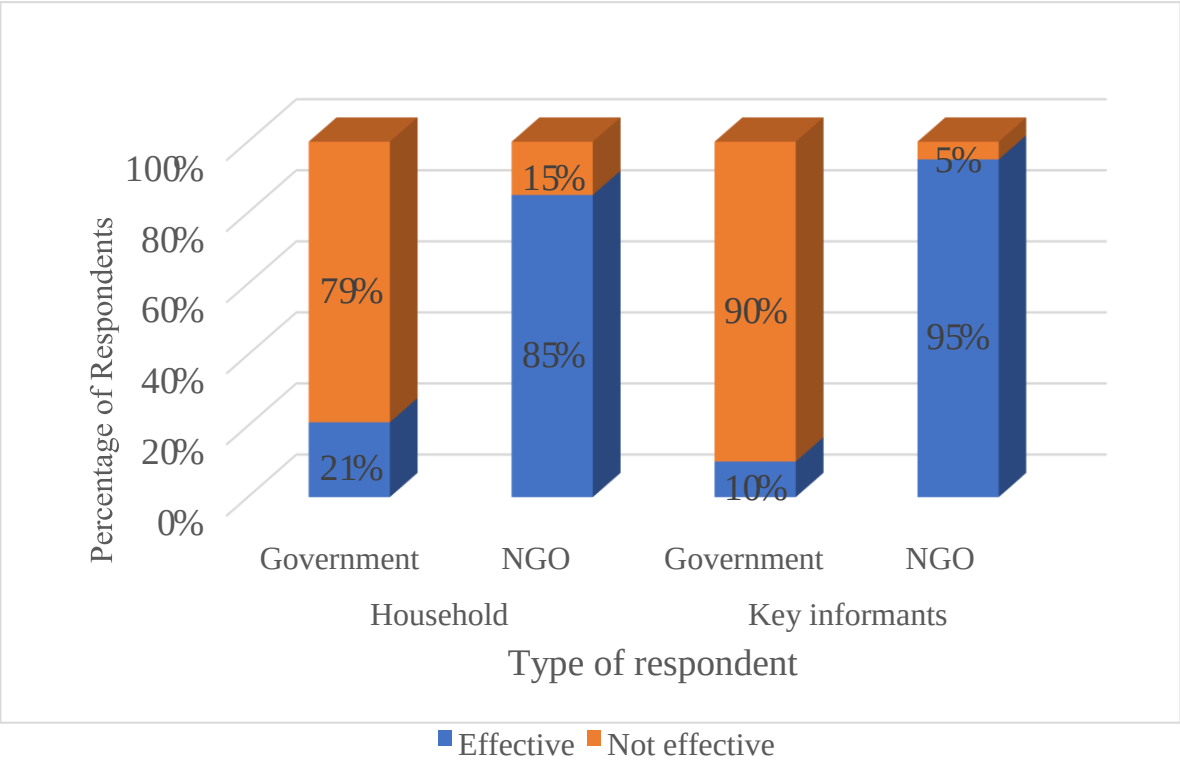

Figure 5.2: Perceived Effectiveness of Climate Change Interventions

Source: Author's analysis of field data, 2021

Table 5.1: Kendall's Results on Ranking of Interventions' Effectiveness

Source of Intervention	**Households**		**Key Informants**	
	Mean rank	**Rank**	**Mean rank**	**Rank**
NGO	2.23	1st	1.90	1st
Government	4.05	2nd	3.81	2nd
Kendall's Test Statistics				
Number of observations	4353		53	
Kendall's W	0.812		0.657	
Chi-Square	491.118***		936.916***	
Asymptotic Significance	0.000		0.003	
Two sample *t* - test				
t – value	9.238***		3.667***	
P – value	0.000		0.004	

Note: *** denotes statistically significant at 1%

Source: Authors' Analysis of Field Data, 2021

5.4 Coherence of Climate Change Interventions with SDGs

Climate change interventions implemented by both government and NGOs were scrutinized to determine their contribution towards achieving selected SDGs. To ascertain the coherence of climate change interventions with the SDGs, this objective examined the extent to which interventions objectives and operations of the sampled government and NGO interventions are in tandem with the themes or sub-objectives of the selected SDGs (SDG 1 – poverty, SDG 2 – end hunger, SDG 5 – gender equality and women empowerment, and SDG 13 – climate action). Reviews and assessments of climate change intervention documents found that almost 90 percent of both government and NGO interventions have objectives and activities directed towards the achievements of SDG 13 (climate action). This confirms my initial findings that activities of most interventions included training beneficiaries on climate-smart agricultural practices, providing climate information services to farmers, and sensitizations of farmers to adapt to climate change.

Following the work of Louman et al (2019), SDG 13 can be effectively achieved if programmes and projects aimed at (1) building and strengthening agricultural resilience and adaptive capacity, (2) providing a platform to integrate climate change measures into national policies, strategies, and planning, (3) enhancing education, awareness-creation, and people and organizational capacity building, (4) implement the green climate fund fully via its capitalization of USD 100 billion per annum, and (5) full support for less developing economies focusing on women and youth in the marginalized rural communities. At the global level, FAO leads and participates in multisystem agencies to foster climate action in agriculture and food

systems. It is stated in the literature that about 70 percent of national-level planning frameworks focus on SDG 13 while 60 percent of local and international evaluation reports identified climate-smart agriculture as the most significant initiative toward achieving climate action (FAO, 2021).

Further analysis revealed that about 84 percent of NGO interventions have activities and/or objectives geared toward poverty reduction and hence, contributing to the achievement of SDG 1 (zero poverty) compared to 72 percent of government interventions. Though the study revealed that activities of both government and NGO intervention are tailored towards reducing poverty, the World Bank (2020) Ghana poverty assessment report revealed that poverty levels, gaps, and severity in the five northern regions are increasing. The finding of this study confirms Bicaba et al. (2015) who reported high poverty levels in less developed countries especially where there are conflicts and political instability. It has been predicted that extreme poverty is expected to increase astronomically by 2030 if there is no social shift policy (United Nations, 2019). In 2020, poverty levels increased by about 7 percent as a result of the ongoing COVID-19 pandemic (BMGF, 2020).

The study further revealed that about 82 percent of NGOs' climate change interventions have project objectives or activities aimed at reducing hunger and food insecurity, hence, coherent with SDG 2 (end hunger) relative to 65 percent of government interventions. Notwithstanding, about 88 percent of NGOs' interventions contained project objectives or implemented activities aimed at

promoting gender equality and women empowerment relative to 55 percent of government interventions. Thus, the results showed that about 88 percent of NGO intervention objectives and activities are coherent with SDG 5 (gender equality and women empowerment) compared to 55 percent of government interventions. The findings on government interventions' coherence with gender equality are consistent with Mabe et al. (2018) who reported that most government-led interventions in Northern Ghana had no women inclusion strategy to promote women's participation in agricultural programmes and decision-making. On the other hand, the findings on NGO interventions' coherence with gender equality are consistent with Matsvai (2018) who found that most NGO interventions in Zimbabwe promoted women's participation in economic activities as a way of empowering women, hence contributing to the achievement of SDG 5. The radar diagram, presented in Figure 5.3 shows the coherence of government and NGO interventions with selected SDGs.

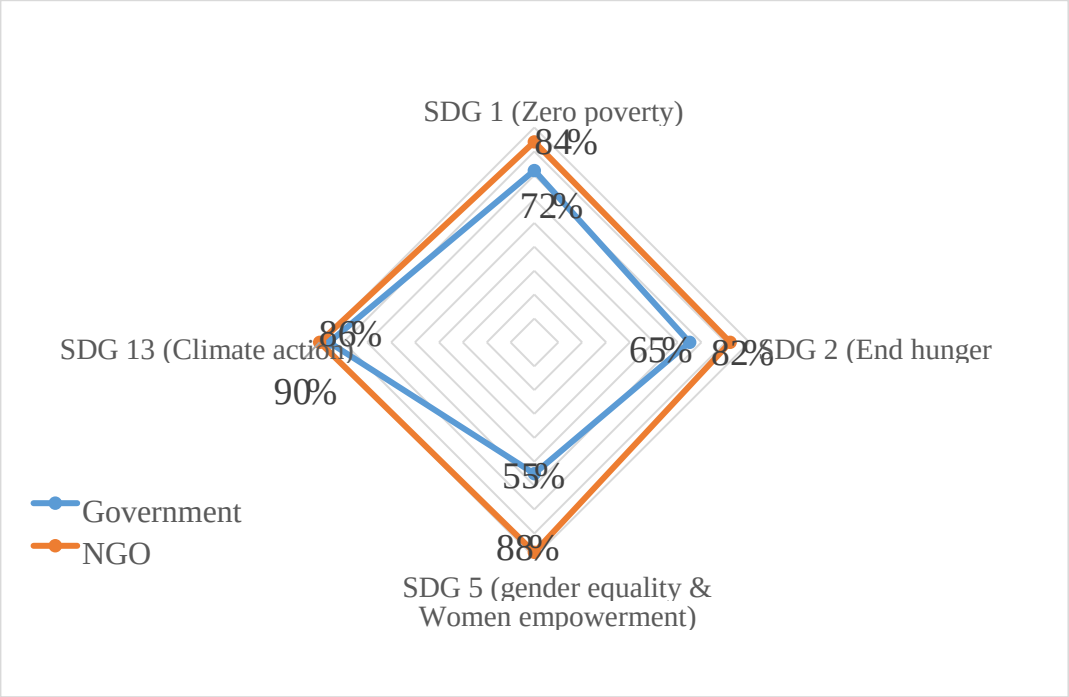

Figure 5.3: Coherence of Climate Change Interventions in Northern Ghana with Selected SDGs

Source: Author's analysis of field data, 2021

CHAPTER SIX

FACTORS INFLUENCING HOUSEHOLDS' PARTICIPATION IN CLIMATE CHANGE INTERVENTIONS

6.1 Introduction

This Chapter presents the results and discussions of factors influencing farm households' participation in climate change interventions. It begins with the socio-demographic characteristics of respondents, and tests of the robustness of the METE model and ends with results and discussions on determinants of households' participation in climate change interventions. The chapter ends with the conclusions from the study results.

The analysis of the socio-demographic characteristics of respondents considered in the study included both categorical and continuous variables. Beginning with categorical socio-demographic features of respondents, out of 8,707 respondents, about 2,987 (34.3%) and 2,970 (34.11%) respondents participated in only NGO and government interventions respectively while 981 (11.27%) participated in both NGO and government interventions. The remaining 1,769 respondents (20.32%) did not participate in any NGO or government interventions considered for this study. The non-participant households served as the control group while respondents who participated in only NGO, only government, and both NGO and government were the treatment groups. The non-participants were selected from both project intervention (beneficiary) and non-project intervention (non-beneficiary) communities to serve as counterfactuals for the treated groups.

The results (Table 6.1) suggest that the majority of the respondents or farm households (79.68%) participated in either only government interventions or only NGO interventions or both. The reason for the high participation in climate change intervention could be attributed to the high coverage of government interventions since the government has the responsibility of reaching every community with its interventions. A high rate of participation in climate change interventions implies that more households have the opportunity to access interventions activities such as climate information, farm inputs, market, training on climate-smart agricultural technologies, sensitization/advocacy, mechanization, financial support, livelihood diversification, agro-processing and afforestation which could improve livelihood outcomes of farm households.

The study revealed that access to credit among respondents has been low with less than 8 percent of non-participants (7.2%) and participants in only NGO (6.1%), only government (6.9%), and both NGO and government interventions (7.0%) households reported having access to credit. Access to credit included both input and financial credit to farm households with beneficiaries having to pay back after harvest. The reason for the low access to credit among participant households could be that most interventions use demonstration sites to train beneficiaries on new technologies and later provide starter packs to farmers for free without beneficiaries paying back.

Access to the output market was low among non-participants (21.7%) and participants in only government interventions (23.8%) compared to participants in

only NGO interventions (58.4) and both NGO and government interventions (64.8%). Some interventions especially NGOs linked farmers to aggregators and crop-buying companies who could buy the farm produce of beneficiary farming households. This finding suggests participant farmers have more access to output markets than non-participant farming households.

Furthermore, respondents' membership with groups (e.g., FBO, civic groups, forest groups, etc.) provides social capital to enhance participation in NGO and/or government climate change interventions and also improve the livelihoods of members. Respondents' membership with forest groups, farmer-based organisations, and civic groups was considered. The fourth category was respondents who belong to multiple groups. The results revealed that membership with forest groups is low among both non-participant and participant households with only 12 non-participant households (1.2%) and less than 3 percent of households who participated in only NGO, only government, and both NGO and government intervention belonging to forest groups. Forest groups consist of people whose activities are geared towards restoring, protecting, and managing the forest within the community.

Membership with civic groups among respondents was also low with only 5.7 percent of participants in only government interventions, 6.7 percent of the participants in only NGO interventions, and 9.3 percent of participants in both NGO and government interventions reported being members of civic groups. Civic groups constitute members who have the aim of protecting the civil rights or

responsibility of members such as children and women abuse, demanding fair development for their communities, and ensuring accountability of community leaders.

Farmer-based organisations (FBOs) on the other hand consist of people whose main objective is to promote the farming activities of members. Members could share information, access farm inputs, and price quotations for agricultural produces, among other welfare issues of members. The results revealed that 23.3 percent of non-participant households and households that participated in only government interventions belong to FBOs. On the other hand, 26.5 percent of participants in only NGO interventions and 24.8 percent of participants in both NGO and government interventions are members of FBOs. Membership with social groups (such as FBOs, forests, and civic groups) can enhance households' participation in climate change interventions and/or improve women's empowerment, food security, or welfare. The results further indicate that 13.66 percent of farm households that participated in both NGO and government interventions belong to multiple groups while almost 3 percent of households that participated in only NGO or only government intervention belong to multiple groups.

The results showed that more farm households who participated in both NGO and government intervention (72.8%) engaged in off-farm activities than households that participated in only government interventions (56.2%), only NGO interventions (63.4%), and non-participant households (57.9). Engagement in off-farm activities is critical in providing alternative livelihoods to rain-fed agriculture-

dependent farm households, especially in Northern Ghana. The results revealed that whereas the majority of non-participant farm households (75.7%) and only government intervention participant farm households (80.6%) were headed by males, the majority of the households that participated in only NGO (58.1%) were headed by females. NGO interventions often target women more than government interventions (Mabe et al., 2018). However, the reason could be that most households in Northern Ghana are headed by males (GSS, 2021). In any case, the sex of the household head influences women's participation in climate change intervention, empowerment, and livelihoods of farming households due to access to productive resources and decision-making. The results further showed that most household heads of non-participant households (73.4%), households that participated in only government interventions (77.3%), and only NGO interventions (80.7%) were married compared to 48.4 percent of household heads from households that participated in both NGO and government interventions.

Three main sources of labour were considered: family, hired, and communal labour. The results showed that almost all farm households used family labour for their agricultural activities. Hired labour was used more by households that participated in interventions than non-participant households (15.2%). The results further showed that few farm households that participated in only government interventions used communal labour (10.6%) compared to non-participant households (20.0%), households that participated in only NGO interventions (23.6%), and households that participated in both government and NGO interventions (24.2%). Hired labour involves cost and households without financial

resources find it difficult to employ hired labour, but rely more on family labour or communal labour to carry out their agricultural activities. Access to labour is critical in farmers' participation in agricultural interventions and adoption of technologies especially those that are labour-demanding.

Access to information is a vital determinant of participation in climate change intervention and subsequently livelihood outcomes (women empowerment, food security, and consumption expenditure). The results revealed that only 16.96 percent of non-participant households have access to information on the existence of climate change interventions. However, access to information was high among households that participated in only NGO interventions (84.0%) and both NGO and government interventions (80.12%) than among households that participated in only government interventions (64.1%). Households' source of information on climate change interventions is mainly from peer farmers, social groups, or extension officers. Households with more information are more empowered and likely to participate in interventions than households without access to information.

Finally, the results showed that respondents from households that participated in only NGO interventions and both NGO and government interventions participated in household-level decisions more than respondents from non-participant households and only government intervention participant households. Household heads who participate in decision-making at the community level are more likely to participate in interventions. Table 6.1 presents descriptive statistics of categorical variables considered in the study.

Table 6.1: Descriptive Statistics of Categorical Independent Variables in the METE Regression Model

Variable	Interventions			
	Non-Participant	Only Gov't	Only NGOs	Both NGO & Gov't
Number of observations	1,769 (20.32)	2,970 (34.11)	2,987 (34.30)	981 (11.27)
Access to credit	54 (7.2)	70 (6.9)	59 (6.1)	247 (7.0)
Access to output market	163 (21.7)	242 (23.8)	564 (58.4)	2296 (64.8)
Group membership				
Forest group	12 (1.2)	13 (1.3)	23 (2.4)	81 (2.3)
FBO	175 (23.3)	238 (23.3)	256 (26.5)	243 (24.8)
Civic group	43 (5.7)	58 (5.7)	65 (6.7)	329 (9.3)
Multiple groups	10 (0.56)	98 (3.30)	101 (3.38)	134 (13.66)
Off-farm activities	555 (57.9)	699 (56.2)	651 (63.4)	2579 (72.8)
Sex of HHH				
Male	727 (75.7)	1003 (80.6)	472 (41.9)	2094 (59.1)
Female	234 (24.3)	241 (19.4)	655 (58.1)	1449 (40.9)
Marital status				
Married	706 (73.4)	956 (77.3)	905 (80.7)	1715 (48.4)
Others	252 (26.6)	282 (22.8)	217 (19.3)	1828 (51.6)
Source of labour				
Family	958 (100)	1198 (96.8)	1036 (92.3)	3472 (98.0)
Hired	146 (15.2)	413 (33.4)	463 (41.3)	1604 (45.3)
Communal	192 (20.0)	131 (10.6)	265 (23.6)	857 (24.2)
Access to information	300 (16.96)	1904 (64.10)	2,509 (84.0)	786 (80.12)
Participation in decision making	245 (13.85)	534 (17.98)	1,955 (65.45)	516 (52.60)

Note: Figures in parentheses are percentages

Source: Author's Analysis of field Data, 2021

Continuous independent variables considered in the regression models used in this study were also analysed using descriptive statistics. Though the mean age of respondents from non-participant households (38.7 years), households that

participated in only government interventions (41.2 years), only NGO interventions 39.4 years) and both NGOs and government interventions (40.7 years) are above the youth age limit of 35 years as indicated in the Ghana Youth Policy document (Ministry of Youth and Sports, 2010), the average ages of respondents are within the working age of 15 to 60 years. The Kruskal-Wallis test showed that the Chi^2 of 3.327 is not significant. This indicates that there is no significant difference in the ages of household heads between participant and non-participant households. Households that participated in only government interventions had the highest average household size of 6.4 persons than non-participant households (5.3), households that participated in only NGO interventions (5.1), and households that participated in both NGO and government interventions (5.6). However, the average household sizes for all four categories of households are higher than the national average household size of 3.6 (Ghana Statistical Service, 2021). Results of the Kruskal-Wallis test showed that the Chi^2 statistic of 60.387 was significant at 1 percent. This implies that there is a significant difference in the average household size among non-participant households and households that participated in only government interventions, only NGO interventions, and both NGO and government interventions. Household size was not used in the METE regression models.

The average dependency ratio of households was also examined by dividing the number of dependents in a household (0 – 14 years and 60+ years) by the active labour force (15 – 59 years). A dependency ratio of more than one indicates that on average, there are more dependents in a household than active labour, which suggests that more household members depend on a few members for their

livelihoods. The results indicate that the average dependency ratios for non-participant and participant households are greater than one. This implies that households considered in this study have more dependents than actively working household members. The Kruskal-Wallis test results showed that the Chi^2 value of 1.905 is not significant. Thus, there is no significant difference in the dependency ratios among households in all four categories of participants.

The percentage of female household members is also critical in determining women's voice and livelihood outcomes of households. The results showed that the proportion of female household members is less than 50 percent for non-participant households (47.7%), households that participated in only government interventions (48.2%), a household that participated in only NGO interventions (49.5%), and households that participated in both NGO and government interventions (47.4%). This is slightly lower than the female share of Ghana's population of 50.7 percent (GSS, 2021). Households with the majority of their members being females could promote women's rights and empowerment. The Kruskal-Wallis test showed no significant difference in households' female population percent among the four categories of participant households.

Results further revealed that the average farm size of non-participant households (8.2 acres) was higher than the average farm size of households that participated in only government interventions (7.6 acres), only NGO interventions (7.5 acres), and both NGO and government interventions (7.9 acres). The Kruskal-Wallis test showed no significant difference in the average farm sizes of all household participants in NGO and/or government interventions and non-participant

households. Some interventions target smallholder farmers; hence, having a large farm size could exclude large-scale farm households from participating in such interventions. The amount realized by households from the sales of crop output per annum was slightly higher for households that participated in only NGO interventions (GHS1, 406.02) than non-participant households (GHS1, 206.00), a household that participated in only government interventions (1, 306.02) and households that participated in both NGO and government interventions (GHS1, 331.60). Households with higher farm income will have higher consumption expenditure, hence, better welfare than households with low farm income, other things being equal. The Kruskal-Wallis test showed no significant difference in crop revenue of non-participant households and participants in NGOs and /or government interventions.

Households' crop outputs were added after reducing each crop output to a common index by dividing the difference between the household's crop output and the observed minimum outputs for all households by the range of the crop output. This was called crop index and ranged between zero and one. The higher the crop index, the higher a household's crop output. The results revealed that households that participated in only NGO interventions (crop index = 0.33) and both NGO and government interventions (crop index = 0.35) had higher crop output than non-participated (crop index = 0.18) and households that participated in only government intervention (crop index = 0.11). Results of the Kruskal-Wallis test showed that there is no significant difference in the means of crop index among non-participants and participants in NGO and/or government intervention

households. Finally, the results showed that household heads of non-participant households had higher years of education (5.8 years) than heads of households that participated in only government interventions (5.2 years), only NGO interventions (5.4 years), and both NGO and government interventions (5.6 years). The Kruskal-Wallis test revealed no significant difference in the mean years of education of household heads of non-participants and participants in NGO and/or government interventions. Descriptive statistics of continuous independent variables are presented in Table 6.2.

Table 6.2: Summary Statistics of Continuous Independent Variables in the METE Regression Model

Variable	**Non-participant**	**Only Gov't**	**Only NGO**	**Both NGO & Gov't**	**Kruskal-Wallis H test**	
	Mean (Std. dev)	Mean (Std. dev)	Mean (Std. dev)	Mean (Std. dev)	Chi2 (3)	P –value
Age	38.7 (17.03)	41.2 (18.34)	39.4 (18.92)	40.7 (19.23)	3.327	0.192
HH size	5.3 (3.25)	6.4 (4.43)	5.1 (2.41)	5.6 (3.21)	60.387***	0.001
Dependency ratio	1.2 (2.39)	1.3 (2.43)	1.1 (1.6)	1.2 (2.45)	1.905	0.341
Female (%)	47.7 (24.9)	48.2 (16.32)	49.5 (5.43)	47.4 (8.43)	1.401	0.7085
Farm size (acres)	8.2 (7.31)	7.6 (4.53)	7.5 (2.40)	7.9 (3.12)	6.482	0.213
Crop Revenue	1206 (256.98)	1123.81 (273.01)	1406.02 (372.01)	1331.6 (253.02)	8.275	0.101
Crop index	0.18 (0.94)	0.11 (0.76)	0.33 (0.51)	0.35 (0.23)	5.362	0.105
Education (years)	5.8 (4.60)	5.2 (3.6)	5.4 (2.13)	5.6 (1.34)	5.669	0.1289

Note: Standard deviations are in parenthesis

Source: Author's Analysis of field Data (2021)

6.3 Factors Influencing Households' Participation in Climate Change Interventions

Before modelling the factors influencing households' participation in climate change interventions, a correlation analysis of the independent variables was conducted to avoid including highly correlated variables in the same model. Results of the correlation analysis indicate that the extension contacts variable was highly correlated with access to information on climate change interventions, FBO membership, forest group, and membership with other groups. Therefore, extension contact was dropped from the models. Also, household size was highly correlated with the female percentage of household membership and dependency ratio and was dropped from the METE models. The Kruskal-Wallis results showed that apart from the household size, which was excluded from the METE regression model, there were no significant differences in the means of all other continuous independent variables for non-participant households, households that participated in only government interventions, only NGO interventions and both NGO and government interventions. Thus, the population was homogenous and the data could be pulled together for analysis.

In the women's empowerment model, the female percentage of household membership was considered an independent variable in the women empowerment model since it influences women's empowerment (Sell and Minot, 2018). In the food security models, the dependency ratio was considered an independent variable. Membership with other groups was dropped from the regression models because it was found to be highly correlated with FBO and forest groups'

membership. Households' engagement in off-farm activities was also found to be significantly correlated with households' crop index, farm size, and households' membership with FBO, forest group, and other groups. Hence, crop revenue was not included in the same model with these independent variables to avoid multicollinearity. Table 6.3 presents the results of the correlation among the independent variables for the regression models.

Table 6.3: Correlation Results on Independent Variables for the Regression Models

Variable	HH size	Dependency ratio	Female %	Age	Years of education	Farm size	Crop revenue	Crop index	Access to credit	Access to market	FBO membership	Forest group membership	Other group membership	Off-farm	Sex	Marital status	Perceived effectiveness	Decision making	Access to information	Extension contacts
HH Size	1.00																			
Dependency ratio	0.87*	1.00																		
Female %	0.83*	0.21	1.00																	
Age	0.09	0.13	0.23	1.00																
Years of education	-0.02	-0.03	-0.24	0.11	1.00															
Farm size	0.63	0.51	0.09	-0.17	0.00	1.00														
Crop revenue	0.02	0.09	-0.08	-0.30	0.00	0.63*	1.00													
Crop index	0.16	0.21	0.07	0.02	0.29	0.55*	0.59*	1.00												
Access to credit	0.11	0.24	0.31	0.41	0.22	0.31	0.42	0.53*	1.00											
Access to market	-0.25	-0.22	0.20	-0.09	0.05	0.41	0.54*	0.46	0.48	1.00										
FBO membership	-0.27	-0.25	0.08	-0.07	-0.18	0.42	0.37	0.29	0.47	0.45	1.00									
Forest group membership	-0.11	-0.08	0.31	0.11	0.20	0.11	0.20	0.09	0.39	0.22	0.43	1.00								
Other groups	0.41	0.22	0.30	0.42	0.62*	0.25	0.32	0.41	0.44	0.41	0.53*	0.65*	1.00							
Off-farm	0.45	0.23	0.30	0.41	0.29	0.63*	0.26	0.69*	0.17	0.41	0.54*	0.51*	0.81*	1.00						
Sex	-0.08	-0.14	0.04	0.15	-0.25	0.04	-0.16	-0.29	0.23	0.09	0.09	-0.03	0.69*	0.43	1.00					
Marital status	-0.11	-0.04	-0.03	0.42	0.19	0,01	-0.07	-0.27	0.32	-0.11	-0.08	0.25	-0.58*	0.49	0.03	1.00				
Perceived effectiveness	-0.22	0.30	0.26	0.45	-0.32	0.61*	0.62*	0.54*	0.42	0.44	0.36	0.19	0.71*	0.31	0.42	0.09	1.00			
Decision making	-0.19	0.31	0.44	0.48	0.43	0.51*	0.20	0.32	0.71*	0.29	0.32	0.31	0.50*	0.37	0.52*	-0.54*	0.32	1.00		
Access to information	0.23	0.21	0.42	0.30	0.44	0.28	0.33	0.14	0.31	0.40	0.47	0.34	0.46	0.42	0.31	0.09	0.42	0.38	1.00	
Extension contacts	0.21	-0.15	0.51	0.41	0.53	0.49	0.32	0.19	0.39	0.32	0.64*	0.52*	0.71*	0.44	0.54*	0.23	0.56*	0.47	0.89 *	1.00

Note:

- Correlations coefficients: 0.00 denotes no correlation, 0.1 – 0.29 denotes low association/correlation, 0.30 – 0.49 denotes medium association/correlation, 0.50 – 0.99 denotes high association/correlation and 1.00 denotes perfect correlation
- * denotes high correlation and both variables cannot be included in the same equation

Source: Author's Analysis of Field Data (2021).

6.3.1 Test for Robustness of the METE Regression Model

The Independence of Irrelevant Alternative (IIA) Assumption

The mixed multinomial logit model is based on the assumption of exclusivity, known as the Independence of Irrelevant Alternative (IIA) assumption. Hence, the METE model was tested for the IIA assumption and multicollinearity. Greene (2003) stated that the IIA assumption follows from the assumption that disturbances are independent and homoscedastic. The IIA assumption suggests that the probability of a household's participation in an intervention is not influenced by the availability or absence of other interventions. The Hausman test was used to test for the violation or otherwise of the IIA assumption. The statistic has a limiting chi-squared distribution with K degrees of freedom and tests the null hypothesis that the odds are not dependent on irrelevant alternatives (Greene, 2003). The hypotheses are stated as:

H_O: Odds of participation in only government climate change intervention are independent of other interventions

H_A: Odds of participation in government climate change intervention are dependent on other interventions

Results of the Hausman test (Table 6.4) could not reject the null hypotheses that the probability of a household participating in one climate change intervention does not depend on the availability or absence of other interventions. Thus, the independence from irrelevant alternative assumptions was not violated by the mixed multinomial logit model, thereby justifying its application in determining factors influencing the choice of indigenous adaptation strategies and the adoption of research-based factors influencing households' participation in climate change interventions.

Table 6.4: Results of Hausman Test for IIA for Mixed Multinomial Logit Regression

H_O: Odds of participation are independent of other interventions

Omitted	Chi2	d.f.	P > Chi2	Evidence
Only NGO intervention	0.432	9	1.000	For H_O
Only government intervention	-1.168	9	1.000	For H_O
Both NGO and government interventions	2.325	9	1.000	For H_O
Non-participant	3.404	9	1.000	For H_O

Source: Author's Analysis of Field Data, 2021

Test for Serial Correlation / Autocorrelation

The Breusch-Godfrey test was employed to test for serial correlation / autocorrelation in the error terms of the three periods. The hypotheses are stated as follows.

H_O: There is no serial correlation in the error term

H_A: There is serial correlation in idiosyncratic errors

The Breusch-Godfrey test results (refer to Table 6.5) could not reject the null hypothesis of no serial correlation.

Table 6.5: Results of Breusch-Godfrey Test for Serial Correlation

Chi^2	Df	P – Value
71.561	20	1.011e-07

Source: Author's Analysis of Field Data, 2021

Test for Multicollinearity

Although the correlation matrix often detects multicollinearity, the correlation result shows only the bivariate relationship between two independent variables and does not show the effect of other independent variables. This is addressed by the Variance Inflation Factor (VIF). The VIF test shows the correlation of a variable with a group of other independent variables. Hence, conducting both the correlation test and VIF was useful to detect the specific variables with high correlation with other independent variables and needed to be dropped from the regression. VIF of 1 denotes no correlation between the independent variable and the other independent variables while VIF between 1 and 5 implies moderate correlation and does not post enough multicollinearity to warrant correction (Neter et al., 1996). However, VIF exceeding 5 indicates a high level of multicollinearity between the independent variables and other independent variables and may post severe misestimating of regression results (Neter et al. 1996; Kutner et al., 2004). Results of the VIF indicate that none of the independent variables has a VIF above 5, hence, no multicollinearity among the independent variables used in the regression models. The reason is that the independent variables with high correlation with other independent variables were identified and excluded from the regression using the correlation results. Thus, the VIF results justify that the METE models were free from the multicollinearity problem. The result of the VIF test for multicollinearity is presented in Appendix A2.

6.3.2 Factors Influencing Households' Participation in Climate Change Interventions

The first stage of the METE model (mixed multinomial logit regression) was used to determine the factors influencing households' participation in climate change interventions. The non-participant households were used as the base category. The Wald test showed that the Wald Chi^2 value of 1854.0 is statistically significant at 1 percent (P-value =0.000). It also suggests that households' participation in only government, only NGO, and both NGO and government interventions are influenced by different factors. Thus, the use of the Mixed Multinomial Logit Model fits the data set and justifies its appropriateness in determining the factors influencing households' participation in different climate change interventions. This finding corroborates with Manda et al. (2016), Khonje et al., (2018), and Issahaku and Abdulai (2019) who employed the Mixed Multinomial Logit Model to determine households' participation and adoption of various climate-smart agricultural technologies introduced by agricultural organisations. The mixed multinomial logit model results on factors influencing households' participation in climate change interventions are presented in Table 6.6.

Table 6.6: Mixed Multinomial Logit Regression Results on Determinants of Participation

Variable	Only gov't	Only NGO	Both gov't & NGO
Sex of HHH	-0.484*** (0.168)	0.926*** (0.180)	0.899 (0.676)
Age of HHH	-0.007** (0.003)	-0.021*** (0.003)	-0.040** (0.010)
Marital status	-0.006 (0.055)	-0.154 *** (0.055)	-1.273*** (0.138)
Access to information	0.183* (0.156)	0.811** (0.178)	0.124** (0.014)
Access to market	0.075 (0.150)	0.132 (0.210)	0.124 (0.202)
Education (years)	-0.010 (0.014)	-0.255*** (0.015)	-0.072* (0.041)
Group Membership			
FBO	0.164** (0.098)	0.225*** (0.099)	0.239** (0.014)
Forest group	0.100 (0.321)	1.121*** (0.310)	1.215** (0.613)
Multiple groups	0.142 (0.222)	0.740*** (0.257)	-0.205 (0.693)
Perceived effectiveness	-0.080 (0.146)	1.457*** (0.176)	0.048 (0.289)
Participation in decision making	0.124* (0.064)	0.337** (0.161)	0.381** (0.115)
Constant	1.632*** (0.411)	2.722*** (0.414)	-5.048*** (1.341)
Number of observations		5518	
Wald Chi^2		1854.00***	
P – value		0.000	

Note: Standard errors are in parentheses

Source: Author's Analysis of Field Data, 2021

The results further revealed that the sex of the household head has a significant negative effect on households' participation in only government climate change interventions and a significant positive effect on participation in only NGO interventions relative to not participating in any climate change intervention.

However, sex has no significant effect on households' participation in both government and NGO interventions compared to non-participation in any intervention. Given that sex was coded as 1 if the household head is a female, the results imply that a female-headed household is more likely to participate in only NGO intervention but less likely to participate in only government interventions compared to not participating in any climate change intervention.

NGO officials indicated that most NGO climate change interventions target women and children who are more vulnerable to climate change than men. Therefore, a farm household headed by a female is more likely to participate in NGO intervention than a household headed by a male. Key informants were unanimous that most NGO interventions are not gender-blind, and have strategies aimed at promoting women's participation (such as quota for women participation in programmes) than government interventions that cover larger geographical space and people. This finding is consistent with Mabe et al. (2018) who revealed that women's participation in the Planting for Food and Job flagship programme of the Government of Ghana had been low due to ineffective strategies aimed at promoting women's participation in the implementation of the programme, although one of the key pillars focused on gender equity. The finding also confirms the view of Tesfaye et al. (2016) who reported that male farmers had a high probability of participating in state-own climate-smart wheat technology in Uganda and Etwire et al. (2013b) also found that female farmers had a higher probability of participating in NGOs climate-smart resilient technologies in Northern Ghana.

The study further found the age of the household head to have a significant negative effect on households' participation in only government, only NGO, and both NGO and government interventions relative to not participating in any intervention. This implies that youthful household heads are more likely to participate in climate change interventions than aged household heads. Thus, an increase in household head age decreases the probability of the households' participation in climate change intervention more than non-participation. Usually, farmers' productivity over time decreases and they become conservative to traditional agricultural practices rather than changing to technologies introduced by agricultural programs. Hence, participation in climate change interventions among aged farmers is low given that they do not want to abandon their traditional farming practices for innovative practices promoted by these interventions. This is further attributed to aged farmers' reluctance to take a risk and so will continuously use indigenous practices.

Interviews with key informants of NGO and government organizations that implemented the intervention revealed that most of the projects aimed at encouraging the youth to venture into agriculture as a way of reducing the increasing youth employment in Ghana. This finding confirms and contradicts some literature on participation in climate change interventions. For instance, the finding is consistent with Arytal et al. (2018) and Zakaria et al. (2020) who reported that the age of farmers negatively influences farmers' participation in agricultural programmes and adoption of climate-smart technologies introduced by such programmes in India and Ghana. However, the finding contradicts Asante et

al. (2014) and Anang (2019) who found age to have a significant positive effect on farmers' participation in interventions that promoted improved yam minisett and rice varieties in Ghana respectively. Manda et al. (2015) reported that the effect of age on farmers' participation in agricultural programmes is mixed and varies over space and time. Hence, disparities in study findings are contextual rather than comparative.

The next factor is the marital status of farm household heads and the results revealed that it has a significantly negative effect on farm households' participation in only NGO intervention and both NGO and government interventions relative to non-participation. Thus, the probability of a household participating in either only NGO or both NGO and government interventions compared to non-participation is low if the household head is married. Spouses could support each other in adapting to the effect of climate change while farmers who are not married are left to their fate and tend to look out to support from interventions of both NGOs and the government. Yet, married farmers have access to family labour and other support compared to unmarried farmers.

The descriptive statistics showed that the majority of the households heads of respondents from non-participant and participant households were married, indicating that being married is not guaranteed participation in climate change interventions. This finding contradicts Zongo et al. (2015) who reported that married farmers participate in climate change programs more than unmarried farmers because married couples tend to access information on agricultural

interventions more than unmarried couples. The finding is also inconsistent with Abdallah et al. (2021). However, the finding is consistent with Martey et al. (2013) who found a significant negative effect of marriage on smallholder rice farmers' participation in development projects in Northern Ghana.

Access to information on climate change intervention is a critical factor influencing farming households' decision to participate in climate change interventions. The results showed that access to information has a significant positive effect on farm households' participation in only government, only NGO, and both government and NGO interventions. Farmers' awareness of the existence of a climate change intervention is the first stage in the process of deciding whether to participate or not. Whereas only 16 percent of non-participant households were aware of the climate change interventions, over 80 percent of households that participated in only government, only NGO, or both government and NGO interventions had information on climate change interventions (refer to Table 6.1). During focus group discussions, it was revealed that farmers' main sources of information on climate change interventions include peer farmers, farmer groups, extension agents, and sometimes at the market when farmers visit to buy input or sell outputs. This finding is consistent with Mapanje et al. (2020) who found that access to information is one of the critical indicators for farmers' decision to participate in climate change projects. It is also consistent with Oduniyi and Tekana (2021), Singh et al. (2016), and Vaughan and Dessai (2014).

The results further revealed that the household head's years of education have a significant negative effect on households' participation in only NGO and both NGO and government interventions compared to not participating in any intervention. However, years of education have no significant effect on households' participation in only government interventions relative to non-participation. This result implies that the probability of a household's participation in only NGO or both NGO and government interventions decreases with increased years of education. Thus, the higher the number of years of a household head's education, the lower the probability of participation in only NGO and both NGO and government interventions.

Officials of NGOs that implemented climate change interventions revealed during interviews that the main target group of NGO interventions is uneducated, who are more vulnerable to the effects of the perennial climate change in northern Ghana. It was further revealed that uneducated households mostly do not have alternative livelihoods aside from farming and need external support than educated households who have formal employment and better social networks to adapt to the adverse effects of climate change on livelihoods. The average years of education were higher for non-participant households than for participant households (refer to Table 6.2). The findings contradict Nigussie et al. (2017) who found education to positively influence farmers' participation in sustainable land management interventions. However, the findings of this study collaborate with Martey et al. (2012) who found that educated households in northern Ghana have more knowledge and skills and are often employed in the formal sector than participating

in agricultural interventions. The finding also confirms Daxini et al. (2018) who reported that education significantly reduces farming households' participation in interventions that seek to promote the adoption of farm nutrients management practices.

Membership with FBOs, forest groups, and both were considered in this study. Though few households belong to groups, membership with groups significantly influences households' participation in climate change interventions. The results revealed that households' membership with FBOs has a significant positive effect on participation in only government, only NGO, and both NGO and government interventions compared to not participating in any intervention. Also, membership in the forest group had a significant positive effect on households' participation in only NGO and both NGO and government interventions relative to not participating in any interventions.

Membership with multiple groups (FBO and forest groups) had a significant positive effect on households' participation in only NGOs relative to non-participation. However, membership with multiple groups had no significant effect on households' participation in only government and both NGO and government interventions. This result differs from Marwa and Manda (2021) who reported that group members had no significant effect on youth farmers' participation in contract farming in Tanzania. However, the finding is consistent with Manda et al. (2015) who found that farm households' membership with one or more social groups has a high probability of participation in agricultural programs. The finding is also

consistent with Narayan and Pritchett (1999), Isham (2002), and Kassie et al. (2013).

Farm households' perception of the effectiveness of intervention has a significant positive effect on participation in only NGO intervention relative to non-participation. However, it had no significant effect on households' participation in only government and both NGO and government interventions. This implies that the probability of households' participation in only NGO intervention is high if they perceived the intervention to be effective in improving their livelihoods. The majority of both key informants and household respondents perceived NGO interventions to be more effective in delivering project activities than government interventions. This could be the reason for the significant positive effect of perceived effectiveness on households' participation in only NGO interventions but not government interventions. This is consistent with Kwon et al. (2019) and Drews and Van den Bergh (2016) who reported that farmers' participation and support for the implementation of climate change interventions depend on their perceived benefits. The result is also consistent with Manda et al. (2015) and Kassie et al. (2013) who found that farmers' trust in government support had a significant positive effect on participation in agricultural intervention in Zambia and Tanzania respectively.

Finally, the results show that respondents' participation in the household's decision has a significant positive effect on participation in all interventions compared to non-participation. This implies that respondents who participated in the household's

decision are more likely to participate in climate change intervention relative to respondents who do not participate. Households that allow members to take independent decisions bothering their production and livelihood empower members to assess the likely impacts of interventions on their livelihoods before considering the decision to participate in such projects or not. This finding is consistent with Samaddar et al. (2019), Hiwasaki et al. (2015), and Okada et al. (2013) who all reported a significant positive effect of farmers' involvement in decision and participation in agricultural interventions.

CHAPTER SEVEN

EFFECTS OF PARTICIPATION IN CLIMATE CHANGE INTERVENTIONS ON WOMEN EMPOWERMENT

7.1 Introduction

This Chapter presents the results and discussions on the levels of women's empowerment and the effects of households' participation in climate change interventions on women's empowerment of households.

7.2 Women Empowerment of Participant and Non-participant Households

Households' disempowerment of men and women in the five domains of empowerment (5DE) consisting of production, resource, income, leadership, and work and leisure were first analysed in terms of their disempowerment in the empowerment indicators. Results (Table 7.1) showed that for the production domain, women from households that participated in only NGO interventions (19.5%) were more disempowered than women from non-participant households (12.0%) and households that participated in only government (11.2%) and both government and NGO interventions (16.4%). Although there was high production disempowerment among households that participated in only NGO interventions, the results showed that the disparity in disempowerment between men and women within households that participated in only NGO intervention (men – 19.2%, women – 19.5%) was low compared to non-participant households (men –8.3%, women – 12.0%) and households that participated in only government (men – 9.6%, women – 11.2%) and both government and NGO interventions (men –

15.2%, women – 16.4%). Women's disempowerment in the production domain emanates from their inability to contribute to production decisions at the household level. This could be attributed to gender inequality and the patrilineal system is an accepted cultural practice in Northern Ghana where the man has the final say in the household's decisions including what, how, and when to produce.

The results further show that there is high women disempowerment in the resource domain among households that participated in only government interventions (23.7%) and both NGO and government (23.4%) than women from non-participated households (21.9%) and households that participated in only NGO interventions (21.7%). The disparity in resource disempowerment domain between men and women was lower for households that participated in both NGO and government interventions (men - 24.4%, women 23.4%) than household from non-participant households (men – 20.5%, women – 21.9%) and households that participated in only NGO interventions (men – 19.6%, women - 23.7%). The results revealed that women's disempowerment in access to and credit decisions are the main contributors to their disempowerment in the resource domain.

Most women are disempowered in the income domain than men as shown among both non-participant and participant households. The results further showed that the disparity in income disempowerment between men and women was high among non-participant households (men – 10.1%, women – 13.5%) than households that participated in only government interventions (men – 12.2%, women 14.7%), only NGO interventions (men - 21.3%, women – 23.8%) and both

NGO and government interventions (men – 22.2%, women – 23.5%). This finding is attributed to the cultural norms and practices in Northern Ghana where men control household income including income owned by women and children of the household. This disempowers women in controlling the use of their incomes more than men within the same households.

Also, results showed that women are more disempowered in terms of leadership than men. It further revealed that women from non-participant households (42.6%) and only government interventions participant households (41.4%) are more disempowered in leadership relative to men than women from households that participated in only NGO (men – 23.7%, women – 23.5%) and both NGO and government interventions (men – 26.2%, men – 28.1%). Women's disempowerment in leadership emanates from their inability to speak in public while men's disempowerment in group membership was the main reason for men's leadership disempowerment. In northern Ghana, men are often regarded as the mouthpiece of the household and women are often not comfortable taking up leadership roles and/or speaking in the presence of men. Culturally, if a woman has something to talk about in a community, she is required to tell her husband who will speak for her during community gatherings or community elders' meetings.

The last empowerment domain of WEAI is time and consists of the workload and leisure time of men and women in a household. Results showed that apart from households that participated in only NGO interventions (men – 10.4%, women –

11.5%), men are more disempowered in terms of time domain than women in non-participant households (men – 28.5%, women – 10.0%) and households that participated in only government (men – 26.2%, women – 9.0%) and both NGO and government interventions (men – 12.0%, women – 8.6%) (Refer to Table 7.1). However, the income disempowerment gap between men and women is low among households that participated in only NGO interventions than other households. The results further show that whereas the workload is the main reason for men's time disempowerment, leisure is the main contributor to time disempowerment among women. Similar to SPRING (2017), the computed 5DEs revealed that the leadership domain appears to be the major contributor to the disempowerment of both women and men from participant and non-participant households.

Table 7.1: Decomposed 5DEs for Men and Women of Participant and Non-participant Households

Indicators of Five Domains of empowerment	Type of intervention							
	Non-participants		Only Gov't		Only NGO		Both Gov't and NGO	
	Men	Women	Men	Women	Men	Women	Men	Women
Production								
Overall contribution of production domain	*8.3%*	*12.0%*	*9.6%*	*11.2%*	*19.2%*	*19.5%*	*15.2%*	*16.4%*
Inputs in productive decisions	3.0%	5.6%	3.1%	3.3%	8.2%	7.7%	5.0%	6.4%
Autonomous in production	3.2%	2.2%	3.4%	2.5%	6.4%	5.4%	3.6%	2.8%
Ownership of assets	2.1%	4.2	3.1%	5.4%	4.6%	6.4%	6.6%	7.2%
Resources								
Overall contribution of resource domain	*20.5%*	*21.9%*	*19.6%*	*23.7%*	*25.4%*	*21.7%*	*24.4%*	*23.4%*
Purchase, sales or transfer of assets	9.2%	10.1%	8.3%	9.4%	15.0%	11.0%	10.4%	10.3%
Access to and decisions on credit	11.3%	11.8%	11.3%	14.3%	10.4%	10.7%	14.0%	13.1%
Income domain								
Control over use of income	*10.1%*	*13.5%*	*12.2%*	*14.7%*	*21.3%*	*23.8%*	*22.2%*	*23.5%*
Leadership Domain of Empowerment								
Overall contribution of leadership domain	*32.6%*	*42.6%*	*32.4%*	*41.4%*	*23.7%*	*23.5%*	*26.2%*	*28.1%*
Group membership	20.4%	11.6%	19.2%	11.1%	10.2%	10.4%	14.2%	15.1%
Speaking in public	12.2%	31.0%	13.2%	30.3%	13.5%	13.1%	12.0%	13.0%
Time domain								
Overall contribution of time domain	*28.5%*	*10.0%*	*26.2%*	*9.0%*	*10.4%*	*11.5%*	*12.0%*	*8.6%*
Workload	17.2%	6.0%	16.3%	5.0%	6.4%	6.8%	8.1%	4.4%
Leisure	11.3%	4.0%	9.9%	4.0%	4.0%	4.7%	3.9%	4.2%

Source: Author's Analysis of Field Data, 2021

Results on the measurement of women empowerment considered in this study include disempowered headcount, average inadequacy score, disempowerment index, 5DE index [1-M_0], women with no gender parity, average empowerment gap, GPI, and WEAI. The average inadequacy score measures the extent of disempowerment of both women and men at a farm household level. It has been mentioned that when the inadequacy score average is above 20 percent, then an individual is considered to be empowered (Zereyesus et al., 2014). The computed 5DEs showed that almost all women in non-participant households (96%) and only government interventions participant households (95%) are disempowered compared to women from households that participated in only NGO interventions (27%) and both government and NGO interventions (41%). Thus, whereas only 4 percent of women from non-participant households and 5 percent of women from only government interventions participant households are empowered, about 63 percent of women from households that participated in only NGO interventions and 59 percent of women from households that participated in both government and NGO interventions are empowered. The decomposed 5DE indicators show that both men and women are highly disempowered in leadership and women from non-participant households (42.6%) and households that participated in only government interventions (41.4%) have been the most disempowered in leadership than women from households that participated in only NGO (23.5%) and both NGO and government interventions (28.1%) due to their inability to also join groups and speak in public. This was revealed during focus group discussions and key informant interviews.

Results further showed that 81 percent of women from non-participant households and 80 percent of women from households that participated in only government interventions had no gender parity compared to only 22 percent of women from households that participated in only NGO interventions and 30 percent of women from households that participated in both government and NGO interventions. The results also revealed that for the 81 percent of women from non-participant households and 80 percent of women from only government intervention participant households who had not achieved gender parity, the average empowerment gap between the primary male and primary female adults was 60.4 percent and 54 percent respectively. This is higher than the average empowerment gaps for women without gender parity among households that participated in only NGO interventions (36%) and households that participated in both government and NGO interventions (34%). This finding confirms Zereyesus et al. (2014) findings which reported high gender parity gap between primary males and females in northern Ghana.

Results of the GPI showed that on average, women from both non-participant households (GPI = 0.51) and only government intervention participant households (GPI = 0.57) had no gender parity with primary male adults in the households. On the contrary, women from households that participated in only NGO interventions (GPI = 0.92) and households that participated in both NGO and government interventions (GPI = 0.89) had gender parity with the primary male adults in the households. Given that the threshold for empowered women is 0.8 and above, the computed WEAI for non-participated households (WEAI = 0.57) and households

that participated in only government interventions (WEAI = 0.64) suggest that average, women from non-participated and only government interventions participant households are not empowered. On the other hand, on average, women from households that participated in only NGO interventions (WEAI = 0.94) and both NGO and government interventions (WEAI = 0.90) are empowered. This result differs from SPRING (2017) which reported that participating women in the SPRING project (WEAI = 0.75) and non-participant households (WEAI = 0.62) did not achieve the minimum empowerment threshold of 0.80, although the *t*–test showed a significant difference in the WEAI of participant and non-participant farmers. This finding is also inconsistent with Zereyesus et al. (2014) who reported that women from households within Northern Ghana had no gender parity with men. The effects of participation in climate change interventions on women's empowerment were examined and presented in the next section of this chapter. Table 7.2 presents the computed WEAI indices for non-participated and participant households.

Table 7.2: Computed WEAI for Participant and Non-Participant Households

Indexes	Non-participant		Only Gov't		Only NGO		Both NGO & Gov't	
	Women	Men	Women	Men	Women	Men	Women	Men
Disempowered head count (H)	96%	97%	95%	94.1%	27%	28%	41%	30%
Average inadequacy score (A)	44%	45%	47%	46.4%	22%	22%	24%	22%
Disempowerment Index (M_O)	0.42	0.44	0.45	0.44	0.06	0.06	0.10	0.07
5DE Index [1-M_O]	0.58	0.56	0.65	0.56	0.94	0.94	0.90	0.93
Number of observations	3,474	2,980	14,036	13,504	5,318	4,609	4,098	3,102
Women with no gender parity (H_{GPI})	81%		80%		22%		30%	
Average Empowerment Gap (I_{GPI})	60.4%		54%		36%		34%	
GPI	**0.51**		**0.57**		**0.92**		**0.89**	
WEAI	**0.57**		**0.64**		**0.94**		**0.90**	

Source: Author's Analysis of FtF Data (2021)

7.3 Effects of Participation in Climate Change Interventions on Women Empowerment

The effects of households' participation in climate change interventions on women's empowerment were examined using the second stage of the women empowerment METE model. Women empowerment was measured in two ways: first as a continuous variable ($0 \leq WEAI \leq 1$) and second as a dummy (empowered = 1 and not empowered = 0). In addition to the treatments (participation in climate change interventions), household-level independent variables (education of female household heads, women's engagements in off-farm activities, crop revenue of female household heads, type of locality, and percentage of household's female population) were also considered in the women empowerment outcome METE model. The results for both models are similar and this study discusses only results from the continuous WEAI METE model.

Except for participation in both NGO and government interventions, the coefficients of the latent variables for the only government (0.014) and only NGO (-0.015) are significant at 5 percent and 1 percent respectively. The /lambda_only gov't coefficient of 0.014 suggests that farm households are 1.4 percent more likely to participate in only government interventions relative to non-participation in any other intervention based on their unobserved characteristics. The /lambda_only NGO coefficient of -0.015 suggests that based on unobserved characteristics, farm households are 1.5 percent less likely to participate in only NGO interventions compared to non-participation in any intervention. The /sigma for both continuous WEAI (-3.262) and dummy WEAI (-1.918) METE Models are

both significant at 1 percent. These suggest the presence of endogeneity or sample selection bias which has been corrected by the METE model, hence, justifies the use of the endogenous regression model for the data. Results of the likelihood-ratio test for exogeneity showed that the estimates of the unobservable variables influencing participation in climate change interventions were exogenous, implying that results from the METE model are consistent and reliable for policy recommendations on women empowerment. Table 7.3 presents METE results on the treatment effects of participation in climate change interventions on women empowerment.

Table 7.3: METE Results on Treatment Effects of Participation in Intervention on Households' Women Empowerment

Treatment and independent variables	WEAI as continuous		WEAI as dummy	
	Coefficient	Std Error	Coefficient	Std Error
Only government intervention	0.003	0.030	0.008	0.013
Only NGO intervention	0.118***	0.002	0.073***	0.011
Both NGO and government	0.125***	0.008	0.661***	0.026
Sex*Education	0.038***	0.013	0.028**	0.007
Sex*Engagement in off-farm	0.122***	0.031	0.098**	0.012
Sex*Crop revenue	0.008	0.013	0.010	0.012
Type of locality	0.293*	0.161	0.237	0.205
Household female %	0.013	0.013	0.011	0.021
Constant	1.668***	0.409	1.233***	0.321
/lambda_only gov't	0.014**	0.003	0.069**	0.010
/lambda_only NGO	-0.015***	0.002	-0.050	0.013
/lambda_Both NGO and gov't	-0.021	0.062	-0.001	0.007
/lnsigma	-3.262***	0.032	-1.918***	0.027
Number of observations	5518		5518	

Note: ***, ** and * denote statistically significant at 1%, 5% and 10% respectively
Source: Author's analysis of FtF Data, 2021

The results showed that participation in only government interventions does not significantly improve women's empowerment compared to non-participation. Women from households that participated in only NGO interventions are 11.8 percent more empowered than women from non-participant households. Also, women from households that participated in both NGO and government interventions are 12.5 percent more empowered than women from non-participant households. It was revealed during key informant interviews and community focus group discussions that NGOs often engage women in alternative livelihood generation activities and also train them to take up leadership positions in their communities. Engaging women in alternative livelihood sources liberates women from being income dependents while taking up leadership positions ensures that issues bothering women are brought to light for appropriate policy actions. The findings of this study agree with SPRING (2017) which reported that households that participated in the SPRING project in Bangladesh reported significantly higher women empowerment than a household that did not participate in the project.

Other independent variables with significant effects on women's empowerment are Sex*education, sex*engagement in off-farm, and type of locality. The interactive term of sex and education is significant at 1 percent. Given that sex was measured as a dummy variable (1 = female and 0 = otherwise), the coefficient of sex*education suggests that for every additional year of women's education, women empowerment increases by 3.8 percent. Educated women have more knowledge and skill and are more enlightened to defend their rights than

uneducated women. This result confirms Dinada (2019) who also reported a significant effect of education on the economic empowerment of rural women in the Philippines. The result is also consistent with Abbas et al., 2021; Amanuel et.al (2016); Alkire et al (2012); Aregu et al, (2017); Khalid (2014); Cinar and Kose (2018) and Njega (2015), but not consistent with Ahmed (2013) and Zhera (2014) who found no significant effect of women education on women empowerment.

Also, the interactive term of sex and engagement in off-farm activities was positive and significant at 1 percent. This implies that women who are engaged in off-farm activities are 12.2 percent more empowered than women who are not engaged in any off-farm activities. Women who have alternative livelihood sources in addition to farming do not necessarily depend on their husbands in periods of low harvest. This result is consistent with Maligaliga et al. (2019) who reported that engagement in off-farm employment increases women's empowerment in the Philippines. It is also consistent with Aregu et al (2017) and Zhera (2014).

Finally, the location of farm households has a significant effect on women's empowerment with women in urban households being more empowered than women in rural farm households (locality of households was measured as a dummy: 1 = urban and 0 = otherwise). Women in urban households are more empowered than women in rural areas partly because urban areas are more cosmopolitan where the culture of women marginalization is minimised due to improved gender equality. Also, access to alternative livelihood and women empowerment programs especially from NGOs is more in urban Northern Ghana

than in rural Northern Ghana. This result is consistent with Sell and Minot (2018) who reported a significant effect of cultural factors based on respondents' geographical location on the empowerment of women in Uganda. This is also consistent with Abbas et al. (2021).

CHAPTER EIGHT

EFFECTS OF PARTICIPATION IN CLIMATE CHANGE INTERVENTIONS ON FOOD SECURITY AND CONSUMPTION EXPENDITURE

8.1 Introduction

This Chapter presents and discusses the results of the effects of participation in climate change interventions on households' food security and consumption expenditure. Section 8.2 presents and discusses the results on households' food security status computed using the minimum dietary diversity score for women, households' food expenditure share, and households' hunger scores. Section 8.3 presents the results and discussions on the effects of households' participation in climate change interventions on food security while section 8.4 presents the effects of participation in climate change interventions on the consumption expenditure of households.

8.2 Food Security Status of Participant and Non-Participant Farm Households

The food security status of farm households was examined using three approaches: household food expenditure share, minimum dietary diversity for women, and household hunger scale. I analysed the effects of participation on food security and consumption expenditure across non-participant households, participants in only government interventions, a participant in only NGO interventions, and participants in both NGO and government interventions. In terms of households'

food expenditure share as a measure of food security, results revealed that the majority of households that participated in only NGO interventions (84.6%) and both NGO and government interventions (93.7%) spend less than 50 percent of their household income on food, hence have low food insecurity status than households that did not participate in any intervention or only government intervention. The results further showed that about 34.4 percent of non-participant households and 25.9 percent of households that participated in only government interventions spent more than 75 percent of their household income on food, hence, are extremely food insecure compared to households that participated in only NGO and both NGO and government interventions where no household is extremely food insecure. This demonstrates the complementarity of the interventions. The food security status of participant and non-participant households measured by the three approaches are presented in Table 8.1.

Table 8.1: Summary Statistics of Households' Food Security by Different Approaches

Food Insecurity Status	Intervention			
	Non-Participant	Only Gov't	Only NGO	Both NGO and Gov't
Farm Household Food Expenditure Share				
Extreme	608 (34.4)	769 (25.9)	0 (0)	0 (0.0)
High	195 (11.0)	451 (15.2)	164 (5.5)	9 (0.9)
Moderate	156 (8.8)	561 (18.9)	296 (9.9)	53 (5.4)
Low	810 (45.8)	1,188(40.0)	2,527(84.6)	919 (93.7)
Minimum Dietary Diversity for Women				
Food secured	547 (30.9)	924 (31.1)	2,198(73.6)	702 (71.6)
Food insecure	1,222(69.1))	2046(68.9)	789 (26.4)	279 (28.4)
Household Hunger Scale				
Little to no hunger	0 (0.0)	0 (0.0)	2,178(72.9)	853 (87.0)
Moderate hunger	1,260 (71.2)	2,970(100)	786 (26.3)	128 (13.0)
Severe hunger	509 (28.8)	0(0.00)	24 (0.8)	0(0)

Note: Figures in parentheses are in %

Source: Author's analysis of FtF Data, 2021

The second food security measurement approach was minimum dietary diversity for women, which indicates the number of food groups consumed by women in a household. The results show that whereas 73.6 percent of households that participated in only NGO interventions and 71.6 percent of households that participated in both NGO and government interventions consumed at least six out of the twelve food groups and are thus food secure; about 69.1 percent of non-participant households and 68.9 percent of households that participated in only

government interventions are food insecure because they could not consume at least six out of the twelve food groups within the study period. Though the quantity of each food group consumed was not captured in the survey, it is assumed that women who consume more food groups get varied nutrients and are more food secure than women who consume fewer food groups.

The third food security measure was the household hunger scale. The results show that whereas almost no household participated in only NGO intervention (0.8%), only government interventions (0%), and both NGO and government (0%) did not experience severe hunger, about 28.8 percent of non-participant households experience severe hunger for at least one month within the study period. All households that participated in only government interventions experienced moderate hunger for at least one month during the study period. The results further show that the majority of households that participated in only NGO interventions (72.9%) and both NGO and government interventions (87.0%) experienced little to no hunger for at least one month within the study period. This result implies that by the household hunger scale, most households that did not participate in any interventions and households that participated in only government interventions are more food insecure than households that participated in only NGO and both NGO and government interventions. In summary, it is observed from the results of all three food security measures (household food expenditure share, minimum dietary diversity for women, and household hunger scale) that households that participate in either only NGO interventions or both NGO and government

interventions are more food secure than households that participate in only government interventions or did not participate in any intervention.

8.3 METE Results on the Effect of Participation in Climate Change Interventions on Households' Food Security

The effects of participation in climate change interventions on households' food security was examined using the three measures of food security as outcome variables in the METE model: households' food expenditure share, minimum dietary diversity for women and households' hunger score. The following sub-sections present the effects of participation in climate change interventions on households' food expenditure share, dietary diversity for women and households hunger scale.

8.3.1 Effects of Participation in Climate Change Interventions on Households' Food Expenditure Share

The second stage of the Household Food Expenditure Share METE model was used to determine the effect of participation in only NGO, only government, and both NGO and government climate change interventions on households' food expenditure share. The dependency ratio, engagement in off-farm activities, crop index (measured as the sum index of standardized household's crops outputs), and locality of households were other household-level independent variables considered in the food expenditure share outcome METE model.

The coefficients of the latent variables for only NGO interventions (-0.171) and both NGO and government interventions (0.102) were significant at 1 percent and

suggest that farm households are 17.1 percent less likely to participate in only NGO intervention than non-participation based on unobserved characteristics, but are 10.2 percent more likely to participate in both NGO and government interventions than non-participation based on their unobserved characteristics. The results showed that the /sigma coefficient when food security is measured using the percentage of households' food expenditure share (-2.215) and the dummy (food secured and food insured) of households' food expenditure share (-0.961) were both significant at 1 percent. This indicates the presence of sample selection bias, justifying the use of the METE model to correct the endogeneity. The likelihood-ratio test rejected the null hypothesis of no exogeneity in the unobservable variables of participation in treatment (/lambda_only gov't = /lambda_only NGO = /lambda_both NGO and gov't = 0). This suggests that the estimates from the METE model are consistent and reliable for policy recommendations on households' food expenditure share. The METE result on the treatment effect of participation in climate change interventions on households' food expenditure share is presented in Table 8.2.

Table 8.2: METE Results on Treatment Effects of Participation in Intervention on Households' Food Expenditure Share

Treatment and independent variables	HFES (%)		HFES (Dummy)	
	Coefficient	Std Error	Coefficient	Std Error
Only government intervention	0.069**	0.031	0.254***	0.083
Only NGO intervention	-0.080**	0.041	-0.436***	0.089
Both NGO and government	-0.012**	0.004	-1.288***	0.086
Dependency ratio	0.091**	0.004	0.024*	0.010
Off-farm	0.022	0.014	0.042	0.0321
Crop index	-0.033	0.044	0.01	0.032
Type of locality	0.003	0.020	0.010	0.031
Constant	-4.957***	1.341	-1.423***	0.180
/lambda_only gov't	-0.002	0.028	-0.075	0.055
/lambda_only NGO	-0.171***	0.041	0.761***	0.063
/lambda_Both NGO and gov't	0.102**	0.044	-0.434***	0.061
/lnsigma	-2.215***	0.213	-0.961***	0.171
Number of Observations	8706		8706	

Note: ***, ** and * denote statistically significant at 1%, 5% and 10% respectively

Source: Author's analysis of FtF Data, 2021

The results showed that participation in only government climate change intervention has a significant positive effect on households' food expenditure share while participation in only NGO and both NGO and government interventions have significant negative effects on households' food expenditure share. Thus, the

null hypotheses of no significant effect of participation in only government, only NGO and both NGO and government interventions on households' food expenditure share are rejected. The METE estimates indicate that households' participation in only government increases households' food expenditure share by 6.9 percent while participation in only NGO and both NGO and government interventions reduces households' food expenditure share by 8 percent and 1.2 percent respectively. This confirms the earlier results (presented in section 5.3 of Chapter Five) that households and key informants perceived government-led intervention to be ineffective in delivering project activities compared to NGO-led interventions.

As stated in literature (INDDEX Project, 2018; Lele et al., 2016; Smith and Subandoro, 2007), households that spend a higher proportion of their income on food are more vulnerable to food insecurity during periods of food price hikes, especially households that are already consuming lowest-cost foods. Thus, households that participated in only government interventions are more susceptible to food insecurity than households that participated in only NGO and both NGO and government interventions. Key informant interviews and community focused group discussions revealed that government-led interventions often do not deliver farm inputs and other project activities in time. Farming in Northern Ghana is rain-fed and time-bound. Hence, farmers who depend on government interventions experience low yields due to late ploughing and farm input delivery. This finding is consistent with Azumah and Zakaria (2019) who found rice farmers in Northern

Ghana who participated in the Government of Ghana fertilizer subsidy programme to be mostly food insecure due to low rice productivity.

The results also showed that the dependency ratio has a significant positive effect on households' food expenditure share. A higher dependency ratio implies that few people are working to provide the food needs of the majority of household members. Thus, a household with more dependents than active labour spends more on food than households with more active labour than dependents because more labour is required to produce enough food for the household. This finding is consistent with Akukwe (2020) who found that a high dependency ratio increases households' expenditure on food among farm households in South-Eastern Nigeria.

8.3.2 Effects of Participation in Climate Change Interventions on Households' Women's Dietary Diversity

The second stage of the minimum dietary diversity for women METE model was used to determine the effect of participation in only NGO, only government, and both NGO and government climate change interventions on households' minimum dietary diversity for women. In addition to the treatment variable (participation in climate change interventions), dependency ratio, engagement in off-farm activities, crop index (measured as the sum index of standardized household's crops outputs), and locality of households were the other household level independent variables considered in the METE outcome model.

The latent variables for only government, only NGO, and both NGO and government interventions were significant at 1 percent. The /lambda_only gov't and /lambda_only NGO coefficients of -0.148 and -0.070 suggest that farm households are 14.8 percent and 7 percent less likely to participate in only government and only NGO climate change interventions respectively based on their unobserved characteristics. Also, the /lambda_both gov't and NGO coefficient of 0.086 implies that unobserved characteristics increase the likelihood of farm households' participation in both government and NGO climate change interventions by 8.6 percent. The /sigma for households' minimum dietary diversity for women measured as a continuous variable (-4.613) and dummy variable (-2.714) were both significant at 1 percent. These indicate the presence of endogeneity or selection bias in the data which has been corrected in the model. Therefore, the use of the METE regression model fits the data and is justified. The likelihood-ratio test was conducted and the results show exogeneity of the unobservable variables of participation in treatments (/lambda_only gov't = /lambda_only NGO = /lambda_both NGO and gov't = 0). This implies that the estimates from the METE model are consistent and reliable for policy recommendations on households' minimum dietary diversity for women. The METE result on the treatment effect of participation in climate change interventions on households' minimum dietary diversity for women is presented in Table 8.3.

Table 8.3: METE Results on Treatment Effects of Participation in Intervention on Households' Minimum Dietary Diversity for Women

Treatment and independent variables	MDD_W (Continuous)		MDD_W (Dummy)	
	Coefficient	Std Error	Coefficient	Std Error
Only government intervention	0.018	0.056	0.078	0.063
Only NGO intervention	0.090***	0.009	1.524***	0.044
Both NGO and government	0.086***	0.011	0.877***	0.044
Dependency ratio	-0.027	0.233	0.128	0.112
Off-farm	0.029	0.016	0.014	0.092
Crop index	0.012	0.142	0.032	0.231
Type of locality	-0.025**	0.012	-0.013*	0.009
Constant	2.772***	0.411	0.213***	0.002
/lambda_only gov't	-0.148***	0.002	-0.070***	0.022
/lambda_NGO	-0.070***	0.001	-0.963***	0.012
/lambda_Both NGO and gov't	-0.033***	0.002	-0.182***	0.026
/lnsigma	-4.613 ***	0.328	-2.714***	0.188
Number of observations	8707		8707	

Note: ***, ** and * denote statistically significant at 1%, 5% and 10% respectively

Source: Author's analysis of FtF Data, 2021

The results further showed that participation in only government intervention has no significant effect on women's dietary diversity. Hence, we do not reject the null hypothesis of participation in government intervention has no effect on women's dietary diversity. This finding confirms Mabe et al. (2018) who reported that the government of Ghana's agricultural interventions in northern Ghana have no strategic inclusion plans for improving women's food security and livelihoods. However, farm households' participation in only NGO and both NGO and

government interventions had a significant positive effect on women's dietary diversity. Therefore, we reject the null hypotheses of no significant effect of participation in only NGO and both NGO and government interventions on women's dietary diversity. The treatment effect coefficients indicate that farm households that participated in only NGO and both NGO and government interventions increased women's dietary diversity by 9 percent and 8.6 percent respectively. Thus, women's dietary diversity improves when farm households participate in only NGO or both NGO and government interventions, but not only government interventions. Results from focus group meetings and key informant interviews revealed that NGO interventions often sensitize women, especially pregnant women to eat multiple food groups for a healthier life. This is consistent with IFAD (2016) report that households that participated in IFAD's nutrition-sensitive interventions in Kenya, Mozambique, and Zambia improved dietary diversity of women.

The results further revealed that households' location has a significant effect on women's dietary diversity. Given that type of locality was measured as a dummy (1 denoting urban and 0 denoting otherwise), the result suggests that urban farm households are less likely to consume more diverse dietary than rural, and peri-urban farm households. This is inconsistent with Gyimah et al. (2021), Desta et al. (2019), and Ruel et al. (2010). However, the reason could be that farm households in rural areas have access to wild fruits, cheaper and different foods than households in urban areas.

8.3.3 Effects of Participation in Climate Change Interventions on Households Hunger Scale

The effects of participation in climate change interventions on households' hunger scale were examined using the second stage of the household hunger scale METE model. Other household-level independent variables considered in the outcome mode are dependency ratio, engagement in off-farm activities, crop index (measured as the sum index of standardized household's crops outputs), and locality of households were the other household level independent variables considered in the METE outcome model.

Results on the latent variables for only NGO and both NGO and government interventions, but not only government are significant at 1 percent, which indicates that unobservable household characteristics have significant effects on farm households' participation in only NGO and both NGO and government interventions than non-participation. The /lambda_only NGO coefficient of -0.312 means that farm households are 31.2 percent less likely to participate in only NGO interventions relative to non-participation based on unobserved household characteristics. Also, the /lambda_both NGO and gov't coefficient of 0.286 suggests that farm households are 28.6 percent more likely to participate in both NGO and government climate change interventions compared to non-participation based on unobserved households' characteristics. The /sigma for both continuous (-1.644) and categorical (-12.014) household hunger scales are both significant at 1 percent. These indicate the presence of sample selection bias in the data which has been corrected in the METE model. Therefore, the use of the METE regression

model fits the data and justifies its use. The likelihood-ratio test for exogeneity rejected the null hypothesis of no exogeneity among the unobserved variables influencing participation in climate change interventions (/lambda_only gov't = /lambda_only NGO = /lambda_both NGO and gov't = 0). Hence, the METE model estimates are consistent and reliable for policy recommendations on reducing households' hunger through climate change interventions. Table 8.4 presents METE results on the effect of participation in climate change interventions on households' hunger scores.

Table 8.4: METE Results on Treatment Effects of Participation in Intervention on Households' Hunger Scores (HHS)

Treatment and independent variables	**HHS (Continuous)**		**HHS (Dummy)**	
	Coefficient	**Std Error**	**Coefficient**	**Std Error**
Only government intervention	0.200***	0.041	0.047**	0.007
Only NGO intervention	-0.645***	0.047	-0.251***	0.082
Both NGO and government	-0.146 **	0.052	-0.163**	0.045
Dependency ratio	0.063***	0.003	0.102**	0.008
Off-farm employment	0.047**	0.020	0.120	0.413
Crop index	-0.061**	0.032	-0.230*	0.104
Type of locality	-0.025	0.237	-0.182	0.216
Constant	-1.916***	0.024	0.069***	0.010
/lambda_only gov't	-0.011	0.027	-0.109	0.094
/lambda_NGO	-0.312***	0.039	-0.242***	0.019
/lambda_Both NGO and gov't	0.286***	0.048	0.172**	0.032
/lnsigma	-1.644***	0.090	-12.014***	0.812
Number of observations	8708		8708	

Note: ***, ** and * denote statistically significant at 1%, 5% and 10% respectively

Source: Author's analysis of FtF Data, 2021

The results of the treatment effect showed that participation in climate change intervention has a significant effect on households' hunger. Hence, we reject the null hypotheses of no significant effect of participation in only government, NGO, and both NGO and government interventions on households' hunger. The results showed that participation in only government interventions increases farm households' hunger significantly by 20 percent compared to non-participant households. Though this result does not meet the *a prior* expectation of the study, it was revealed that most farm households in rural northern Ghana depend on their farm produce for food, and households that participate in only government interventions had low yields due to delays in farm input delivery, hence, experienced a longer period of hunger than non-participant household. This is consistent with Azumah & Zakaria (2019) who found that participation in fertilizer subsidy programme reduces rice production in northern Ghana. The result is however inconsistent with Chirwa et al. (2017) who reported a significant positive effect of participation in the Malawian Government Income Diversification Programme on households' food security measured by household hunger scale.

As expected, participation in only NGO interventions and both NGO and government interventions reduces households' hunger significantly by 64.5 percent and 14.6 percent respectively. Results presented in Table 8.1 indicate that the majority of households that participated in only NGO interventions and both NGO and government interventions experienced little to no hunger compared to the majority of non-participant households and households that participated in only government interventions experienced moderate to severe hunger. NGO

interventions are often more effective in delivering program activities than government interventions. Thus, given that agriculture in northern Ghana is rain-fed and time-bound, usually between June and September each year, households that depend on their farm produce for food often experience more hunger during periods of poor yield because they are unable to access farm inputs at the right time. This situation is more prevalent among households that participate in government interventions than NGO interventions. The result is often a higher yield for NGO intervention participants who tend to be more food secure than governmental intervention participants who get low yields. This finding is consistent with Adu et al. (2018) who reported that NGO agricultural interventions were more successful in reducing household hunger than most governmental interventions in northern Ghana.

For household and farm level variables, whereas dependency ratio and engagement in off-farm activities have a significant positive effect on household hunger, crop index significantly reduces household hunger. The results showed that a unit increase in dependency ratio increases household hunger by 6.3 percent. Households with more dependents (children and aged members) will not have enough family labour to work on a farm, resulting in low yield, hence insufficient food for the household. Thus, households with higher dependency ratios have fewer members working to provide the food needs of the majority of household members. This is consistent with Akbar et al. (2020) findings that households with more dependents experience prolonged hunger in Pakistan. The coefficient for off-farm employment indicates that households engaged in off-farm employment are

4.7 percent more likely to experience hunger compared to non-participant households. This finding does not agree with intuition and a *prior* expectation of the study. However, the reason for these results could be that households that engage in off-farm activities do not have enough labour hours to work on their farms, and given that most households depend on their farm produce for food, such households will experience high hunger if the income generated from off-farm is low to buy enough food for the household. Finally, an increase in crop output (proxies as crop index) by one unit reduces households' hunger by 6.1 percent. Higher crop output implies more availability of food for the household, hence, less hunger.

8.4 METE Results on the Effect of Participation in Climate Change Intervention on Households' Consumption Expenditure

The effects of participation in climate change interventions on households' consumption expenditure were examined using the second stage of the welfare METE model. The dependency ratio, engagement in off-farm activities, crop revenue/farm income, and household location were the household-level independent variables considered in the outcome model in addition to the treatment (participation in climate change interventions). Results on the latent variables show a significant effect of unobserved households' characteristics on participation in all three types of interventions. The /lambda_only gov't coefficient of 0.381 means that farm households are 38.1 percent more likely to participate in only government interventions relative to non-participation based on unobserved household characteristics.

Also, the /lambda_only NGO coefficient of -0.392 suggests that farm households are 39.2 percent less likely to participate in only NGO-led climate change interventions compared to non-participation based on unobserved households' characteristics. The lambda_both NGO and gov't coefficient of -0.189 indicate that unobserved factors reduce the likelihood of farm households' participation in both NGO and government interventions by 18.9 percent. The estimated /sigma (-0.082) is significant at 1 percent, suggesting the presence of sample selection bias in participation in all three types of interventions, and has been corrected in the METE model. Thus, the use of the METE regression model fits the data. The likelihood-ratio test for exogeneity rejected the null hypothesis of no exogeneity among the unobserved variables influencing participation in climate change interventions (/lambda_only gov't = /lambda_only NGO = /lambda_both NGO and gov't = 0). Hence, the METE model estimates are consistent and reliable for policy recommendations on improving households' consumption expenditure through climate change interventions. The METE result on the effects of participation in climate change interventions on households' consumption expenditure is presented in Table 8.5.

Table 8.5: METE Results on Treatment Effects of Participation in Intervention on Households' Consumption Expenditure

Treatment and independent variables	Coefficient	Std Error
Only government intervention	-0.145***	0.075
Only NGO intervention	0.155**	0.088
Both NGO and government	0.153**	0.091
Dependency ratio	-0.170	0.681
Off-farm employment	0.163***	0.057
Crop revenue	0.277***	0.086
Type of locality	0.011	0.055
Constant	-0.050***	0.014
/lambda_only gov't	0.381***	0.041
/lambda_only NGO	-0.392***	0.074
/lambda_Both NGO and gov't	-0.189***	0.066
/lnsigma	-0.082***	0.054
Number of observations	8707	

Note: *** and ** denotes statistically significant at 1% and 5% respectively

Source: Author's analysis of FtF Data, 2021

The results reveal a significant effect of treatments (participation in all climate change interventions) on households' welfare (proxy by households' total consumption expenditure). However, whereas participation in only government interventions reduces farm households' total consumption expenditure by 14.5 percent, participation in only NGO interventions and both NGO and government

interventions increase households' households' consumption expenditure by 15.5 percent and 15.3 percent respectively. Therefore, the null hypotheses of no significant effect of participation in only government, only Ngo, and both NGO and government interventions on household consumption expenditure are rejected. The results on participation in only government interventions did not meet a *prior* expectation of the study but were consistent with Prince (2020) who found a significant negative effect of the government of Ghana expenditure on household consumption expenditure during the first year of the Covid-19 pandemic. The finding of this study contradicts Teka and Lee (2020) who reported a significant improvement in welfare (expenditure per adult) of farmers who participated in government-supported-agricultural programmes in rural Ethiopia. The reason for this difference in findings is that in Ghana, farm households' expenditure is either from sales of farm produce or income earn from off-farm engagement or both.

However, government interventions in Northern Ghana do not often engage farm households in other livelihood sources and also delay in delivering project activities such as farm inputs, credit, and access to the market. This results in low yield and farm income. Hence, the consumption expenditure of households that depend only on government interventions reduces. On the contrary, households that participated in NGO interventions benefited from livelihood diversification programmes and were assisted to engage in other off-farm livelihood activities. It was also revealed in focus group discussions and key informant interviews that NGO intervention participants had access to credit, farm inputs for higher yield, and markets to sell their farm produce for more income, hence, earn more income

to meet households' needs than households that did not participate in any intervention and/or households that participated in only government interventions. This is consistent with Adjei et al. (2012).

Households' engagements in off-farm employment and the proceeds from the sales of crops (crop revenue/farm income) are the only other factors with a significant effect on households' consumption expenditure (welfare). Engagements in off-farm employment increase households' consumption expenditure by 16.3 percent while each Ghana cedi realized from the sales of crops increases households' consumption expenditure by 27.7 percent. The main source of income for farm households is farm income and non-farm income. Thus, the disposable income of farm households for their expenditure is high when they earn more income from the proceeds of their farm produce or other livelihood off-farm activities or both. This finding is consistent with Mahama and Nkegbe (2021) and Danso-Abbeam et al. (2020) who reported that off-farm income diversification increased households' welfare significantly in Ghana through consumption expenditure per capita. The finding is also consistent with Martin and Lorenzen (2016) who reported that income diversification through off-farm engagements in rural areas leads to the accumulation of wealth and thus improves the livelihoods of farmers in rural Laos.

CHAPTER NINE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

9.1 Introduction

This chapter presents a summary of the study, key findings, conclusions from the findings, policy implications and recommendations, contribution of the study, and suggestions for future studies.

9.2 Summary of Findings

Agriculture employs a majority of the labour force in Northern Ghana and is mainly rain-fed, rendering these farmers more vulnerable to poverty, food insecurity, women's disempowerment, and other adverse effects of climate change. A plethora of interventions from both governmental and non-governmental organizations have been rolled out in northern Ghana to ameliorate the negative effect of climate change on the livelihoods of farm households. Northern Ghana has been described as the ‘hub of NGOs’ because of the high number of NGOs operating in the region. Despite these interventions, poverty eradication, the fight against hunger, and the promotion of women's empowerment have achieved minimal results given that majority of farm households in Northern Ghana are still poor, food insecure and women are disempowered. Given this, most stakeholders, especially farm households have been questioning the effectiveness of these interventions and their coherence with Sustainable Development Goals. This study is in response to farm households' call for an evaluation of climate change interventions implemented in Northern Ghana.

The study assessed the effects of participation in climate change interventions on women empowerment, food security, and consumption expenditure of farm households in Northern Ghana. Specifically, the study profiled and reviewed the coherence of climate change interventions implemented in northern Ghana with selected SDGs (SDG 1 – zero poverty, SDG 2 – end hunger, SDG 5 – gender equality and women empowerment, and SDG 13 – climate action) using descriptive statistics, thematic and content analysis; examined the factors influencing farm households' participation in climate change interventions using a first stage of the multinomial endogenous treatment effect regression (mixed multinomial endogenous logit regression) model; and determined the effect of participation in climate change interventions on women empowerment, food security and consumption expenditure of farm households using the second stage of the multinomial endogenous treatment effect regression model. Women empowerment was measured using the women empowerment in an agricultural index. Food security was measured using the households' food expenditure share, minimum dietary diversity for women, and household hunger score. Household welfare was measured using households' consumption expenditure per annum.

In pursuance of the study objectives, both primary and secondary data were collected. Primary data was collected through key informant interviews with organizations that implemented climate change interventions, and focus group discussions with the beneficiary and non-beneficiary communities. Three types of secondary data were used, out of which two were to achieve the first objective of examining the coherence of climate change interventions with SDGs. Initially, the

researcher conducted an online such for climate change interventions implemented in northern Ghana. Reports on climate change interventions were also obtained through personal visits to offices of organizations that implemented climate change programmes. A total of 112 interventions were selected after screening consisting of 78 NGO interventions and 34 government interventions which were used for the analysis. The third type of secondary data was the USAID Feed the Future Population-Based Survey data with a baseline in 2012, midline in 2015, and endline in 2019. About 4600 households were sampled in each of the three rounds of surveys totalling 13, 800. The data was unbalanced panel collected from both non-participant and participant households of USAID ADVANCE I and II, Resilience in Northern Ghana (RING), Ghana Commercial Agricultural Project (GCAP), and the Ghana Agricultural Sector Investment Programme (GASIP). Thus, household respondents of the study were categorized into four groups: households that did not participate in any climate change intervention (non-participants/control group), households that participated in only government interventions (GCAP and/or GASIP), households that participated in only NGO interventions (ADVANCE and/or RING), and households that participated in both government interventions (GCAP and/or GASIP) and NGO interventions (ADVANCE and/or RING).

About 1, 769 (20.32%) did not participate in any climate change intervention and served as a control group or counterfactual. On the other hand, 2, 970 (34.11%) and 2, 987 (34.3%) household respondents participated in only government and only NGO interventions respectively while 981 (11.27%) households participated

in both NGO and government interventions. Less than 10 percent of all farm households had access to credit. Whereas less than 25 percent of non-participant and only government intervention participant households had access to the output market, 58.4 percent of households that participated in only NGO interventions and 64.8 percent of households that participated in both NGO and government interventions had access to the output market. Also, whereas less than 3 percent of all households belong to a forest group, almost 25 percent of all households belong to a farmer-based organisation. Most households did not belong to multiple groups, except households that participated in both NGO and government interventions (13.66%). The majority of households are engaged in off-farm activities. Whereas the majority of non-participant households and households that participated in only government interventions are headed by males, almost half of the households that participated in only NGO interventions are headed by females. Also, the majority of sampled households are married and rely on family labour for farming activities. Furthermore, there is high access to information among households that participated in only NGO interventions (84%), only government interventions (64.1%), and both NGO and government interventions (80.12%) compared to non-participant households (16.96%). Yet, respondents from households that participated in only NGO interventions (65.45%) and both NGO and government interventions (52.6%) reported had participated in household-level decision-making relative to respondents from non-participant households (13.85%) and households that participated in only government interventions (17.98).

The average age of respondents was almost 40 years and the average household size in the combined data was almost 6 persons per household and almost half of the households' population was composed of females. The average dependent ratio for both participant and non-participant households was above 1. An average year of education was less than 6 years for all households and households cultivated 8 acres on average. Average crop revenue was high among households that participated in only NGO interventions (GHS1, 406.02) than other households. The average household expenditure was almost GHS2000 for all households. A Kruskal-Wallis test was conducted for the continuous independent variables and the result showed that except for household size, there was no significant difference in all independent variables for non-participant households and households that participated in only NGO, only government and both NGO and government interventions, hence, the data was pulled together for analysis. A correction test was conducted among independent variables and variables with high correction coefficients were excluded from the same models to avoid multicollinearity in the regressions.

The results showed that the majority of both NGO and government climate change interventions were into training farmers on climate-smart agricultural practices, sensitization, and advocacy, giving climate information, and delivering farm inputs. Most households (85%) and key informants (95%) perceived NGO interventions to be more effective in delivering project objectives than government interventions. Almost 90 percent of both NGO and government interventions are coherent with SDG 13 (climate action). However, most of the activities and

objectives of NGO interventions are more coherent with SDG 1 (zero poverty), SDG 2 (no hunger), and SDG 5 (gender equality and women empowerment) than government interventions.

Whereas households headed by females and the age of the household head have a significant negative effect on households' participation in only government interventions; access to information, membership with FBO, and participation in the household decision have a significant positive effect on households' participation in only government interventions. Also, participation in only NGO interventions is negatively influenced by a married household head, years of education, and age, but positively influenced by female household headship, access to information, membership with FBO and multiple groups, perceived effectiveness of an intervention, and participation in households' decisions. Participation in a household decision, membership with forest groups and FBO, and access to information have a significant positive effect on households' participation in both NGO and government climate change interventions while the age of the household head, marital status, and years of education have a significant negative effect on farm households' participation in both NGO and government climate change interventions.

The computed gender parity index (GPI) and women empowerment in the agricultural index (WEAI) revealed that women from non-participant and only government intervention participant households have not achieved gender parity with their men counterparts and are not empowered compared to women from

households that participated in only NGO and both NGO and government interventions. Households' participation in only government interventions has no significant effect on women's empowerment. But, households' participation in only NGOs and both NGO and government interventions have a significant positive effect on women's empowerment. Also, women's crop output, education, and engagements in off-farm activities have a significant positive effect on women's empowerment.

Participation in only government interventions significantly increases households' food expenditure share by 6.9 percent, households' hunger by 20 percent, and households' consumption expenditure by 14.5 percent, but has no significant effect on minimum dietary diversity for women. Conversely, participation in only NGO interventions reduces households' food expenditure share by 8 percent, and hunger by 64.5 percent, but increases minimum dietary diversity for women by 9 percent and consumption expenditure by 15.5 percent. Similarly, participation in both NGO and government interventions reduces household food expenditure share by 1.2 percent and hunger by 14.6 percent but increases minimum dietary diversity for women by 8.6 percent and consumption expenditure by 15.3 percent. Crop output and revenue, engagement in off-farm activities, dependency ratio, and type of locality also had significant effects on households' food expenditure share, hunger, minimum dietary diversity for women, and consumption expenditure.

9.3 Conclusion of the Study

The following conclusions are drawn from the key findings of the study:

1. Most climate change interventions are into sensitization, advocacy, and training of farm households on climate-smart agricultural practices. However, though government interventions have more coverage, more NGO interventions embark on these activities than government interventions.

2. The programme objectives and activities of NGOs-led climate change interventions are more coherent with SDGs, hence, contribute to the achievement of poverty reduction (SDG 1), reducing food insecurity (SDG 2), and gender equality and women empowerment (SDG 5) and effective in achieving programme objectives than government-led interventions. Both NGO and government-led interventions' objectives are highly coherent with SDG 13 (climate action). NGO interventions often have exit strategies before programme wrap–up. This consolidates interventions' achievements and ensures the sustainability of project gains/achievements than government-led interventions.

3. Farm households' participation in climate change interventions is positively influenced by group membership, access to information, perceived effectiveness of the intervention, and participation in the household's decision-making. However, the sex of the household head, age, and

education have significant negative effects on farm households' participation in climate change interventions.

4. Whereas participation in only government intervention has no significant effect on women's empowerment, participation in only NGO interventions and both NGO and government interventions significantly empower women of farm households. NGO interventions target women but government interventions have no strategic women inclusion strategies in their programmes. Also, women's education and engagement in off-farm income activities as well as unobserved factors such as cultural practices have a significant effect on women's empowerment.

5. Participation in only NGO or both NGO and government interventions improves farm households' food security. However, participation in only government interventions increases farm households' food insecurity. Households' food insecurity is also significantly influenced by households' dependency ratio, engagement in off-farm income, and crop outputs.

6. Finally, whereas participation in only NGO intervention and both NGO and government interventions increase farm households' consumption expenditure significantly, participation in only government intervention reduces farm households' consumption expenditure significantly. Thus, farm households' consumption expenditure is reduced when they participate in only government interventions but increased when they participate in either only NGO interventions or both NGO and government interventions.

9.4 Policy Implication and Recommendations of the Study

1. The study found that participation in either only NGO or both NGO and government interventions significantly improves farm households' women empowerment, food security, and consumption expenditure but not when households participate in only government interventions. The implication is that joint efforts from both government and non-government organisations are necessary for the efficient and effective utilization of technical and financial resources for climate change adaptation and mitigation. Thus, this study recommends that an effective NGO – government collaboration is required to ensure that the numerous interventions implemented in Northern Ghana remain relevant in reducing hunger, ensuring women's empowerment, and reducing poverty, and food and nutrition insecurity. However, this collaboration should be led by the NGO.
2. Given that group membership significantly influenced participation in climate change interventions, farm households, especially women are encouraged to form viable and active groups to foster their participation in especially NGO interventions.
3. Based on the conclusion that women's education and engagement in off-farm income generation activities improve women's empowerment and food security, it is recommended that climate change interventions should focus more on improving the education of farm households, especially women through the night school system and also assist

women to diversify their livelihood by engaging in other off-farm income generation activities.

4. The study revealed that most government interventions do not have criteria for women's inclusion and empowerment; it is recommended that future government climate change interventions should be redirected to focus on women's empowerment and gender equity, at the community level to achieve the SDGs on gender equity.

9.5 Contribution of the Study

This thesis assessed the extent to which governmental and non-governmental organizations' interventions are in tandem with Sustainable Development Goals and also their effectiveness in ameliorating the effects of climate change on livelihood outcomes (women empowerment, food security, and consumption expenditure). The contribution of the study to literature, policy, and development is outlined below:

- The thesis compared and contrasted the effectiveness of government and NGO climate change interventions, especially in Northern Ghana. Hence, it fills the gap in the literature on the difference in coherence to SDGs between government and NGO climate change interventions. The thesis contributes to the literature on climate change and livelihood nexus by examining the effect of government and NGO climate change interventions on women empowerment, food security, and wellbeing of farm households.

- The results from the study provide a guide to the Government of Ghana's clarion call for the "Ghana Beyond Aid" agenda. Government institutions need to be strengthened to ensure a successful implementation of the Ghana Beyond Aid agenda. The finding contributes to the evaluation and restructuring of climate change interventions to achieve desired sustainable development goals (SDGs). This thesis will serve as a reference document for reviewing the Ghana National Climate Change Master Plan Action Programmes.
- The finding of this thesis will redirect donor funding to areas that need urgent development attention and also more effective and efficient organizations' utilization of limited resources. This will ensure the achievement of global development goals

9.6 Suggestions for Future Studies

This thesis assessed the coherence of climate change interventions with SDGs and the effects of participation in selected governmental and non-governmental climate change interventions on women's empowerment, food security, and welfare using unbalanced three-period data. Agreeably, the study is particularly limited by its inability to estimate the average treatment effect of the treated because the data was not collected from the same respondents over the three survey periods. In the future, similar studies should use balanced panel data from more periods to establish the long-term impact of climate change interventions on farm households' livelihood outcomes.

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APPENDIX

Appendix A1: Validity Test of Instrument (Access to information)

Independent variables	**Outcome Variables**									
	Women empowerment		**Food Security**						**Consumption Expenditure**	
			MDD_W		**HHS**		**HFES**			
	Coeffic	**P > Z**	**Coeffic**	**P > Z-**	**Coeffic**	**P > Z**	**Coeffic**	**P > Z**	**Coeffi**	**P > Z**
Participation in intervention										
Only gov't	0.003 (0.030)	0.212	0.016 (0.056)	0.210	0.190 (0.041)	0.000	0.067 (0.030)	0.032	-0.142 (0.074)	0.009
Only NGO	0.117 (0.002)	0.002	0.088 (0.009)	0.007	-0.645 (0.047)	0.000	-0.078 (0.041)	0.025	0.152 (0.088)	0.012
Both NGO & gov't	0.125 (0.008)	0.000	0.086 (0.011)	0.009	-0.146 (0.052)	0.013	-0.012 (0.004)	0.047	0.151 (0.090)	0.014
Household female %	0.014 (0.013)	0.218								
Dependency ratio			-0.027 (0.233)	0.312	0.061 (0.003)	0.007	0.090 (0.004)	0.025	-0.170 (0.680)	0.526
Type of locality	0.296 (0.162)	0.071	-0.025 (0.012)		-0.023 (0.237)	0.102	0.003 (0.021)	0.342	0.012 (0.055)	0.453
Crop revenue									0.268 (0.085)	0.000
Crop output/index			0.012 (0.142)	0.464	-0.059 (0.032)	0.023	-0.037 (0.045)	0.206		

Independent variables	Outcome Variables									
	Women empowerment		Food Security						Consumption Expenditure	
			MDD_W		HHS		HFES			
	Coeffic	P > Z	Coeffic	P > Z	Coeffic	P > Z	Coeffic	P > Z	Coeffi	P > Z
Off-farm			0.031 (0.015)	0.239	0.044 (0.020)	0.041	0.020 (0.015)	0.147	0.162 (0.056)	0.003
Sex*education	0.037 (0.0.14)	0.008								
Sex*engagement in off-farm	0.123 (0.033)	0.000								
Sex*crop revenue	0.008 (0.013)	0.504								
Access to information	0.053 (0.070)	0.228	0.014 (0.025)	0.302	-0.011 (0.241)	0.419	-0.005 (0.244)	0.641	0.014 (0.021)	0.137
Constant	1.668 (0.409)	0.000	2.765 (0.410)	0.000	-1.913 (0.021)	0.000	-4.946 (1.341)	0.000	-0.051 (0.015)	0.006

Note:

Standard errors are in parentheses

Appendix A2: Results of VIF test for Multicollinearity

Variable	**VIF**	**1/VIF**
Sex of HHH	1.07	0.935
Age of HHH	1.90	0.526
Marital status	2.07	0.484
Access to information	2.66	0.376
Access to market	2.62	0.381
Years of education	1.16	0.864
Group membership	1.02	0.979
Perceived effectiveness	1.08	0.926
Participation in decision making	1.01	0.990
Mean VIF	1.62	0.617

Appendix B1: Mixed Multinomial Logit Regression Results on Determinants of Participation

Variable	Only gov't		Only NGO		Both gov't & NGO	
	Coeff	**P > Z**	**Coeff**	**P > Z**	**Coeff**	**P > Z**
Sex of HHH	-0.484	0.000	0.926	0.000	0.899	0.788
	(0.168)		(0.180)		(0.676)	
Age of HHH	-0.007	0.021	-0.021	0.004	-0.040	0.015
	(0.003)		(0.003)		(0.010)	
Marital status	-0.006	0.213	-0.154	0.005	-1.273	0.002
	(0.055)		(0.055)		(0.138)	
Access to information	0.183	0.081	0.811	0.041	0.124	0.036
	(0.156)		(0.178)		(0.014)	
Access to market	0.075	0.412	0.132	0.236	0.124	0.224
	(0.150)		(0.210)		(0.202)	
Education (years)	-0.010	0.127	-0.255	0.005	-0.072	0.053
	(0.014)		(0.015)		(0.041)	
Group Membership						
FBO	0.164	0.024	0.225	0.008	0.239	0.019
	(0.098)		(0.099)		(0.014)	
Forest group	0.100	0.342	1.121	0.000	1.215	0.042
	(0.321)		(0.310)		(0.613)	
Multiple groups	0.142	0.201	0.740	0.002	-0.205	0.242
	(0.222)		(0.257)		(0.693)	
Perceived effectiveness	-0.080	0.426	1.457	0.002	0.048	0.421
	(0.146)		(0.176)		(0.289)	
Participation in decision making	0.124	0.072	0.337	0.030	0.381	0.017
	(0.064)		(0.161)		(0.115)	
Constant	1.632	0.009	2.722	0.000	-5.048	0.000
	(0.411)		(0.414)		(1.341)	
Number of observation	5518					
Wald Chi^2	1854.00					
P – value	0.000					

Note: Standard errors are in parentheses

Appendix B2: METE Results on Treatment Effects of Participation in Intervention on Households' Women Empowerment

Treatment and independent variables	WEAI as continuous			WEAI as dummy		
	Coeffici	Std Error	P > Z	Coeffici	Std Error	P > Z
Participation in interventions						
Only gov't	0.003	0.030	0.212	0.008	0.013	0.235
Only NGO	0.118	0.002	0.002	0.073	0.011	0.006
Both NGO and gov't	0.125	0.008	0.000	0.661	0.026	0.000
Sex*Education	0.038	0.013	0.008	0.028	0.007	0.023
Sex*Engagement in off-farm	0.122	0.031	0.000	0.098	0.012	0.015
Sex*Crop revenue	0.008	0.013	0.504	0.010	0.012	0.543
Type of locality	0.293	0.161	0.072	0.237	0.205	0.195
Household female %	0.013	0.013	0.217	0.011	0.021	0.320
Constant	1.668	0.409	0.000	1.233	0.321	0.003
/lambda_only gov't	0.014	0.003	0.042	0.069	0.010	0.047
/lambda_only NGO	-0.015	0.002	0.008	-0.050	0.013	0.102
/lambda_Both NGO & gov't	-0.021	0.062	0.391	-0.001	0.007	0.424
/lnsigma	-3.262	0.032	0.000	-1.918	0.027	0.000
Number of observations	5518			5518		

Appendix B3: METE Results on Treatment Effects of Participation in Intervention on Households' Food Expenditure Share

Treatment and independent variables	**HFES (%)**			**HFES (Dummy)**		
	Coeffi	**Std Error**	**P > Z**	**Coeffi**	**Std Error**	**P > Z**
Participation in interventions						
Only gov't	0.069	0.031	0.032	0.254	0.083	0.006
Only NGO	-0.080	0.041	0.025	-0.436	0.089	0.000
Both NGO and gov't	-0.012	0.004	0.047	-1.288	0.086	0.000
Dependency ratio	0.091	0.004	0.024	0.024	0.010	0.071
Off-farm	0.022	0.014	0.145	0.042	0.032	0.216
Crop index	-0.033	0.044	0.204	0.01	0.032	0.233
Type of locality	0.003	0.020	0.341	0.010	0.031	0.392
Constant	-4.957	1.341	0.000	-1.423	0.180	0.005
/lambda_only gov't	-0.002	0.028	0.201	-0.075	0.055	0.290
/lambda_only NGO	-0.171	0.041	0.004	0.761	0.063	0.000
/lambda_Both NGO and gov't	0.102	0.044	0.014	-0.434	0.061	0.005
/lnsigma	-2.215	0.213	0.000	-0.961	0.171	0.000
Number of observations	8706			8707		

Appendix B4: METE Results on Treatment Effects of Participation in Intervention on Households' Minimum Dietary Diversity for Women

Treatment and independent variables	MDD_W (Continuous)			MDD_W (Dummy)		
	Coefficie	Std Error	P > Z	Coefficie	Std Error	P > Z
Participation in interventions						
Only gov't	0.018	0.056	0.210	0.078	0.063	0.285
Only NGO	0.090	0.009	0.007	1.524	0.044	0.004
Both NGO and gov't	0.086	0.011	0.009	0.877	0.044	0.000
Dependency ratio	-0.027	0.233	0.312	0.128	0.112	0.345
Off-farm	0.029	0.016	0.237	0.014	0.092	0.294
Crop index	0.012	0.142	0.462	0.032	0.231	0.490
Type of locality	-0.025	0.012	0.048	-0.013	0.009	0.044
Constant	2.772	0.411	0.000	0.213	0.002	0.003
/lambda_only gov't	-0.148	0.002	0.001	0.070	0.022	0.000
/lambda_NGO	-0.070	0.001	0.006	-0.963	0.012	0.000
/lambda_Both NGO and gov't	0.086	0.011	0.004	-0.182	0.026	0.005
/lnsigma	-4.613	0.328	0.000	-2.714	0.188	0.000
Number of observations	8707			8707		

Appendix B5: METE Results on Treatment Effects of Participation in Intervention on Households' Hunger Scores (HHS)

Treatment and independent variables	HHS (Continuous)			HHS (Dummy)		
	Coeffici	Std Error	P > Z	Coeffici	Std Error	P > Z
Participation in interventions						
Only gov't	0.200	0.041	0.000	0.047	0.007	0.021
Only NGO	-0.645	0.047	0.000	-0.251	0.082	0.003
Both NGO and gov't	-0.146	0.052	0.011	-0.163	0.045	0.033
Dependency ratio	0.063	0.0.003	0.007	0.102	0.008	0.021
Off-farm	0.047	0.020	0.041	0.120	0.413	0.124
Crop index	-0.061	0.032	0.023	-0.230	0.104	0.058
Type of locality	-0.025	0.237	0.101	-0.182	0.216	0.136
Constant	-1.916	0.024	0.000	0.069	0.010	0.002
/lambda_only gov't	-0.011	0.027	0.403	-0.109	0.094	0.312
/lambda_NGO	-0.312	0.039	0.003	-0.242	0.019	0.004
/lambda_Both NGO & gov't	0.286	0.048	0.005	0.172	0.032	0.028
/lnsigma	-1.644	0.090	0.000	-12.014	0.812	0.000
Number of observations	8708			8708		

Appendix B6: METE Results on Treatment Effects of Participation in Intervention on Households' Consumption Expenditure

Treatment and independent variables	Coefficient	Std Error	P > Z
Participation in interventions			
Only government	-0.145	0.075	0.009
Only NGO	0.155	0.088	0.011
Both NGO and government	0.153	0.091	0.013
Dependency ratio	-0.170	0.681	0.524
Off-farm	0.163	0.057	0.003
Crop revenue	0.277	0.086	0.000
Type of locality	0.011	0.055	0.453
Constant	-0.050	0.014	0.006
/lambda_only gov't	0.381	0.041	0.000
/lambda_only NGO	-0.392	0.074	0.000
/lambda_Both NGO and gov't	-0.189	0.066	0.004
/lnsigma	-0.082	0.054	0.007
Number of observations	8707		

IMPLICATIONS OF PARTICIPATION IN CLIMATE CHANGE INTERVENTIONS ON WOMEN EMPOWERMENT AND LIVELIHOOD OUTCOMES OF FARM HOUSEHOLDS IN NORTHERN GHANA

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